Appendix E

Geotechnical Report

Geotechnical Investigation and Pavement Assessment Report For the Proposed Widening of Mayfield Road Between Chinguacousy Road and

December 2013

Prepared for:
Regional Municipality of Peel
10 Peel Centre Drive
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Project No. 101-17262-00

GENIVAR

Project No. 101-17262-00

December 2, 2013

Mr. Neal Smith
Regional Municipality of Peel
10 Peel Centre Drive
Suite B, 4th Floor
Brampton, Ontario L6T 4B9

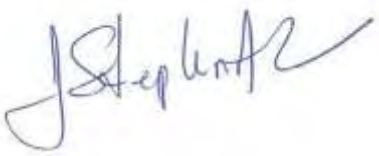
Re: Geotechnical Investigation and Pavement Assessment Report
For the Proposed Widening of Mayfield Road Between Chinguacousy Road and Heart Lake Road, Region of Peel, Ontario

Dear Mr. Smith:

We are pleased to submit our Geotechnical Investigation and Pavement Assessment Report for the proposed widening of Mayfield Road between Chinguacousy Road in the west to Heart Lake Road in the east. The report is based on information obtained from a site visit, a borehole investigation and a laboratory testing program completed in March, 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.



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1. Introduction

GENIVAR Inc. (GENIVAR) was retained by the Regional Municipality of Peel (Region) to carry out a geotechnical investigation and pavement assessment report for the proposed 5.6 km widening of Mayfield Road by the year 2031, between Chinguacousy Road in the west and Heart Lake Road in the east, in the Region of Peel, Ontario as part of Mayfield Road Environmental Assessment project. A Site Location Map is attached as Figure 1.

The scope of work is summarized below:

- Review of existing geotechnical investigation reports for Mayfield Road provided to us by the Region.
- Preliminary geotechnical pavement investigation along the proposed widening of Mayfield Road by means of drilling boreholes on selected locations.
- Pavement Condition Survey including Ride Quality Index and Distress Manifestations for Mayfield Road between Chinguacousy Road in the west and Heart Lake Road in the east,

It is understood that Mayfield Road will be widened as follows:

- From Chinguacousy Road to Hurontario Street, Mayfield Road will be widened from 2 lanes to 4 lanes by year of 2021 and from 4 lanes to 6 lanes by year of 2031,
- From Hurontario Street to Heart Lake Road, Mayfield Road will be widened from 4 lanes to 6 lanes by year of 2021.

It should be noted that the geotechnical investigation conducted for this study is preliminary investigation. Further and more comprehensive geotechnical investigation will be needed for the detailed design.

The purpose of the geotechnical investigation was to obtain information about the subsurface conditions by advancing boreholes at twenty five (25) locations drilled along Mayfield Road at the edge of the pavement and ditch along the proposed widening. Subsurface conditions were assessed using semi-empirical methods to provide design recommendations for the pavement structure of the road and to describe the requirements for excavations, backfill, lateral 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 recommendations 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 Peel and its designers. Third party use of this report without GENIVAR consent is prohibited.

2. Review of Historic Technical Data

Various geotechnical investigations have been conducted along the subject portion of Mayfield Road between 2003 and 2008. This section provides a brief overview of the purpose and scope of the studies. Results and recommendations are presented in the following sections of this report.

The following historic geotechnical reports were provided by the Region of Peel and provide relevant background subsurface information for the site:

- Geotechnical and Foundation Investigation Report for Widening Mayfield Road between Hurontario Street to Heart Lake Road, Region of Peel, Ontario, Thurber Engineering Ltd. (July 2003).
- Geotechnical Investigation for Proposed Watermain along Mayfield Road between Hurontario Street and Heart Lake Road, Region of Peel, Ontario, John Emery Geotechnical Engineering Limited (July 2005).
- Supplementary Geotechnical Investigation for Proposed Widening of Mayfield Road between Hurontario Street and Heart Lake Road, Region of Peel, Ontario, Thurber Engineering Ltd. (July 2005).
- Additional Geotechnical Investigation of Mayfield Road, Wetland 1, 2 and 3 between Hurontario Street and Heart Lake Road, Region of Peel, Ontario, Thurber Engineering Ltd. (February 2007).
- Additional Geotechnical Investigation for Mayfield Road Widening – Wetland 1, Brampton, Region of Peel, Ontario, Thurber Engineering Ltd. (July 2008).
- The above reports provide an overview of the subsurface conditions encountered within the subject study area of Mayfield Road between McLaughlin Drive and Heart Lake Road.

The following section is a summary of the subsurface conditions based on the pervious geotechnical investigations.

2.1 Mayfield Road from McLaughlin Drive to Hurontario Street

In summary, the depth of topsoil at the borehole locations adjacent to the roadway was observed to be approximately 100 mm to 200 mm; and the asphalt thickness of the road ranged from 100 mm to 200 mm. For the boreholes drilled on the road, a granular base material consisting of sandy gravel was encountered below the asphalt and ranged in thickness between 300 mm and 700 mm. A fill layer of silty clay was encountered below the topsoil or pavement structure in a number of the boreholes, to depths ranging from 0.8 m to 1.8 m. The native subsoil encountered below the fill layer at the borehole locations was generally confirmed to consist of stiff to very stiff silty clay to clayey silt till which extended to bedrock. Weathered Queenston Shale bedrock was encountered in a few boreholes located between McLaughlin Drive and the CP rail track at depths ranging between 2.5 m and 6.0 m below the surface of the road.

Groundwater conditions observed in the open boreholes during drilling and records from installed piezometers indicate that the groundwater level is between 4.0 m and 5.0 m below the ground surface.

2.2 Mayfield Road from Hurontario Street to Kennedy Road

The embankment fill within this section consists of asphalt ranging in thickness from 75 mm to 150 mm, with an average thickness of 125 mm. This asphalt is underlain by 475 mm to 920 mm of granular fill. The shoulder of this section consists of granular material ranging in thickness from 600 mm to 1500 mm.

The native soil within this section is generally clayey silt till and is encountered below the embankment fill. Weathered Queenston Shale bedrock was encountered in some of the deep boreholes, indicating that the shale bedrock is about 30 m below the ground surface.

Boreholes were drilled in the vicinity of Snelgrove Bridge indicated a fill layer at 1.4 m to 2.9 m depth, underlain by recent alluvial strata between 1.5 m and 2.0 m in thickness. The alluvial soil overlies native clayey silt deposits that extend down to bedrock at about 30 m depth below the ground surface.

Groundwater conditions observed in the open boreholes during drilling and records from installed piezometers within this section indicate that the groundwater level is between 2.0 m to 6.0 m below the ground surface, but generally at 4.0 m depth.

2.3 Subsurface Condition: Kennedy Road to Heart Lake Road

The embankment fill within this section consists of asphalt ranging from 150 mm to 300 mm thick, average 245 mm. The asphalt is underlain by 460 mm to 920 mm of granular fill. The shoulder of this section consists of granular material ranging from 610 mm to 760 mm in thickness. The native subsoil encountered at the borehole locations generally consisted of clayey silt to silt some clay.

Groundwater conditions observed in the open boreholes during drilling and based on piezometer installation records for this section indicate that the groundwater level is between 2.0 m to 6.0 m below the ground surface, but generally at 4.0 m depth.

It should be noted that a high fill road embankment, about 400 m west of Heart Lake Road, will need further borehole investigation both on the north and south side of Mayfield Road, to assess the geotechnical capabilities and settlement characterization of the soil beneath the proposed high embankment.

2.3.1 Subsurface Condition: Wetlands

Three major wetland areas are encountered below and along Mayfield Road between Kennedy Road and Heart Lake Road as follows:

- Wetland 1 - North side of Mayfield Road east of Kennedy Road (approximately from Station 11+508 to 11+758.

Within the intersection of Mayfield Road and Kennedy Road, pavement structures and fill of up to 4.5 m in thickness overlie approximately 2.2 m of peat that extends across the width of the Mayfield Road embankment. Beyond, the peat thickness appears to taper off in the north and south directions. Below the peat, a layer of firm clayey silt to firm or loose silt with some clay was encountered with thickness ranging from 2.0 m to 3.0 m. The silt becomes stiffer with depth.

Groundwater is assumed to essentially coincide with the ground surface in the wetland area.

The loose and compressible peat soils were encountered to significant depth in this area and, therefore, the Mayfield Road crossing of the wetland area was constructed by replacing the peat with 0.4 MPa concrete filler caissons 2.5 m to 12.5 m deep. The north side of the road embankment was shored using sheet piles, steel piles and anchor tiebacks.

- Wetland 2 - near culvert crossing under Mayfield Road located approximately 400 m west of Heart Lake Road (approximately from Station 12+308 to 12+458).

In general, the subsurface conditions at this location consist of surficial compact/firm sandy to clayey silt fill overlying a layer of peat and organic silt which ranged between 0.2 m and 1.4 m in thickness. The peat/organic soil is underlain by native loose to compact sandy silt to sand.

Groundwater is assumed to essentially coincide with the ground surface in the wetland area.

- Wetland 3 - South side of Mayfield just west of Heart Lake Road.

The pavement structure of the existing roadway in the Wetland 3 area is underlain by fill to about 4.0 m depth, which is in turn underlain by a fine fibrous to amorphous peat layer with a thickness of between 2.0 m and 2.5 m. The peat extends to about 6 m to 8 m below existing grade, and appears to decrease beyond the existing road shoulders. The fill material generally consists of dense to compact sand overlying stiff silty clay. The peat typically has a soft to firm consistency. A 1.0 m thick layer of very soft organic silt was found underlying the peat in some of the boreholes. Clayey silt to silty clay till of typically stiff to very stiff consistency underlies the entire site area.

Groundwater is assumed to essentially coincide with the ground surface in the wetland area.

3. Investigation Methodology

3.1 Borehole Investigation

Fieldwork for the project was carried out between March 1st and 2nd, 2012. A total of twenty five (25) boreholes, designated as BH1 to BH10 and D1 to D15, were drilled along the proposed widening of Mayfield Road, including ten (10) boreholes (BH1 to BH10) drilled on the edge of the pavement to depths ranging between 2.1 m and 3.1 m below the road surface, and fifteen (15) boreholes (D1 to D15) drilled along the ditch area to depths of between 0.6 m to 0.9 m below ground surface. Borehole Location Plans are presented as Figures 2A to 2E.

It should be noted that five boreholes planned for the westbound lane of Mayfield Road, at the edge of the pavement between Kennedy Road and Heart Lake Road, could not be drilled due to the presence of two untraced watermain pipes in the area. GENIVAR cancelled the drilling of these boreholes as per the recommendations of the Region of Peel's stake out report.

Boreholes at the edge of the pavement 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 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 non-cohesive materials.

The boreholes drilled in the ditch area were advanced using portable hand augering equipment due to the limited access to the ditch area when using the truck-mounted drill rig.

Soil samples were logged in the field and returned to the GENIVAR laboratory for detailed examination by the Project Engineer and for selected laboratory testing.

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

4. Site and Subsurface Conditions

Mayfield Road within the study area is currently situated at the edge of development within the City of Brampton. Most of the area south of Mayfield Road is developed, except between McLaughlin and Chinguacousy, where agricultural land use dominates. To the north, land use is mostly agricultural, with the exception of Snelgrove, located in the vicinity of Hurontario Street. A significant portion of the land between Kennedy Road and Heart Lake Road is covered by wetlands.

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 consisting of asphalt, upper granular base and lower granular subbase, underlain mostly by native silty clay to clayey sandy silt. Descriptions of individual stratigraphic units are as follows.

4.1 Topsoil

A layer of topsoil was encountered at the surface of all the boreholes drilled in the ditch area (D1 to D15). The thickness of the topsoil varied between 75 mm at borehole D10 to 250 mm at borehole D5. The estimated average thickness of the topsoil layer is 150 mm.

A 100 mm thick layer of buried topsoil was encountered beneath the sand and gravel fill at borehole D6, at a depth of 0.3 m below ground surface.

4.2 Existing Pavement Structure

A pavement structure was encountered at the surface of the boreholes drilled at the edge of the road (BH1 to BH10). The pavement consists of an asphalt layer with a thickness ranging from 115 mm at borehole BH10, to 255 mm at boreholes BH1 and BH2. The asphalt layer was underlain by an upper granular base with a thickness ranging from 100 mm at boreholes BH1 and BH2, to 240 mm at borehole BH5, and a lower granular sub-base with a thickness varying between 100 mm in boreholes BH1 and BH2 and 430 mm in borehole BH9.

A summary of the existing pavement structure at the borehole locations is presented in Table 4.1 below:

Table 4.1: Existing Pavement Structure

Pavement Component	No. of Observations	Thickness (mm), Range	Thickness (mm), Mean
Hot Mix Asphalt	10	115-255	170
Granular Base Material	10	100-240	155
Granular Subbase Material	10	100-430	265

Three samples of the granular base material were tested for particle size distribution. Laboratory test results indicate that two samples of granular base taken from boreholes BH6 and BH8, were within the acceptable limits for Granular “A” (OPSS 1010), and one sample of the granular base taken from borehole BH3 was out of the acceptable limits for Granular “A”. It is noted that borehole size samples of aggregate are not sufficient for standardized laboratory tests according to ASTM and MTO/LS criteria, and if necessary should be verified using appropriate bulk-size samples.

The particle size distribution analyses for the three samples of the granular base are provided as Figures B1 to B3 in Appendix B, with results summarized as follows (MIT Scale):

Gravel (>2 mm size):	50 - 61%
Sand (0.06 mm to 2 mm size):	31 - 37 %
Silt and Clay (< 0.06 mm size):	6 - 12 %

In addition, three samples of the granular subbase material were tested for particle size distribution. Laboratory test results indicate that the granular subbase samples were within the acceptable limits for Granular “B” Type I (OPSS 1010), as shown in Figures B4 to B6 in Appendix B, with results summarized as follows (MIT Scale):

Gravel (>2 mm size):	52 - 65 %
Sand (0.06 mm to 2 mm size):	26 - 40 %
Silt and Clay (< 0.06 mm size):	8 - 10 %

4.3 Fill: Silty Sand\Sand\Sand and Gravel\Clayey Silt

A fill material consisting of silty sand to sand and gravel, with a thickness of approximately 200 mm, was encountered beneath the topsoil layer at boreholes D13 and D15. Clayey silt to sand and gravel fill also was encountered beneath the pavement structure at borehole BH4, at 0.6 m depth extending to 1.2 m depth below the road surface.

Standard Penetration Test N values for the fill were 12 blows per 305 mm of penetration at BH4, indicative of compact relative density.

4.4 Organic Clayey Silt

An organic layer of greenish-grey to dark grey clayey silt was encountered below the topsoil at borehole D1, and beneath the granular subbase or fill at boreholes BH3, BH4, BH6 and BH7.

The thickness of the organic layer ranged between 0.2 m and 0.5 m, except at borehole BH7 where the organic clayey silt was encountered at 0.5 m depth and extending to 2.7 m depth below the road surface.

SPT N values in the organic clayey silt layer ranged between 8 to 14 blows per 305 mm of penetration, and indicate a firm to stiff consistency.

Based on laboratory tests, the moisture content of samples taken from this layer ranged between 25% and 30% (by weight).

4.5 Native: Clayey Silt to Clayey Sandy Silt Till

A layer of native clayey silt to clayey sandy silt glacial till was encountered in all of the drilled boreholes except for borehole D14. The clayey silt to clayey sandy silt or sandy clayey silt till was encountered beneath the topsoil or pavement structure of the road, and below the organic clayey silt layer, and extended to borehole termination depths.

A particle size distribution analysis was performed on three selected samples of the native clayey silt to clayey sandy silt till, and results provided as Figures B7 to B9 of Appendix B are summarized as follows (MIT Scale):

Gravel (>2 mm size):	1 - 5 %
Sand (0.06 mm to 2 mm size):	17 - 27 %
Silt (0.002 mm to 0.06 mm size):	46 - 51 %
Clay(<0.002 mm size):	21 - 31%

Standard Penetration Test N values for the clayey sandy silt ranged between 10 and 27 blows per 305 mm of penetration, indicative of stiff to very stiff consistency.

Two samples from the deposit were tested in the laboratory for Atterberg limits. Results are provided as Figure B10 (Atterberg Limits Plasticity Chart) in Appendix B, and are summarized as follows:

Liquid Limit (LL)	26 – 29 %
Plastic Limit (PL)	11 – 19 %
Plasticity Index (PI)	10 – 15 %

From the plasticity chart (Unified Soil Classification Chart) both samples may be classified as inorganic silt and clay with low plasticity (CL).

Moisture content for the clayey silt to clayey sandy silt samples ranged from 12% to 22% based on laboratory tests, indicating moisture content drier than the plastic limit at most of the borehole locations, and at plastic limit to wetter than the plastic limit in boreholes where organic soils exist.

4.6 Native: Sandy Silt

A layer of sandy silt was encountered beneath the topsoil at borehole D14, extending to the borehole termination depth of 0.6 m below ground surface.

4.7 Groundwater Conditions

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

During drilling and at the completion of drilling, significant free groundwater was not encountered in any drilled boreholes. This indicates that the groundwater level at the time of our investigation was typically below the exploration depth.

From the background information, the groundwater table along Mayfield road can be expected at depths ranging from 4.0 m to 6.0 m below the ground surface, except for wetland areas where the groundwater level is assumed to essentially coincide with the ground surface in the wetland.

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

5. Recommendations

We understand that a widening of approximately 5.6 km of Mayfield Road is proposed, between Chinguacousy Road in the west and Heart Lake Road in the east, in the Region of Peel, as part of the Mayfield Road Environmental Assessment project. It is understood that Mayfield Road widening will be as follows:

- From Chinguacousy Road to Hurontario Street, Mayfield Road will be widened from 2 lanes to 6 lanes,
- From Hurontario Street to Heart Lake Road, Mayfield Road will be widened from 4 lanes to 6 lanes.

In general, the subject soil investigation shows a pavement structure consisting of asphalt, an upper granular base and a lower granular subbase, underlain by stiff clayey silt to clayey sandy silt native soils. An organic clayey silt layer was encountered at several locations, and three major wetland areas exist in the area between Kennedy Road and Heart Lake Road.

During drilling and at the completion of drilling, groundwater was not found in any of the boreholes, indicating that groundwater was below a depth of 3.0 m, except for the wetland areas where the groundwater level is assumed to essentially coincide with the ground surface of the wetland.

5.1 Road Classification and Traffic Data

Mayfield Road between Chinguacousy Road and Hurontario Street is currently classified as an undivided Rural Major Arterial Road and Mayfield Road between Hurontario Street and Heart Lake Road is classified as an undivided Urban Major Arterial Road. The classification of Mayfield Road in 2031 between Chinguacousy Road and Heart Lake Road will be a Divided Urban Major Arterial Road with traffic volumes AADT, and % Commercial as presented in Table 5.1

Table 5.1: Traffic Volume and Commercial Percentage

Mayfield Road Section	AADT Projected 2031	% Commercial
Mayfield Road from Chinguacousy Road to Hurontario Street	39,800	15
Mayfield Road from Hurontario Street to Heart Lake Road	46,200	15

5.2 Equivalent Single Axle Loads (ESAL's)

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 widening.

Table 5.2: Input Parameters for ESAL Calculations

AADT (2031)	Avg. Truck Factor	DD[3]	LD[4]	Design No. Of Days per Year	Design Period (Year)	Cumulative ESAL's
39,800[1]	1.925	0.5	0.8	365	20	33,557,300
46,200[2]	1.925	0.5	0.6	365	20	29,215,100

1. AADT for Mayfield Road between Chinguacousy Road and Hurontario Street for projected year=2031
2. AADT for Mayfield Road between Hurontario Street and Heart Lake Road for projected year=2031
3. Directional Distribution
4. Lane Distribution

5.3 Pavement Thickness Design

Pavement structure thickness design for the widening 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 very stiff clayey silt or clayey sandy silt, except for the wetland areas where peat and organic soils were encountered.

Input parameters for the pavement design are shown in Table 5.3 below, and the design output sheets from WinPAS analysis software are presented in the Appendix C.

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 5.2
Cumulative ESAL's	
Mayfield Road from Chinguacousy Road to Hurontario Street	25,168,000
Mayfield Road from Hurontario Street to Heart Lake Road	29,215,100
Subgrade Resilient Modulus (M_R)	
Mayfield Road from Chinguacousy Road to Hurontario Street	30 MPa
Mayfield Road from Hurontario Street to Heart Lake Road	20 MPa
Structural Coefficients ('a' values)	New HMA[1]=0.42 New Base(Gran A)=0.14 New Subbase(Gran B Type I)=0.09
Drainage Coefficient	m= 1.0 (for all typical situations involving new designs and standard drainage features, e.g., adequate ditching, 3% transverse slope on subgrade, adequate day lighting or subdrains)
Reliability and Standard Deviation	R= 90%; SD=0.49

1- HMA = Hot mix asphalt

The required pavement structure for the road widening, based on the MTO routine and AASHTO design methods, for the input parameters noted in Table 5.3 and considering stiff clayey silt to clayey sandy silt subgrade, is shown in Table 5.4 below.

Table 5.4: Pavement Design Summary

Design Methodology	Material Thickness (mm)	SN*	GBE**(mm)
MTO Routine	130 mm hot mix, 150 mm Granular A, 600 mm Granular B Type I	130	810
AASHTO Mayfield Road from Chinguacousy Road to Hurontario Street	180 mm hot mix, 150 mm Granular A, 750 mm Granular B Type I	164	1010
AASHTO Mayfield Road from Hurontario Street to Heart Lake Road	220 mm hot mix, 150 mm Granular A, 830 mm Granular B Type I	188	1143

*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. Therefore, AASHTO results were used as a guideline for layer thickness determination.

5.4 Pavement Recommendations

5.4.1 Road Widening

On the basis of the above analysis, and to facilitate subsurface drainage, the following pavement structure is recommended for the widening and reconstruction of:

Mayfield Road from Chinguacousy Road to Hurontario Street

Excavate from the edge of the existing pavement to provide for:

- **40 mm HL3 or HL1 surface course asphalt concrete** compacted to 97% of the Bulk Relative Density (BRD).
- **140 mm HL8 binder course asphalt concrete**, 40 mm upper binder course, 50 mm middle binder course , and 50 mm lower binder course), compacted to 97% of the Bulk Relative Density (BRD).
- **150 mm Granular A base course** (or 130 mm, 20 mm Crusher Run Limestone), compacted to 100% of the Standard Proctor Maximum Dry Density (SPMDD).
- **750 mm Granular B Type I subbase course,** compacted to 100% of SPMDD.

Mayfield Road from Hurontario Street to Heart Lake Road

Excavate from the edge of the existing pavement to provide for:

- **40 mm HL3 or HL1 surface course asphalt concrete,** compacted to 97% of the Bulk Relative Density (BRD).
- **180 mm HL8 binder course asphalt concrete, 60 mm upper binder course, 60 mm middle binder course, and 60 mm lower binder course,** compacted to 97% of the Bulk Relative Density (BRD).
- **150 mm Granular A base course (or 130 mm, 20 mm Crusher Run Limestone),** compacted to 100% of SPMDD.
- **830 mm Granular B Type I subbase course,** compacted to 100% of SPMDD.

The construction of the Hot Mix Asphalt should be compacted in accordance with the requirement of OPSS 310 Construction Specification for Hot Mix Asphalt. Prior to roller compaction, obvious defects in the HMA material placed must be corrected.

A tack coat should be applied between the binder course and surface course asphalt layers. Binder courses must not be placed unless the air temperature at the surface of the road is a minimum of 2°C and rising. Surface course must not be placed unless the air temperature at the surface of the road is at least 7°C and rising.

All materials must meet the latest OPSS specifications and or MTO specifications. All topsoil, fill materials, peat and organic materials, and any unsuitable materials anticipated along the widening road should be excavated and removed off site.

5.4.2 Pavement Reconstruction

Based on the visual inspection and the field investigation, the following road sections will need full reconstruction for the entire pavement area to provide a uniform pavement structure:

- Mayfield Road (from Station 7 +208 to Station 8 +708): Mayfield Road, from Chinguacousy Road to 50 m east of McLaughlin Road;
- Mayfield Road (from Station 8 +708 to Station 9 +808): Mayfield Road, from 50 m east of McLaughlin Road to 250 m west of Hurontario Street;

The road section from Station 8+708 to Station 9+808 has fair pavement condition with intermittent moderate to frequent slight cracking and intermittent slight to moderate alligator cracking and dishing with fair rideability and a slightly rough and uneven surface. Mayfield Road from Chinguacousy Road to 50 m east of McLaughlin Road (Station 7+208 to Station 8+708) has good pavement condition, with very slight or slight cracking, but full reconstruction will be needed to remove the organic clayey silt layer encountered beneath the existing pavement structure found at several of the borehole locations.

Reconstruction should be performed as follows:

- Mill or remove existing asphalt to the full depth;
- Excavate existing granular base and subbase to the full depth;
- Excavate any organic silty clay layer may encounter below the excavated pavement structure;
- Excavate for new ditches as per OPSD 200.010;
- Perform backfill with excavated granular materials or new OPSS Granular B Type I;

For Mayfield Road from Station 7+208 to Station 9+758, place new pavement structure as follows:

- **40 mm HL3 or HL1 surface course asphalt concrete** compacted to 97% of the Bulk Relative Density (BRD).
- **140 mm HL8 binder course asphalt concrete**, 40 mm upper binder course, 50 mm middle binder course , and 50 mm lower binder course), compacted to 97% of the Bulk Relative Density (BRD).
- **150 mm Granular A base course** (or 130 mm, 20 mm Crusher Run Limestone), compacted to 100% of the Standard Proctor Maximum Dry Density (SPMDD).
- **750 mm Granular B Type I subbase course,** compacted to 100% of SPMDD.

For Mayfield Road from Station 11+308 to Station 12+108, place new pavement structure as follows:

- **40 mm HL3 or HL1 surface course asphalt concrete** compacted to 97% of the Bulk Relative Density (BRD).
- **180 mm HL8 binder course asphalt concrete, 60 mm upper binder course, 60 mm middle binder course, and 60 mm lower binder course),** compacted to 97% of the Bulk Relative Density (BRD).

- **150 mm Granular A base course (or 130 mm, 20 mm Crusher Run Limestone),** compacted to 100% of SPMDD.
- **830 mm Granular B Type I subbase course,** compacted to 100% of SPMDD.

5.4.3 Pavement Rehabilitation

The following road sections have good to excellent pavement condition with very slight or slight cracking with excellent to good Ride Condition:

- Mayfield Road (from Station 9+808 to Station 11+308): Mayfield Road, from 250 m west of Hurontario Street to 150 m west of Kennedy Road;
- Mayfield Road (from Station 11+308 to Station 12+108): Mayfield Road, from 150 m west of Kennedy Road to 700 m west of Heart Lake Road;
- Mayfield Road (from Station 12+108 to Station 12+808: Mayfield Road, from 700 m west of Heart Lake Road (Property # 3742) to Heart Lake Road.

Thus, rehabilitation instead of reconstruction is recommended in conjunction with the road widening operations. Several pavement rehabilitation options such as pulverization to full depth, asphalt removal and mill, full depth reclamation with pre-milling, and full depth reclamation without pre-milling could be considered. Detailed investigation for the existing pavement structure will be needed to establish the most feasible rehabilitation method considering the minimum required structural number (SN = 188).

5.4.4 Stripping, Sub-excavation and Grading

Based on conditions encountered at the boreholes (except in the wetland areas), the proposed subgrade will consist of a variety of soils ranging from granular fill to stiff to very stiff clayey silt. It is expected that local perched groundwater may be encountered during wetter periods.

All the stripping, sub-excavation and grading should be performed in accordance with the requirement of OPSS 206 Construction Specification for Grading.

The site should be stripped of all topsoil, loose fill and any organic or otherwise unsuitable soils to the full depth of the roads, 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 mass 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), as per ASTM D698 procedures. 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 sub-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 be required.

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 98% of SPMDD, or as per MTO or Municipal Standards. The compaction of the new fill should be checked by frequent field tests. It should be noted that only one sample from the existing granular base material was found not to be within Ontario Provincial Standard Specifications for gradation (OPSS 1010).

This can be used as Granular "B" Type I material. The existing Granular subbase is approved Granular "B" Type I as per OPSS 1010, and therefore it can be used as approved backfilling material.

5.4.4.1 Stripping, Sub-excavation in Wetland Areas

In the three wetland areas where peat deposits were encountered to significant depth, it will be necessary to remove this soft, compressible material from below the proposed road widening.

Detailed field investigation will be required in the future for the detailed design, to thoroughly investigate the wetland area and to establish the depth and the extent of the peat layers.

It is recommended that the embankment widening be carried out in accordance with the requirement of OPSS 209 Construction Specification for Embankment over Swamp and Compressible Soils. It is recommended that the excavation be backfilled as close behind excavation as practical. To protect the existing roadway from possible undermining and instability, no more than a 10 m length of excavation should be open and not backfilled at any time.

If deeper excavation is required to address thicker layers of peat and organic soil, temporary support of the excavation side slopes and adjacent roadway will be necessary, as well as backfilling with properly placed, approved fill material. Additionally, the excavation will need to be of sufficient width to provide proper lateral support for the road embankment. Since it is not considered practical to dewater the wetland area where the groundwater table is expected to be at or near surface, it will not be possible compact the backfill placed up to the existing ground level in the wetland. Consequently, the fill below the existing ground level should consist of material, such as clear stone or rock fill, that does not require heavy mechanical compaction. It is recommended that rock fill be used below the water level. The top of the rock fill layer will be covered by geotextile to prevent the migration of the fines from the backfill material overlying the rock fill.

5.4.4.2 Road Widening Crossing Wetland Area 1

The widening of Mayfield Road crossing wetland area 1 located north side of Mayfield Road and just east of Kennedy Road where peat deposits, loose and compressible soils were encountered to significant depth in this area. At the preliminary design stage, several options could be considered for the road crossing wetland area 1 as follows:

- Replace the peat deposit and the underlying loose and compressible soils with 0.4 MPa filler caissons to various depths depending on the thickness of the peat and compressible soil layer within the footprint of the road widening. In addition, shoring should be provided along the north edge of the new embankment using sheet piles and supported by H- piles and anchor tiebacks. It is our opinion that this option is the most recommended option since the existing road was constructed over concrete caissons and therefore will form an integrated foundation for the road that should reduce differential settlement potential.

- Excavate only the peat deposit and replace it with newly constructed embankment using rock fill. The embankment should be placed (prior to the placement of the pavement structure) for a minimum six months to one year (depending on the soil compressibility of the clayey silt to silt some clay layer that lies beneath the peat layer) to accelerate consolidation of compressible soils beneath the widening. Several consolidation tests should be performed during the detailed investigation to determine the compressibility behaviour of the soils.

- Excavate the peat deposit and the underlying loose and compressible soil to the full depth using shoring techniques consisting of sheet piles supported by H- piles and anchor tiebacks. The new sheet piles should be installed at the northerly edge of the proposed new road embankment, and then excavation and removal of the peat and any compressible soils should be conducted between the new sheet piles, from the north and the existing sheet piles to the south. The newly constructed sheet pile wall will be permanent to support the newly constructed embankment.

Since it is not considered practical to dewater the wetland, it will not be possible to compact the backfill placed up to the existing ground level in the wetland. Consequently, the fill below the existing ground level should consist of material, such as clear stone or rock fill, that does not require heavy mechanical compaction. It is recommended that rock fill be used below the water level. The top of the rock fill layer will be covered by geotextile to prevent the migration of the fines from the backfill material overlying the rock fill.

It should be noted that detailed foundation investigation will be required for design of the widening crossing wetland area 1.

5.4.5 Construction

Once the subgrade has been inspected and approved, the granular base and sub-base 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.

The placing, spreading and rolling of the asphalt should be in accordance with OPS Specifications or, as required by the MTO/Municipal Standards. The finished pavement surface and underlying subgrade should be free of depressions and should be sloped as required by MTO/Municipal specifications. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas.

5.4.6 Drainage

A subdrainage system is recommended below the edge of the proposed pavement. Use of 150 mm diameter subdrain pipe wrapped with geotextile (Class 1 non-woven FOS 75-150 µm) is recommended to prevent the loss of (and clogging by) soil fines. The subdrain pipe should be placed at an invert depth of 1.3 m and should be surrounded with 19 mm diameter clear stone. The subdrain system should be connected to adjacent catch basins, or frost free outlets.

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.

5.5 Shoring and Earth Pressures

Shoring systems must be designed by a Professional Engineer, experienced in this type of work. In Ontario, shoring typically consists of soldier pile and timber lagging, or sheet piling (with or without bracing/rakers). The shoring system should be designed so that the lateral movement of any portion of the supported excavation will not exceed the established criterion for the structural performance level.

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
γ = unit weight to backfill
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 backfilling materials.

The coefficients of lateral earth pressure given in Table 5.5 below may be used for the design of temporary shoring and for lateral loading considerations.

Table 5.5: Lateral Earth Pressure Coefficient (Unfactored)

Soil Type	K_{active}	K (at rest)	$K_{passive}$	Unit Weight (kN/m^3)
Granular Pavement Fill	0.33	0.5	3.0	20.5
Clayey Silt to silty clay	0.39	0.56	2.6	19.0
Rock Fill	0.22	0.36	4.5	23.0
Peat and organic soils	0.42	0.57	2.4	14.0

5.6 Frost Penetration Depth

The frost penetration depth for this project is, f = 1.2 m.

5.7 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 and subbase courses, asphalt placement, and compaction.

5.8 Pavement Condition Survey

As a part of the completion of Schedule C Class Environmental Assessment Study for Mayfield Road from Chinguacousy Road to Heart Lake Road, GENIVAR conducted pavement condition surveys including a quality index and summary of distress manifestations. The findings of the pavement condition surveys are summarized in this section. The pavement condition evaluation consisted of an engineer walking the pavement section, identifying and classifying the existing distress features and plotting them, and also driving over the pavement section at posted speeds. Based on the crack mapping and visual observations, a completed Form of the Pavement Surface Distress Manifestations shown in Figure A-1 in the Appendix D was prepared for five sections within the subject limit of Mayfield Road. The following were evaluated:

- Riding Condition Rating (RCR), which indicates the degree of riding comfort that the pavement provides to the travelling public. GENIVAR representatives drove over the pavement section at the posted speed and classified the Pavement's Riding Condition according to Ministry of Transportation of Ontario (MTO) standards.
- Pavement Surface Distress Manifestations, which are evaluated by walking and /or driving and marking the surface distress, surface distortions or deformations, and cracking for the pavement section. See Figure A-1 for the five road sections in the Appendix D.
- Pavement Condition Rating (PCR), which is derived from the pavement riding comfort and from pavement surface distress.

Photos for the road sections are attached in Appendix E.

The subject study of Mayfield Road between Chinguacousy Road and Heart Lake Road is divided to five sections as follows:

- Section 1 (Station 7+208 to Station 8+708): Mayfield Road, from Chinguacousy Road to 50 m east of McLaughlin Road;

- Section 2 (Station 8+708 to Station 9+808): Mayfield Road, from 50 m east of McLaughlin Road to 250 m west of Hurontario Street;
- Section 3 (Station 9+808 to Station 11+308): Mayfield Road, from 250 m west of Hurontario Street to 150 m west of Kennedy Road;
- Section 4 (Station 11+308 to Station 12+108): Mayfield Road, from 150 m west of Kennedy Road to 700 m west of Heart Lake Road (Property # 3742);
- Section 5 (Station 12+108 to Station 12+808): Mayfield Road, from 700 m west of Heart Lake Road (Property # 3742) to Heart Lake Road.

Table 5.6 below summarizes the Riding Condition Rating (RCR), Pavement Surface Distress Manifestations, and Pavement Condition Rating (PCR) for the five pavement sections (see Figure A-1, in Appendix D):

Table 5.6: Summary of Pavement Condition Survey for Mayfield Road between Chinguacousy Road and Heart Lake Road

Section #	Length (km)	PCR	RCR	General Severity of Observed Distresses	General Density of Distress
1	1.45	90	8.0	Very slight	Few
2	1.1	55	5.5	Moderate	Intermittent to Frequent
3	1.5	90	8.5	Very slight	Few
4	0	55	5.5	Moderate	Intermittent to Frequent
5	0	85	8.0	Very slight	Few

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

- Road sections 1, 3, and 5 have good to excellent pavement condition, with slight to very slight cracking and with good to excellent rideability, with a few areas of very slight roughness.
- Road sections 2 and 4 have fair pavement condition, with intermittent moderate and frequent slight cracking, and with intermittent slight or moderate alligator cracking and dishing, fair rideability. Surface is slightly to moderately rough and uneven.

5.9 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.

It should be noted that the geotechnical investigation conducted at this stage is preliminary, for purposes of environmental planning. Further and more comprehensive geotechnical investigations will be required for detailed design.

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

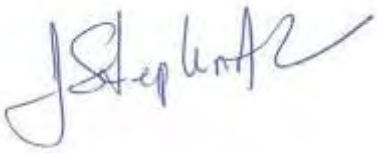
results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

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.

Selim Lutfur, P. Eng.
Geotechnical Engineer

Reviewed by:

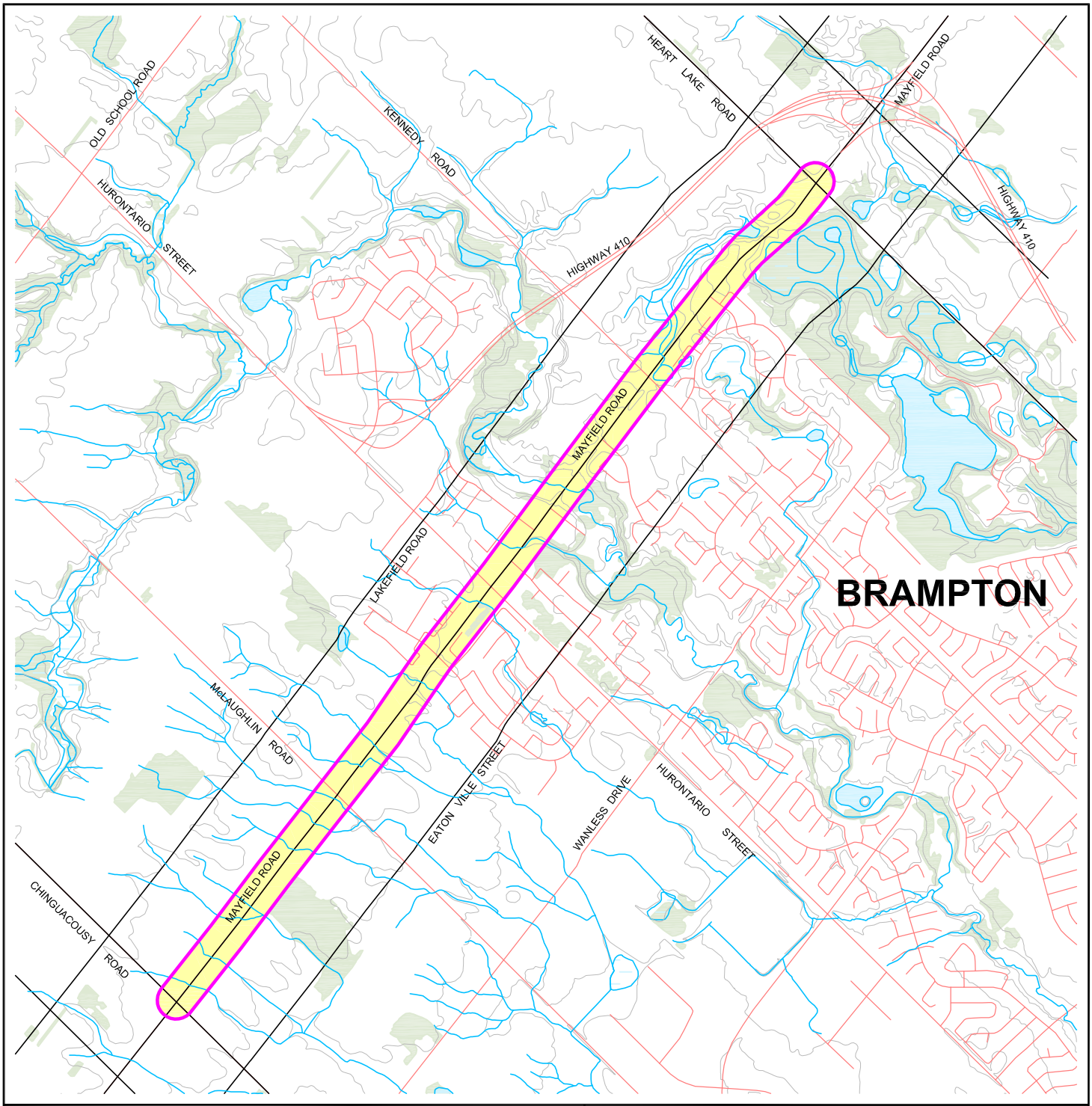


J. Stephen Ash, P. Eng,. P. Geo.
Director, Environment

Figures

Figure 1 – Location Map

Figures 2A to 2E – Borehole Location Plans



LEGEND

STUDY AREA

250 0 500 metres

MAP SOURCE:
OBM 1:10000 MAPPING, NAD 83, ZONE 17 DATUM.

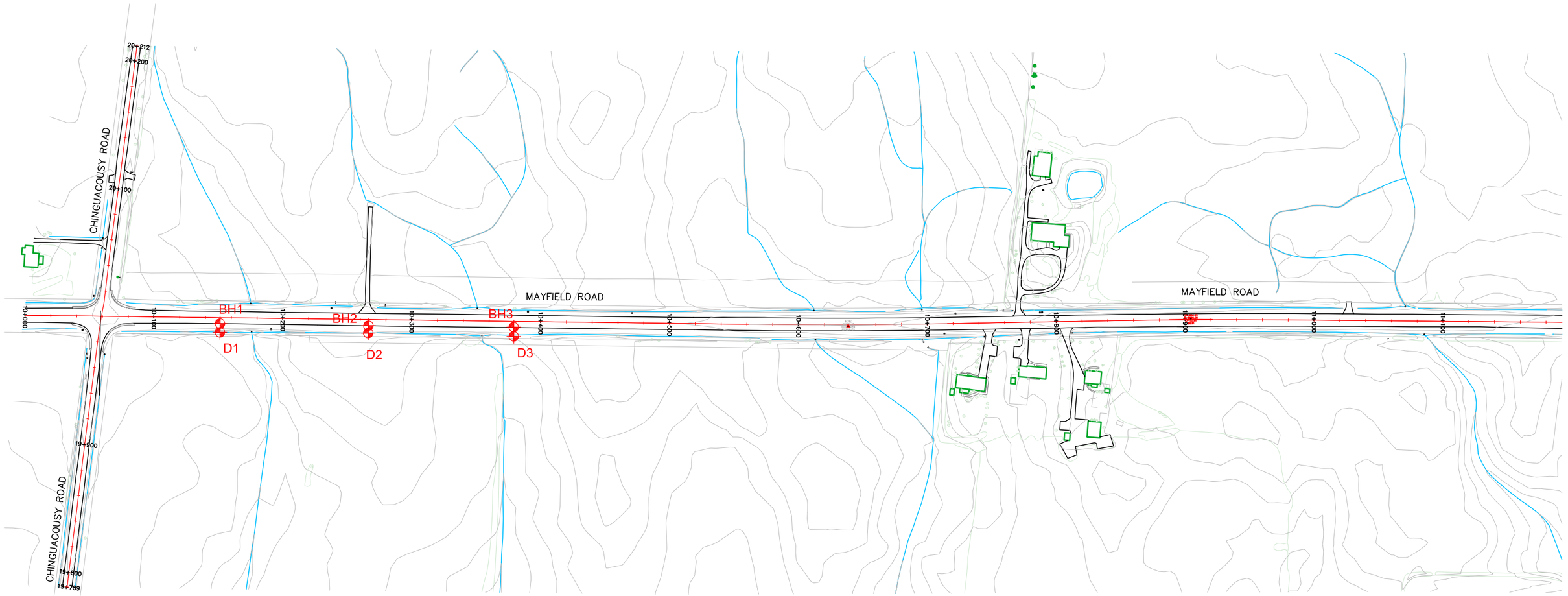
LOCATION MAP

GEOTECHNICAL PAVEMENT INVESTIGATION
MAYFIELD ROAD
(Between Chinguacousy Road & Heart Lake Road)
For Region of Peel

DATE: MARCH 2012	SCALE: 1:30000
PROJECT: 101-17262-00	FILE NO.: 111-17262-00-F1-LM GPD

GENIVAR

FIGURE 1



LEGEND

BH1
D1 BOREHOLE LOCATION AND DESIGNATION

25 0 50 100 metres

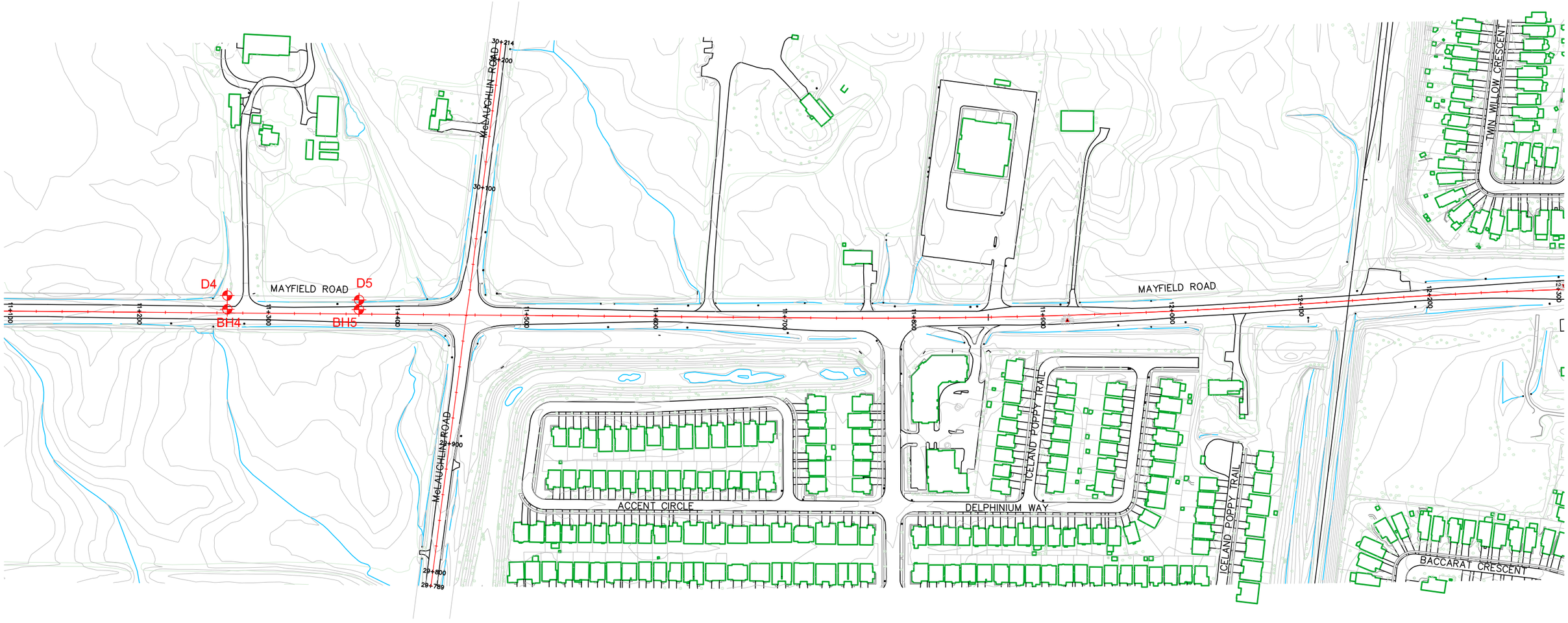
BOREHOLE LOCATION PLAN (Sta 7 + 208 to 8 + 208)

GEOTECHNICAL PAVEMENT INVESTIGATION
MAYFIELD ROAD
(Between Chinguacousy Road & Heart Lake Road)
For Region of Peel

DATE: MARCH 2012	SCALE: 1:3000
PROJECT: 101-17262-00	FILE NO.: 111-MAYFIELD

GENIVAR

FIGURE 2A



LEGEND

BH5
D5 — BOREHOLE LOCATION AND DESIGNATION

25 0 50 100 metres

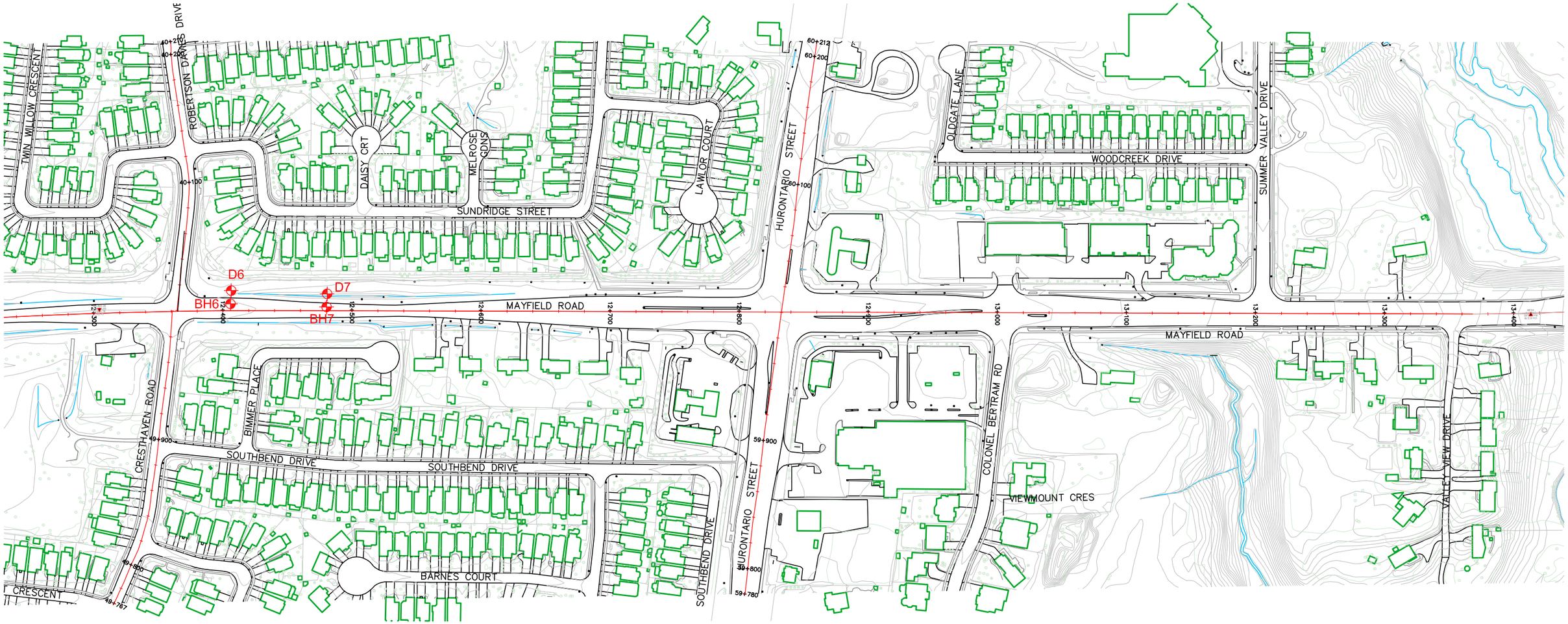
BOREHOLE LOCATION PLAN (Sta 8 + 208 to 9 + 408)

GEOTECHNICAL PAVEMENT INVESTIGATION
MAYFIELD ROAD
(Between Chinguacousy Road & Heart Lake Road)
For Region of Peel

DATE: MARCH 2012	SCALE: 1:3000
PROJECT: 101-17262-00	FILE NO.: 111-MAYFIELD

GENIVAR

FIGURE 2B



LEGEND

BH7
D7 — BOREHOLE LOCATION AND DESIGNATION

25 0 50 100 metres

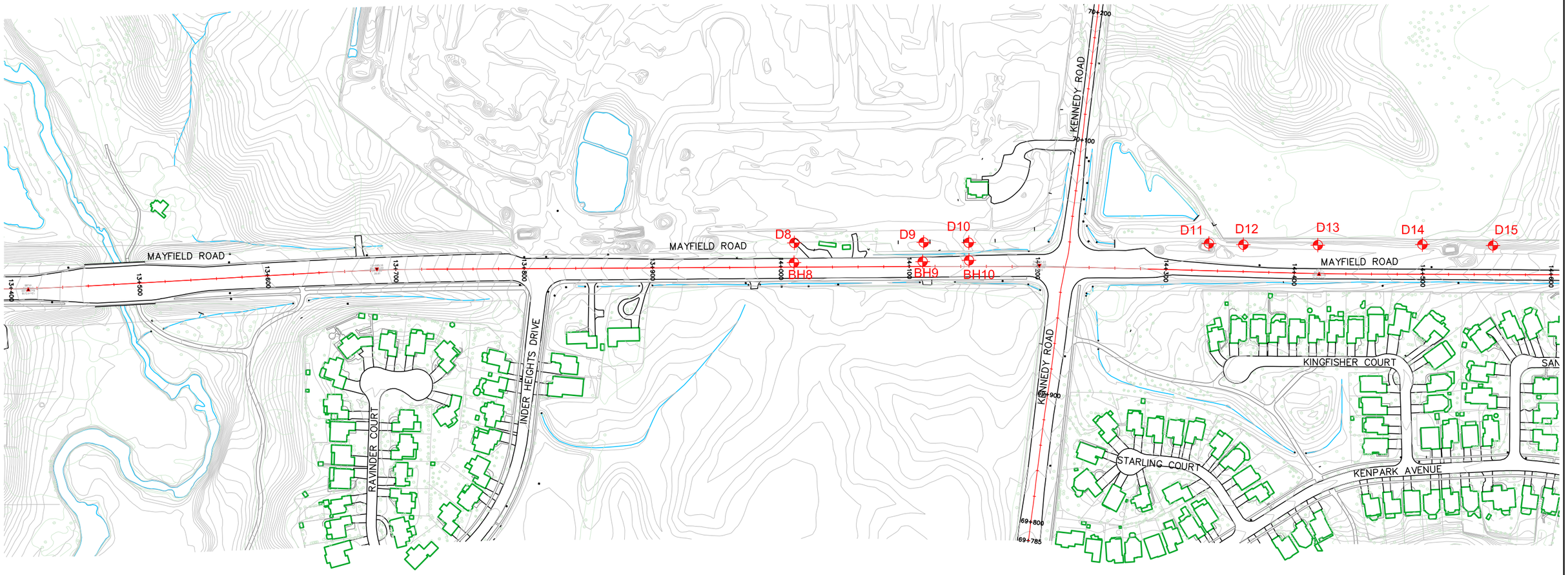
BOREHOLE LOCATION PLAN (Sta 9 + 408 to 10 + 508)

GEOTECHNICAL PAVEMENT INVESTIGATION
MAYFIELD ROAD
(Between Chinguacousy Road & Heart Lake Road)
For Region of Peel

DATE: MARCH 2012	SCALE: 1:3000
PROJECT: 101-17262-00	FILE NO.: 111-MAYFIELD

GENIVAR

FIGURE 2C



LEGEND

BH9
D9 — BOREHOLE LOCATION AND DESIGNATION

25 0 50 100 metres

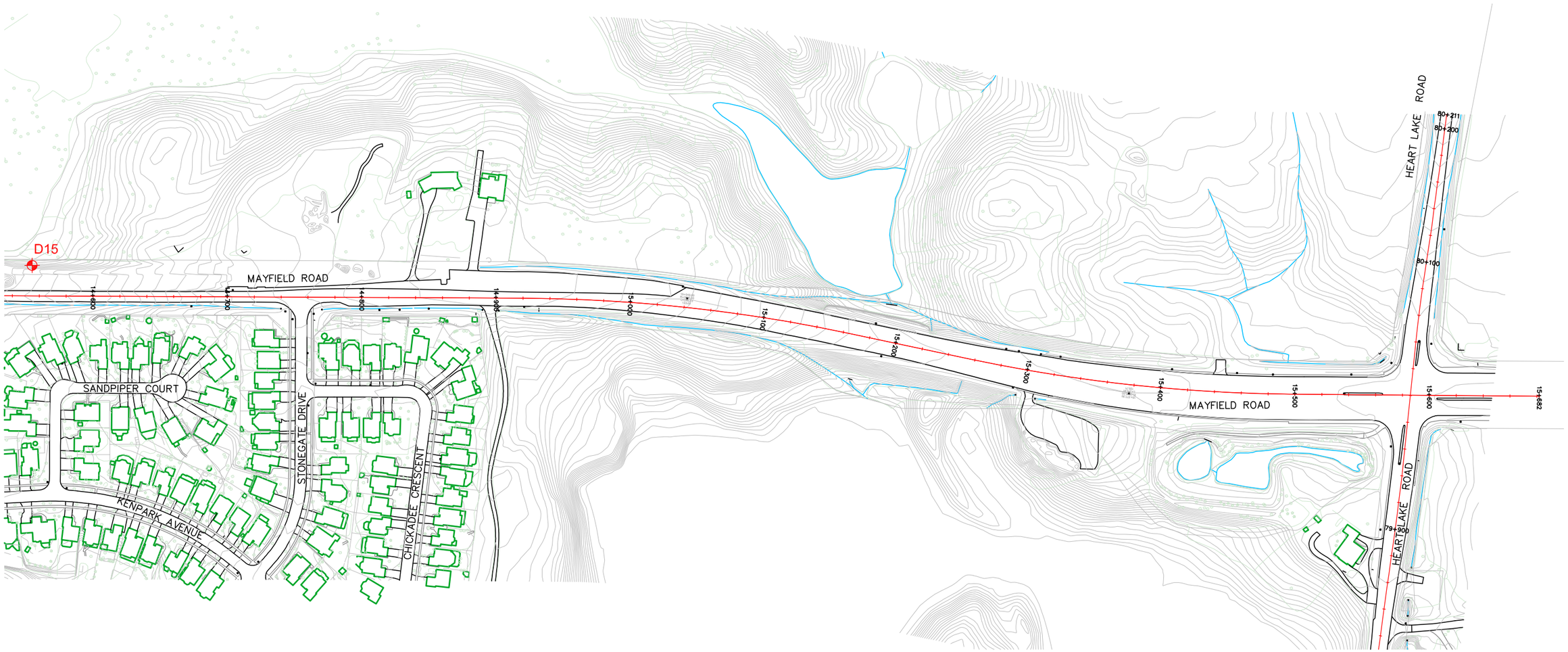
BOREHOLE LOCATION PLAN (Sta 10 + 508 to 11 + 708)

GEOTECHNICAL PAVEMENT INVESTIGATION
MAYFIELD ROAD
(Between Chinguacousy Road & Heart Lake Road)
For Region of Peel

DATE: MARCH 2012	SCALE: 1:3000
PROJECT: 101-17262-00	FILE NO.: 111-MAYFIELD

GENIVAR

FIGURE 2D



LEGEND

D15 BOREHOLE LOCATION AND DESIGNATION

25 0 50 100 metres

SITE PLAN
(Sta 11 + 708 to 12 + 708)

PAVEMENT EVALUATION
MAYFIELD ROAD
(Between Chinguacousy Road & Heart Lake Road)
Region of Peel
For

DATE: MARCH 2012	SCALE: 1:3000
PROJECT: 101-17262-00	FILE NO.: 111-MAYFIELD

GENIVAR

FIGURE 2E

Appendix A

Borehole Explanation Forms

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.

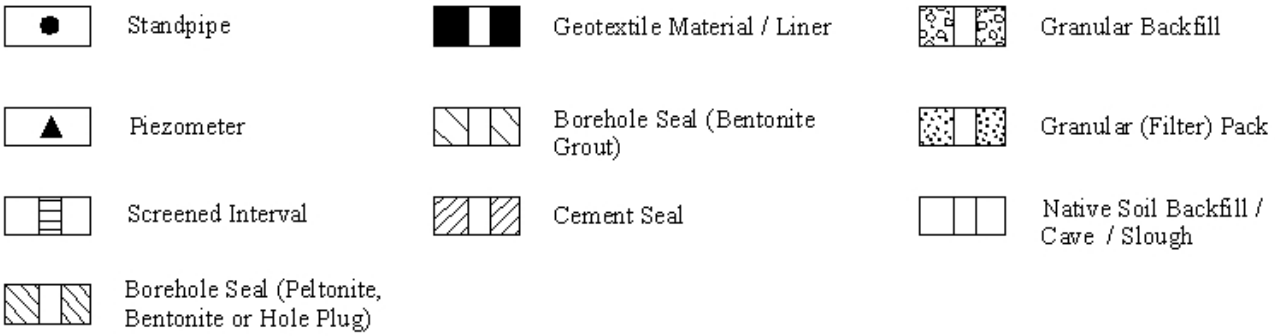
COHESIONLESS SOILS	COHESIVE SOILS		
Dry	DTPL	-	Drier Than Plastic Limit
Moist	APL	-	About Plastic Limit
Wet	WTPL	-	Wetter Than Plastic Limit
Saturated	MWTPL	-	Much Wetter Than Plastic Limit

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.



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, 60º 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: GEOTECHNICAL INVESTIGATION - MAYFIELD ROAD
PROJECT NO.: 101-17262-00

CLIENT: REGION OF PEEL
DATE COMPLETED: Mar 01, 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:** 255 mm THICK, LOWER 150 mm PULVERIZED										BOREHOLE OPEN AND DRY UPON COMPLETION
0.3	**GRANULAR 'A'** 100 mm THICK										
0.4	**GRANULAR 'B'** 100 mm THICK										
0.5	**CLAYEY SANDY SILT TILL** GREENISH-GREY CLAYEY SANDY SILT TILL, SLIGHTLY ORGANIC, SOME GRAVEL, MOIST, COMPACT			SS1	10	16	75				
1.0											
1.4	**CLAYEY SILT TILL** GREENISH-GREY TO BROWN CLAYEY SILT TILL, SLIGHTLY ORGANIC IN UPPER ~ 450 mm, SOME SAND, APL, STIFF			SS2	12	21	83				
2.0											
2.1	BOREHOLE TERMINTATED AT 2.1 m BELOW GROUND SURFACE IN CLAYEY SILT										
3.0											

GENIVAR GEOTECH (M) 101-17262-00.GPJ JAGGER HIMS BASIC.GDT 3/22/12

GENIVAR

BOREHOLE NO. BH4

PROJECT NAME: GEOTECHNICAL INVESTIGATION - MAYFIELD ROAD
PROJECT NO.: 101-17262-00
CLIENT: REGION OF PEEL
DATE COMPLETED: Mar 01, 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:** 200 mm THICK										BOREHOLE OPEN AND DRY UPON COMPLETION
0.2	**GRANULAR 'A'** 150 mm THICK										
0.4	**GRANULAR 'B'** 200 mm THICK										
0.6	**CLAYEY SILT FILL** GREENISH-GREY CLAYEY SILT FILL, SLIGHTLY ORGANIC										
0.8	**SAND AND GRAVEL FILL** BROWN SAND AND GRAVEL FILL, MOIST COMPACT			SS1	12		50				
1.0											
1.2	**ORGANIC CLAYEY SILT** DARK BROWN ORGANIC CLAYEY SILT, TRACE SAND, WTPL, STIFF										
1.8	**CLAYEY SILT TILL** GREENISH-GREY TO BROWN CLAYEY SILT TILL, SLIGHTLY ORGANIC TO ~ 2.4 m , SOME SAND, APL, VERY STIFF			SS2	17		83				
2.0											
3.0											
3.1	BOREHOLE TERMINTATED AT 3.1 m BELOW GROUND SURFACE IN CLAYEY SILT										

GENIVAR

BOREHOLE NO. BH8

PROJECT NAME: GEOTECHNICAL INVESTIGATION - MAYFIELD ROAD
PROJECT NO.: 101-17262-00
CLIENT: REGION OF PEEL
DATE COMPLETED: Mar 01, 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										BOREHOLE OPEN AND DRY UPON COMPLETION
0.2	**GRANULAR 'A'** 200 mm THICK										**GRANULAR 'A' GSA:** GRAVEL 61% SAND 31% SILT 8%
0.4	**GRANULAR 'B'** 405 mm THICK										**GRANULAR B' GSA:** GRAVEL 65% SAND 26% SILT 9%
0.8	**CLAYEY SANDY SILT TILL** BROWN CLAYEY SANDY SILT TILL, SOME GRAVEL, DTPL, VERY STIFF			SS1	18		67				
1.0											
2.0				SS2	20		83				
2.1	BOREHOLE TERMINTATED AT 2.1 m BELOW GROUND SURFACE IN SANDY CLAYEY SILT										
3.0											

GENIVAR GEOTECH (M) 101-17262-00.GPJ JAGGER HIMS BASIC.GDT 3/22/12

GENIVAR

BOREHOLE NO. BH9

PROJECT NAME: GEOTECHNICAL INVESTIGATION - MAYFIELD ROAD
PROJECT NO.: 101-17262-00

CLIENT: REGION OF PEEL
DATE COMPLETED: Mar 01, 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										BOREHOLE OPEN AND DRY UPON COMPLETION
0.2	**GRANULAR 'A'** 180 mm THICK										
0.3	**GRANULAR 'B'** 430 mm THICK										
0.8	**CLAYEY SANDY SILT TILL** BROWN CLAYEY SANDY SILT TILL, SOME GRAVEL, DTPL TO APL, STIFF TO VERY STIFF			SS1	14	13	71				
1.0											
2.0				SS2	25	13	83				
2.1	BOREHOLE TERMINTATED AT 2.1 m BELOW GROUND SURFACE IN CLAYEY SANDY SILT TILL										
3.0											

GENIVAR GEOTECH (M) 101-17262-00.GPJ JAGGER HIMS BASIC.GDT 3/22/12

GENIVAR

BOREHOLE NO. D1

PROJECT NAME: GEOTECHNICAL INVESTIGATION - MAYFIELD ROAD
PROJECT NO.: 101-17262-00
CLIENT: REGION OF PEEL
DATE COMPLETED: Mar 02, 2012
BOREHOLE TYPE: HAND AUGERS, 19 mm DYNAMIC PROBE
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	**TOPSOIL AND SEDIMENT** 100 mm THICK										BOREHOLE OPEN AND DRY UPON COMPLETION
	ORGANIC CLAYEY SILT TILL DARK BROWN ORGANIC CLAYEY SILT TILL, TRACE SAND, APL			GS1							
0.4	**CLAYEY SILT** MOTTLED GREY/BROWN CLAYEY SILT, SOME SAND, TRACE GRAVEL, APL										**GS2 GSA:** GRAVEL 1% SAND 17% SILT 51% CLAY 31%
0.6	BOREHOLE TERMINTATED AT 0.6 m BELOW GROUND SURFACE IN CLAYEY SILT			GS2							
1.0											
2.0											
3.0											

GENIVAR GEOTECH (M) 101-17262-00.GPJ JAGGER HIMS BASIC GDT 3/22/12

GENIVAR

BOREHOLE NO. D8

PROJECT NAME: GEOTECHNICAL INVESTIGATION - MAYFIELD ROAD
PROJECT NO.: 101-17262-00
CLIENT: REGION OF PEEL
DATE COMPLETED: Mar 02, 2012
BOREHOLE TYPE: HAND AUGERS, 19 mm DYNAMIC PROBE
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	**TOPSOIL AND SEDIMENT** 175 mm THICK										BOREHOLE OPEN AND DRY UPON COMPLETION
0.2	**SANDY CLAYEY SILT TILL** BROWN SANDY CLAYEY SILT, TRACE GRAVEL, APL			GS1							
0.6	BOREHOLE TERMINTATED AT 0.6 m BELOW GROUND SURFACE IN SANDY CLAYEY SILT TILL										
1.0											
2.0											
3.0											

GENIVAR GEOTECH (M) 101-17262-00.GPJ JAGGER HIMS BASIC.GDT 3/22/12

GENIVAR

BOREHOLE NO. D9

PROJECT NAME: GEOTECHNICAL INVESTIGATION - MAYFIELD ROAD
PROJECT NO.: 101-17262-00
CLIENT: REGION OF PEEL
DATE COMPLETED: Mar 02, 2012
BOREHOLE TYPE: HAND AUGERS, 19 mm DYNAMIC PROBE
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	**TOPSOIL AND SEDIMENT** 200 mm THICK										BOREHOLE OPEN AND DRY UPON COMPLETION
0.2	**SANDY CLAYEY SILT TILL** BROWN SANDY CLAYEY SILT TILL, TRACE GRAVEL, APL			GS1							
0.6	BOREHOLE TERMINTATED AT 0.6 m BELOW GROUND SURFACE IN SANDY CLAYEY SILT										
1.0											
2.0											
3.0											

GENIVAR

BOREHOLE NO. D10

PROJECT NAME: GEOTECHNICAL INVESTIGATION - MAYFIELD ROAD
PROJECT NO.: 101-17262-00
CLIENT: REGION OF PEEL
DATE COMPLETED: Mar 02, 2012
BOREHOLE TYPE: HAND AUGERS, 19 mm DYNAMIC PROBE
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	**TOPSOIL AND SEDIMENT** 75 mm THICK										BOREHOLE OPEN AND DRY UPON COMPLETION
0.1	**SANDY CLAYEY SILT TILL** BROWN SANDY CLAYEY SILT TILL, SOME GRAVEL, APL			GS1							
0.6	BOREHOLE TERMINTATED AT 0.6 m BELOW GROUND SURFACE IN SANDY CLAYEY SILT										
1.0											
2.0											
3.0											

GENIVAR GEOTECH (M) 101-17262-00.GPJ JAGGER HIMS BASIC.GDT 3/22/12

BOREHOLE NO. D12

PROJECT NAME: GEOTECHNICAL INVESTIGATION - MAYFIELD ROAD
PROJECT NO.: 101-17262-00
CLIENT: REGION OF PEEL
DATE COMPLETED: Mar 02, 2012
BOREHOLE TYPE: HAND AUGERS, 19 mm DYNAMIC PROBE
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	**TOPSOIL** 150 mm THICK			GS1							BOREHOLE OPEN AND DRY UPON COMPLETION
0.2	**CLAYEY SANDY SILT TILL** BROWN CLAYEY SANDY SILT TILL, SOME GRAVEL, APL										
0.6	BOREHOLE TERMINTATED AT 0.6 m BELOW GROUND SURFACE IN SANDY CLAYEY SILT TILL										
1.0											
2.0											
3.0											

GENIVAR GEOTECH (M) 101-17262-00.GPJ JAGGER HIMS BASIC.GDT 3/22/12

GENIVAR

BOREHOLE NO. D13

PROJECT NAME: GEOTECHNICAL INVESTIGATION - MAYFIELD ROAD
PROJECT NO.: 101-17262-00
CLIENT: REGION OF PEEL
DATE COMPLETED: Mar 02, 2012
BOREHOLE TYPE: HAND AUGERS, 19 mm DYNAMIC PROBE
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	**TOPSOIL AND MULCH** 150 mm THICK										BOREHOLE OPEN AND DRY UPON COMPLETION
0.2	**SILTY SAND AND GRAVEL FILL** BROWN SILTY SAND AND GRAVEL FILL, VERY MOIST										
0.4	**CLAYEY SILT** GREENISH-GREY CLAYEY SILT, SLIGHTLY ORGANIC, TRACE SAND AND GRAVEL, APL			GS1							
0.6	**CLAYEY SANDY SILT TILL** BROWN CLAYEY SANDY SILT TILL, TRACE GRAVEL, APL			GS2							**GS2 GSA:** GRAVEL 5% SAND 27% SILT 47% CLAY 21% **GS2 ATTERBERG LIMITS:** LIQIUD LIMIT 26% PLASTIC LIMIT 11%
0.9	BOREHOLE TERMINTATED AT 0.9 m BELOW GROUND SURFACE IN CLAYEY SANDY SILT TILL										
1.0											
2.0											
3.0											

GENIVAR

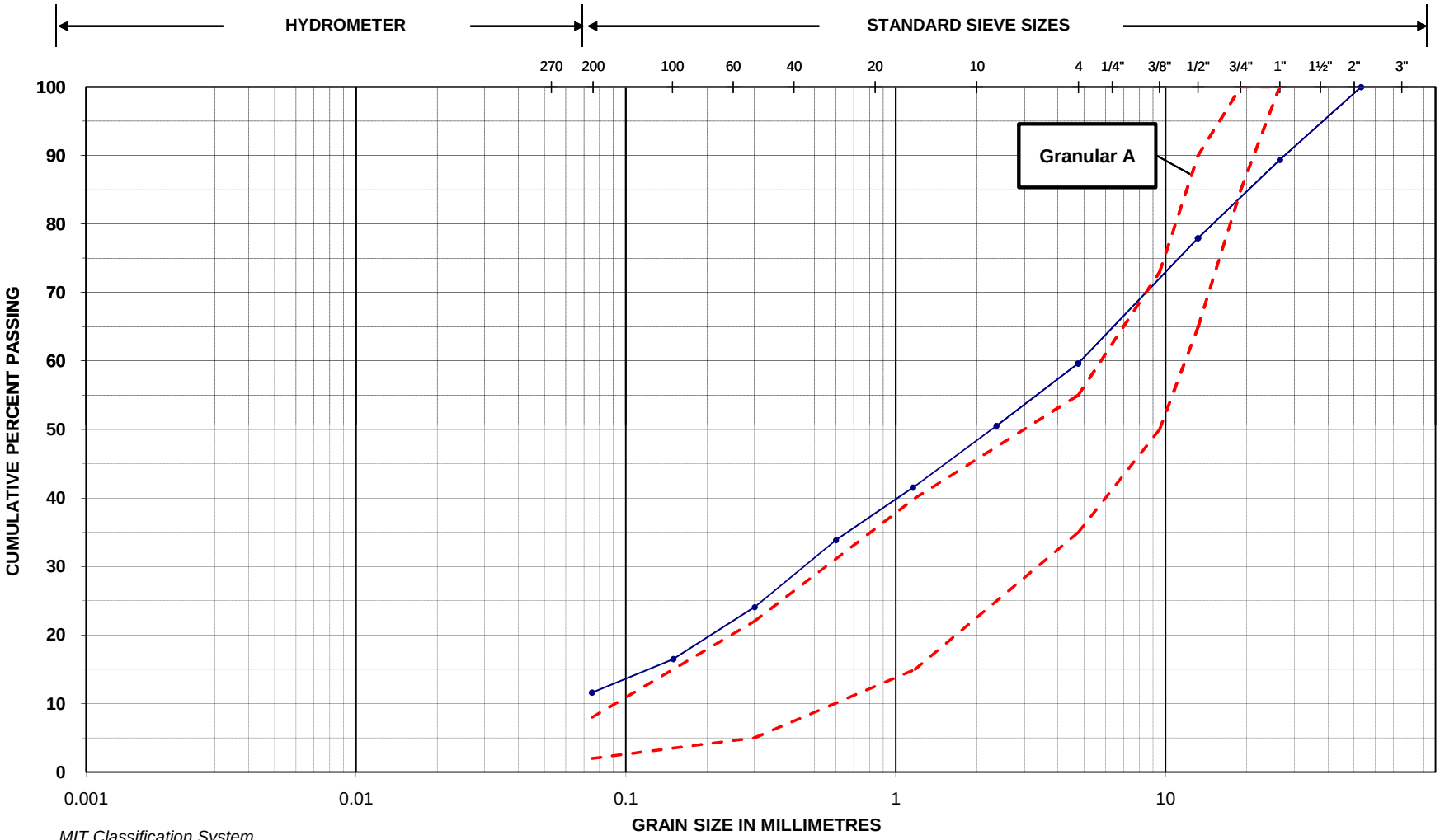
Appendix B

Particle Size Distribution Analyses (Figures B1 to B9)

Plasticity Chart (Figure 10)

GENIVAR

PARTICLE SIZE DISTRIBUTION



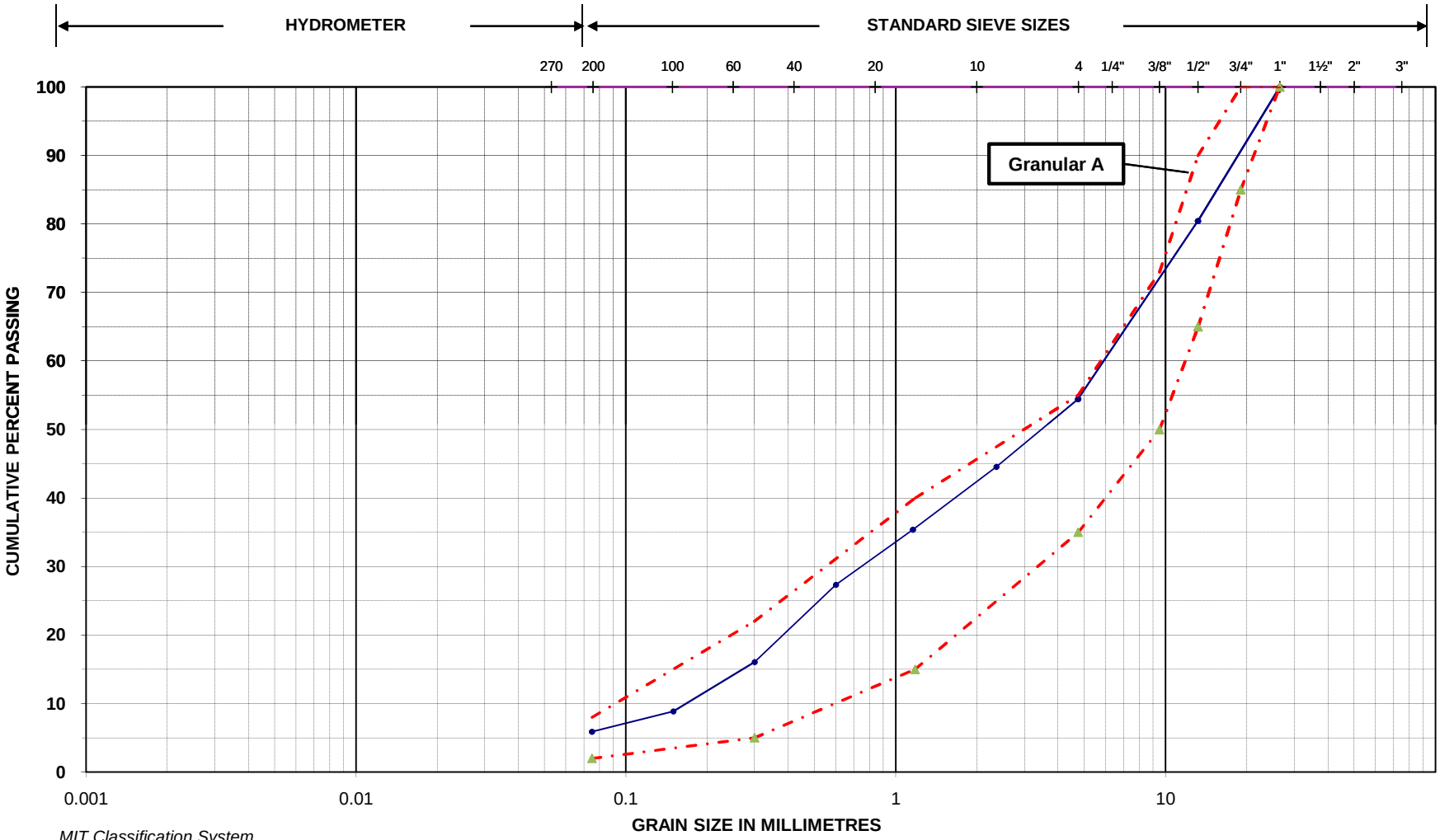
MIT Classification System

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

Project Name:	Mayfield Road			**Project No.:** 101-17262-00	**Figure B1**
Location ID.:	BH3	**Sample No./Depth:**	Granular Base	**Remarks:**	Sandy gravel, some silt

GENIVAR

PARTICLE SIZE DISTRIBUTION



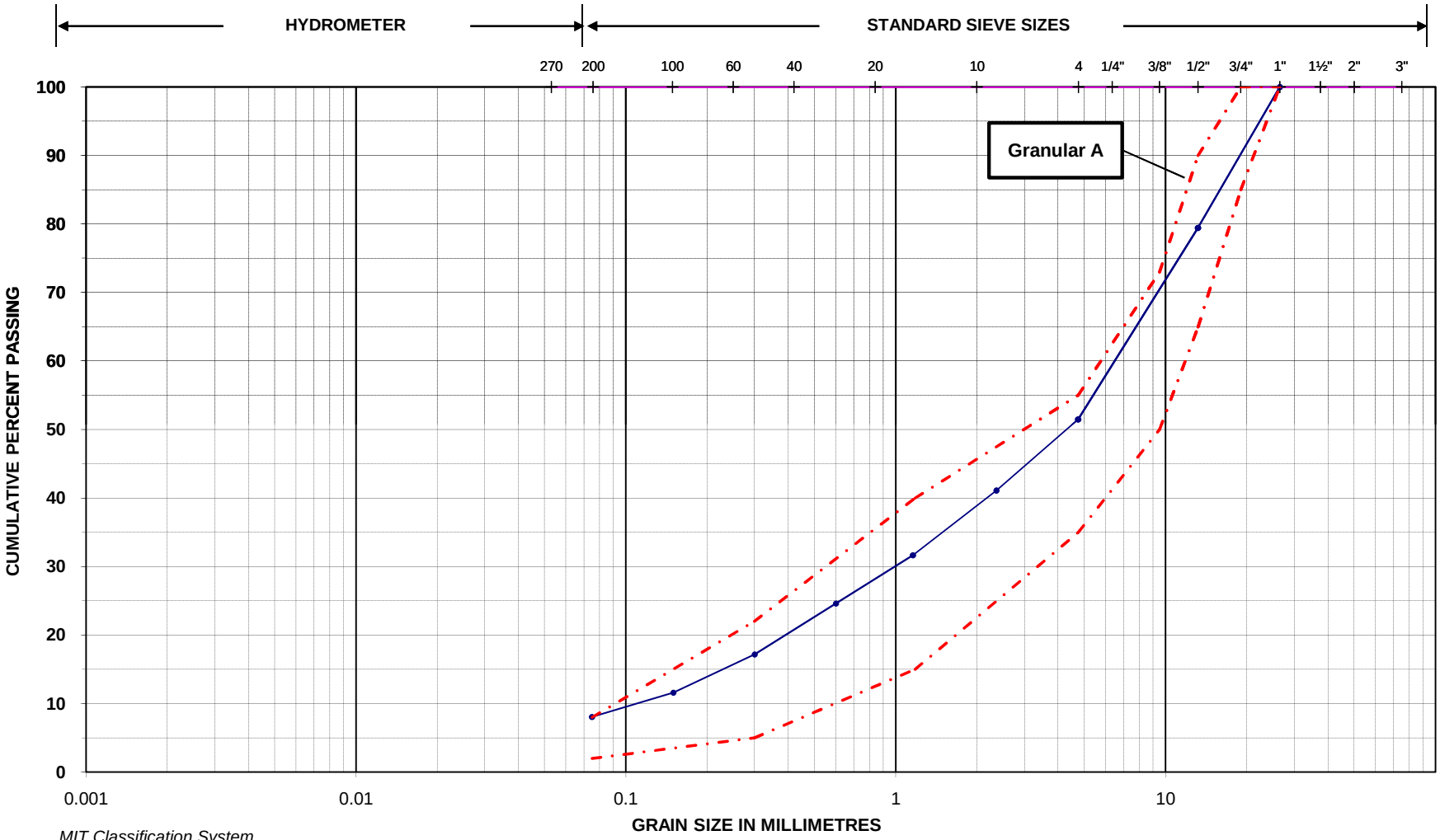
MIT Classification System

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

Project Name:	Mayfield Road			**Project No.:** 101-17262-00	**Figure B2**
Location ID.:	BH6	**Sample No./Depth:**	Granular Base	**Remarks:**	Gravel and sand, trace silt

GENIVAR

PARTICLE SIZE DISTRIBUTION



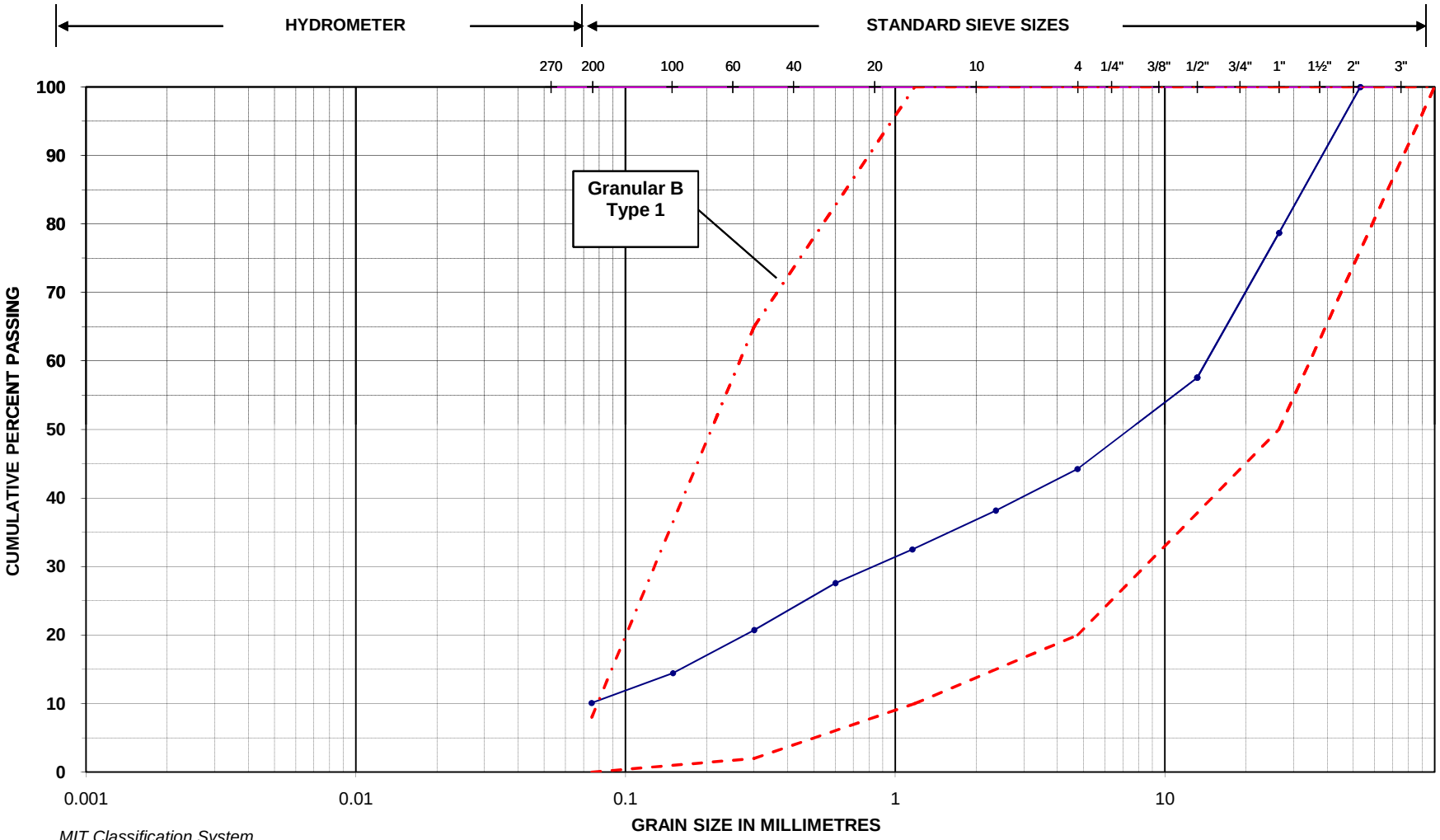
MIT Classification System

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

Project Name:	Mayfield Road			**Project No.:** 101-17262-00	**Figure B3**
Location ID.:	BH8	**Sample No./Depth:**	Granular Base	**Remarks:**	Sandy gravel, trace silt

GENIVAR

PARTICLE SIZE DISTRIBUTION



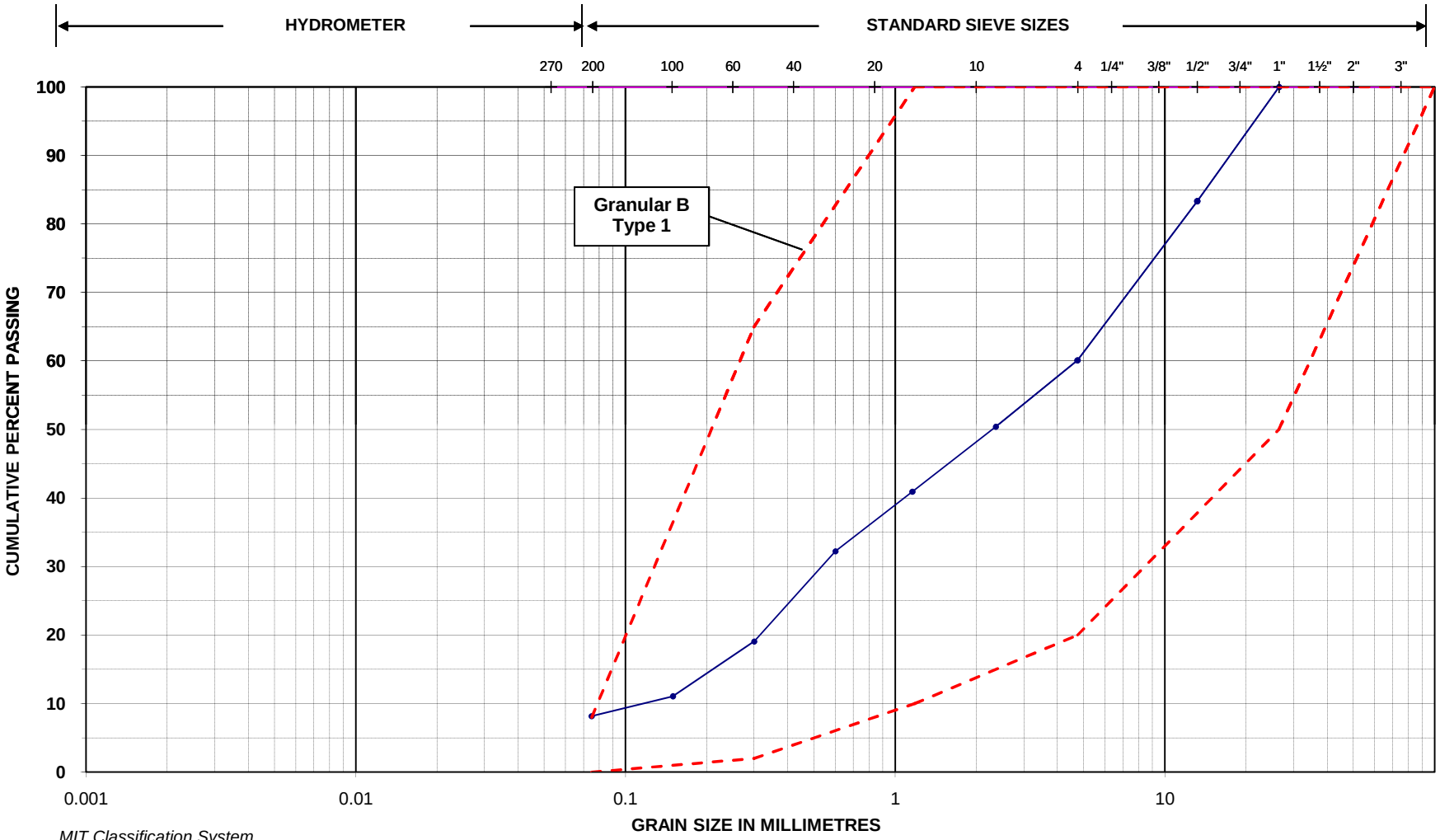
MIT Classification System

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

Project Name:	Mayfield Road			**Project No.:** 101-17262-00	**Figure B4**
Location ID.:	BH3	**Sample No./Depth:**	Granular Sub Base	**Remarks:**	Sandy gravel, trace silt

GENIVAR

PARTICLE SIZE DISTRIBUTION



MIT Classification System

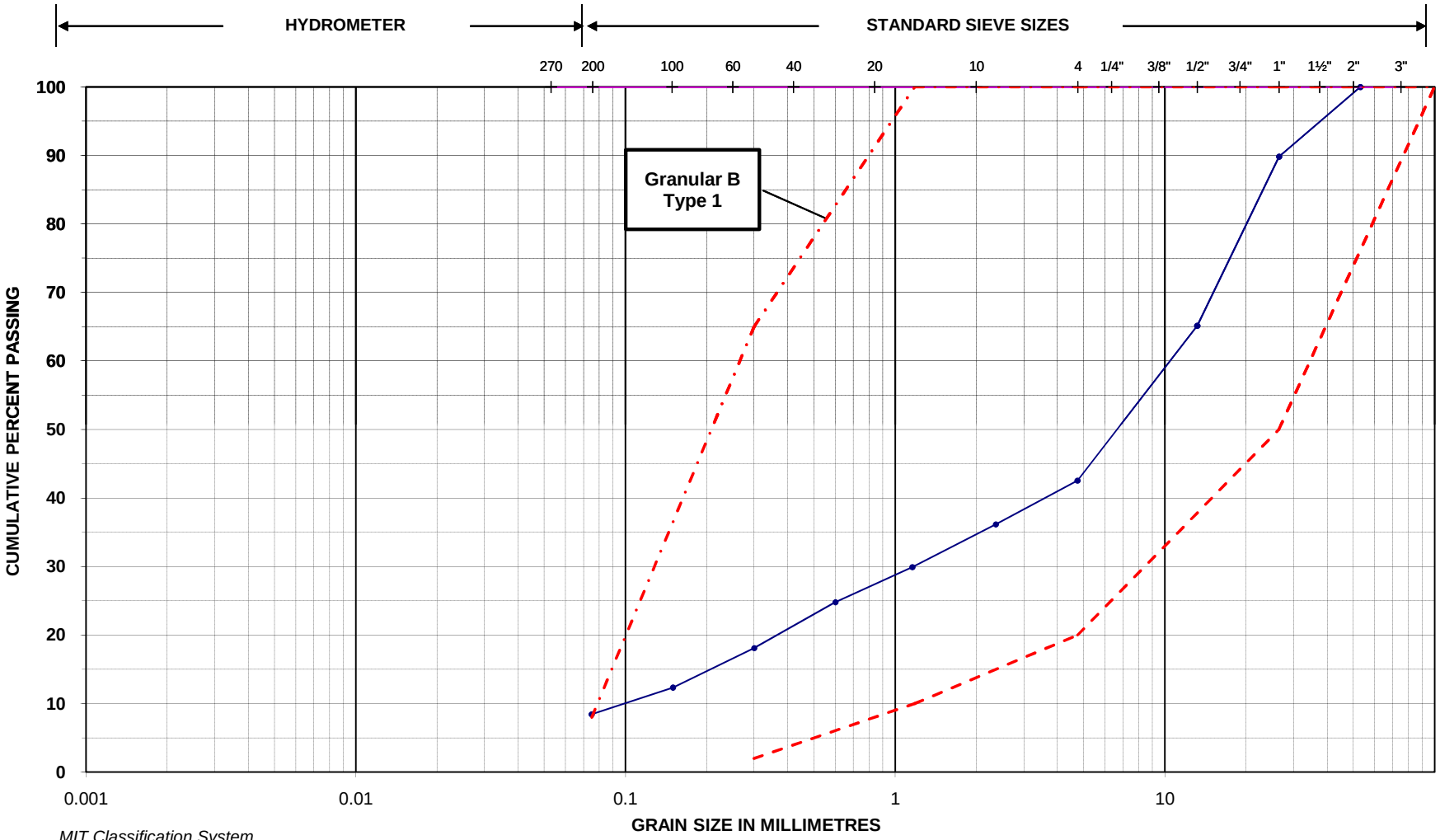
CLAY	SILT			SAND			GRAVEL			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	

Project Name:	Mayfield Road			**Project No.:**	101-17262-00
Location ID.:	BH6	**Sample No./Depth:**	Granular Sub Base	**Remarks:**	Gravel and sand, trace silt

Figure B5

GENIVAR

PARTICLE SIZE DISTRIBUTION



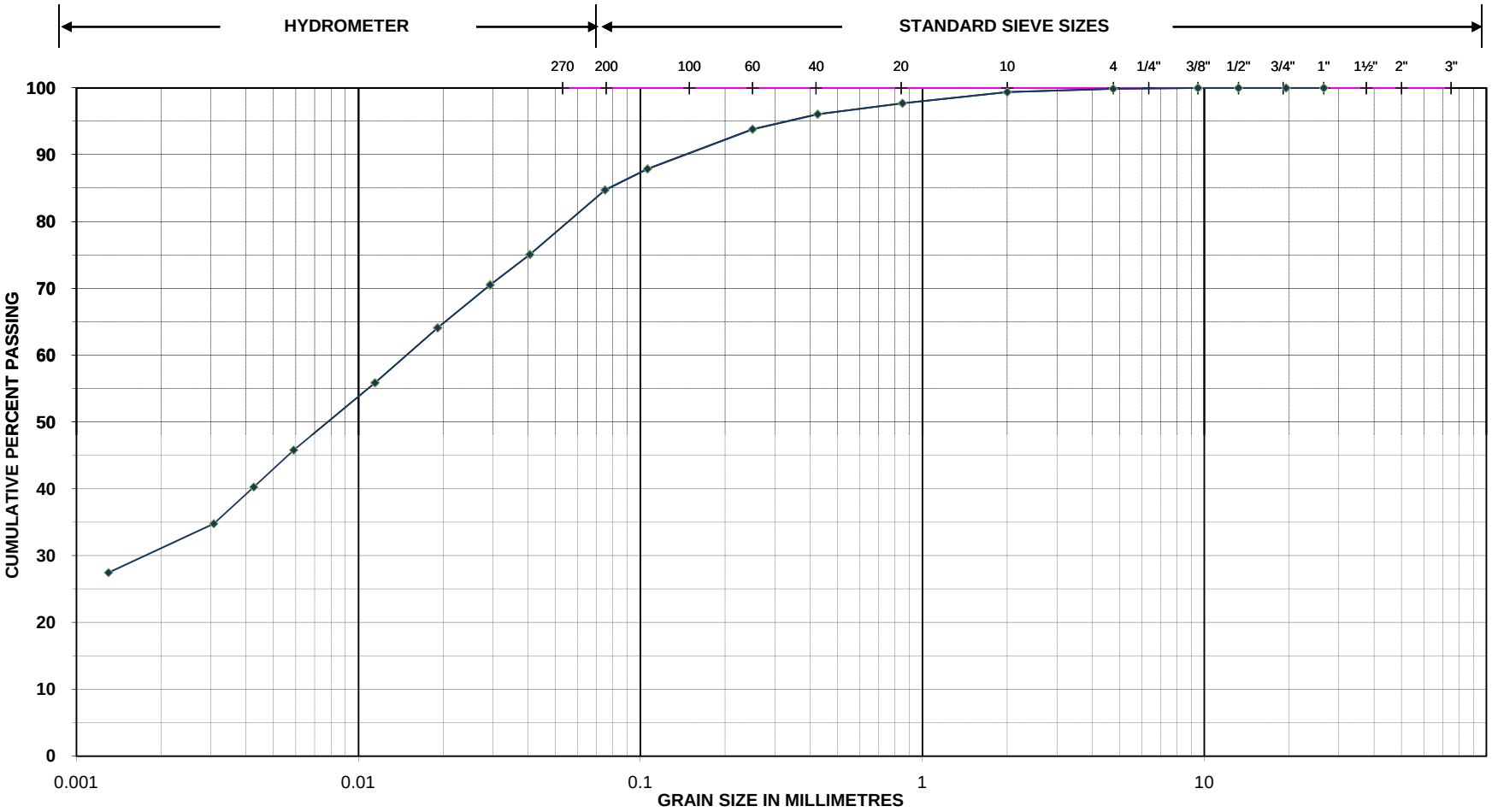
MIT Classification System

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

Project Name:	Mayfield Road			**Project No.:** 101-17262-00	**Figure** B6
Location ID.:	BH8	**Sample No./Depth:**	Granular Sub Base	**Remarks:**	Sandy gravel, trace silt

GENIVAR

PARTICLE SIZE DISTRIBUTION



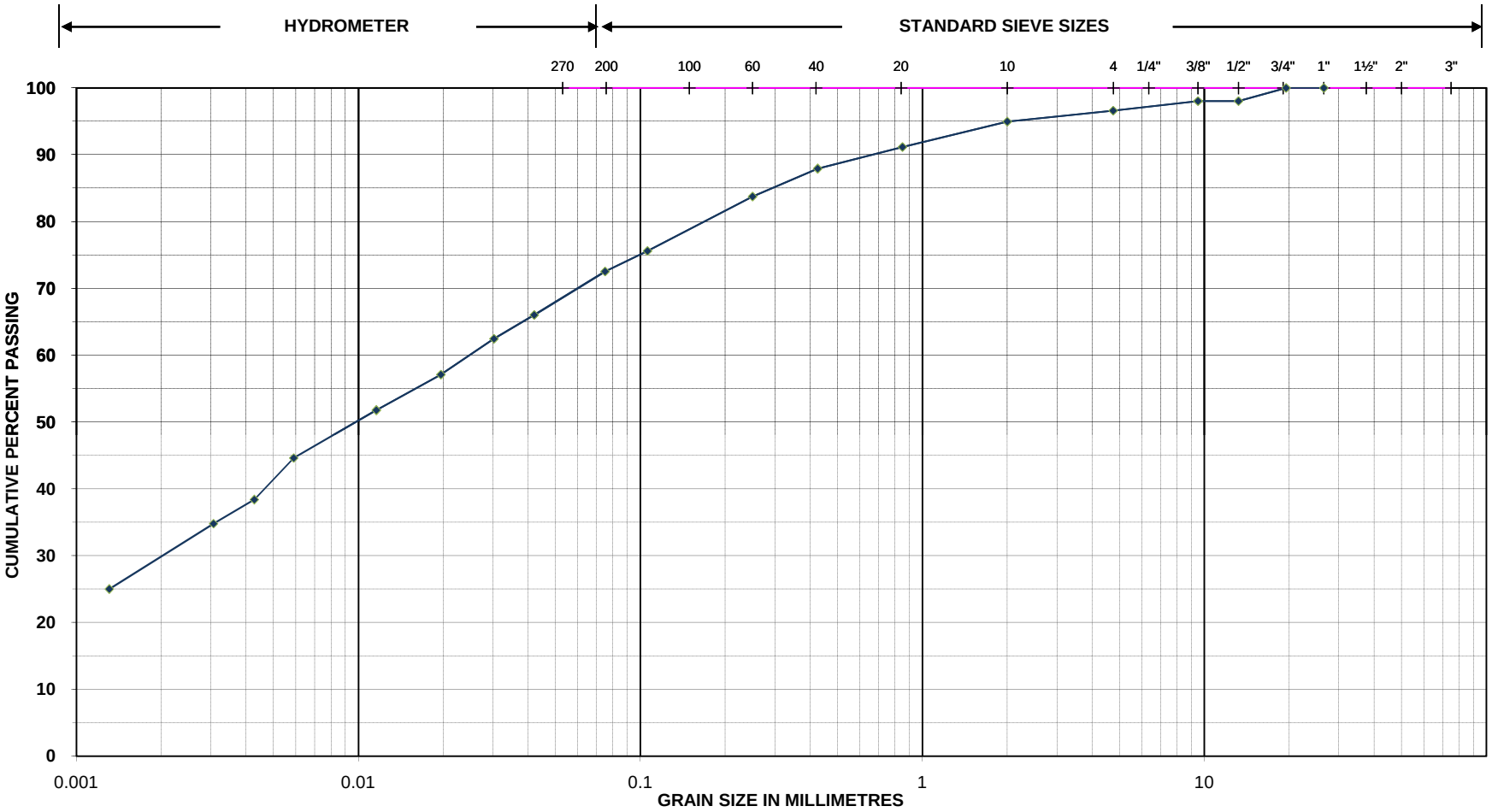
MIT Classification System

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

Project Name:	Mayfield Road		**Project No.:**	101-17262-00	**Figure B7**
Location ID.:	D1	**Sample No./Depth:**	GS2	**Remarks:**	Clayey silt, some sand, trace gravel

GENIVAR

PARTICLE SIZE DISTRIBUTION



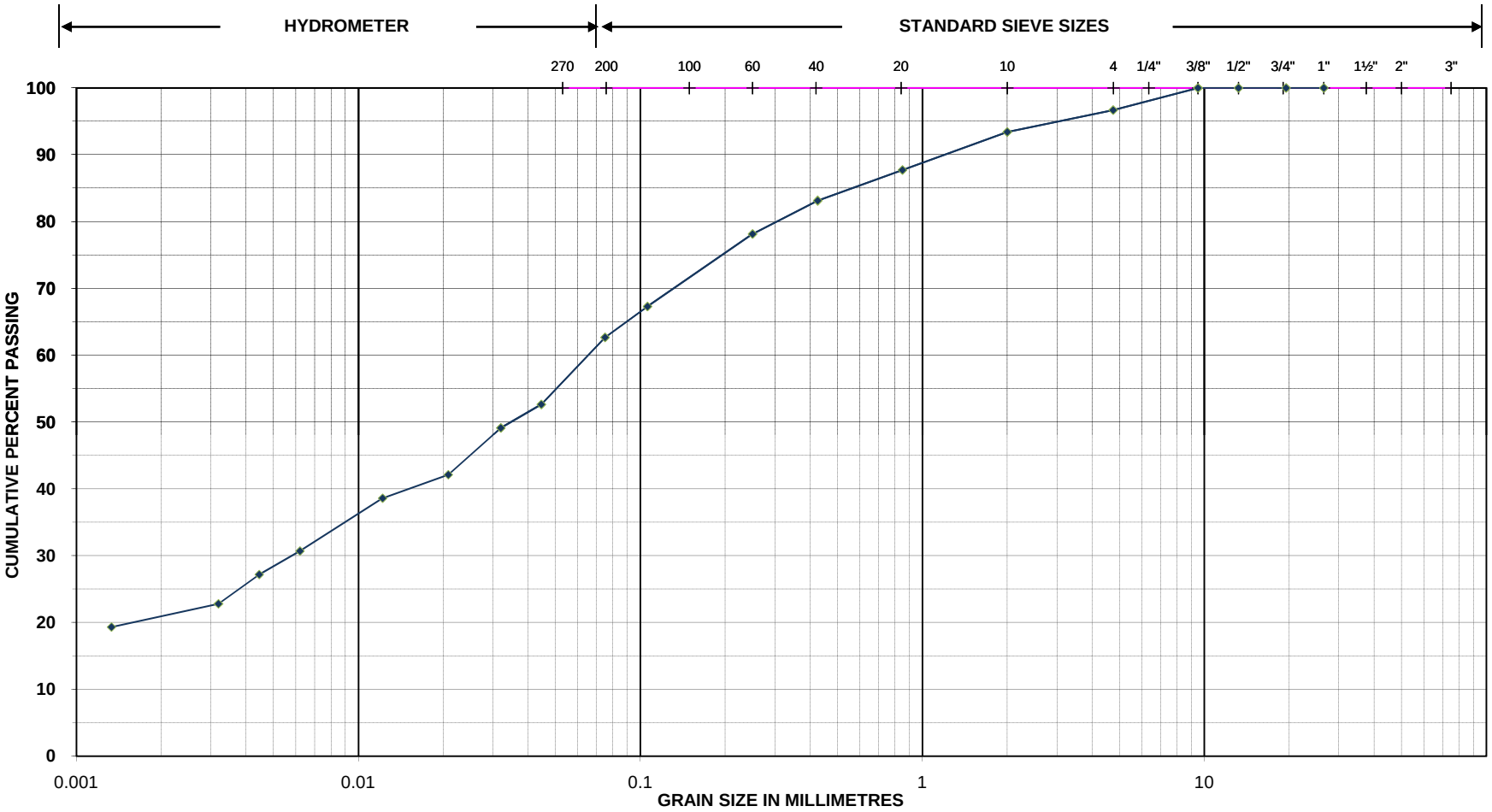
MIT Classification System

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

Project Name:	Mayfield Road		**Project No.:**	101-17262-00	**Figure B8**
Location ID.:	D7	**Sample No./Depth:**	GS1	**Remarks:**	Clayey, sandy silt, trace gravel

GENIVAR

PARTICLE SIZE DISTRIBUTION

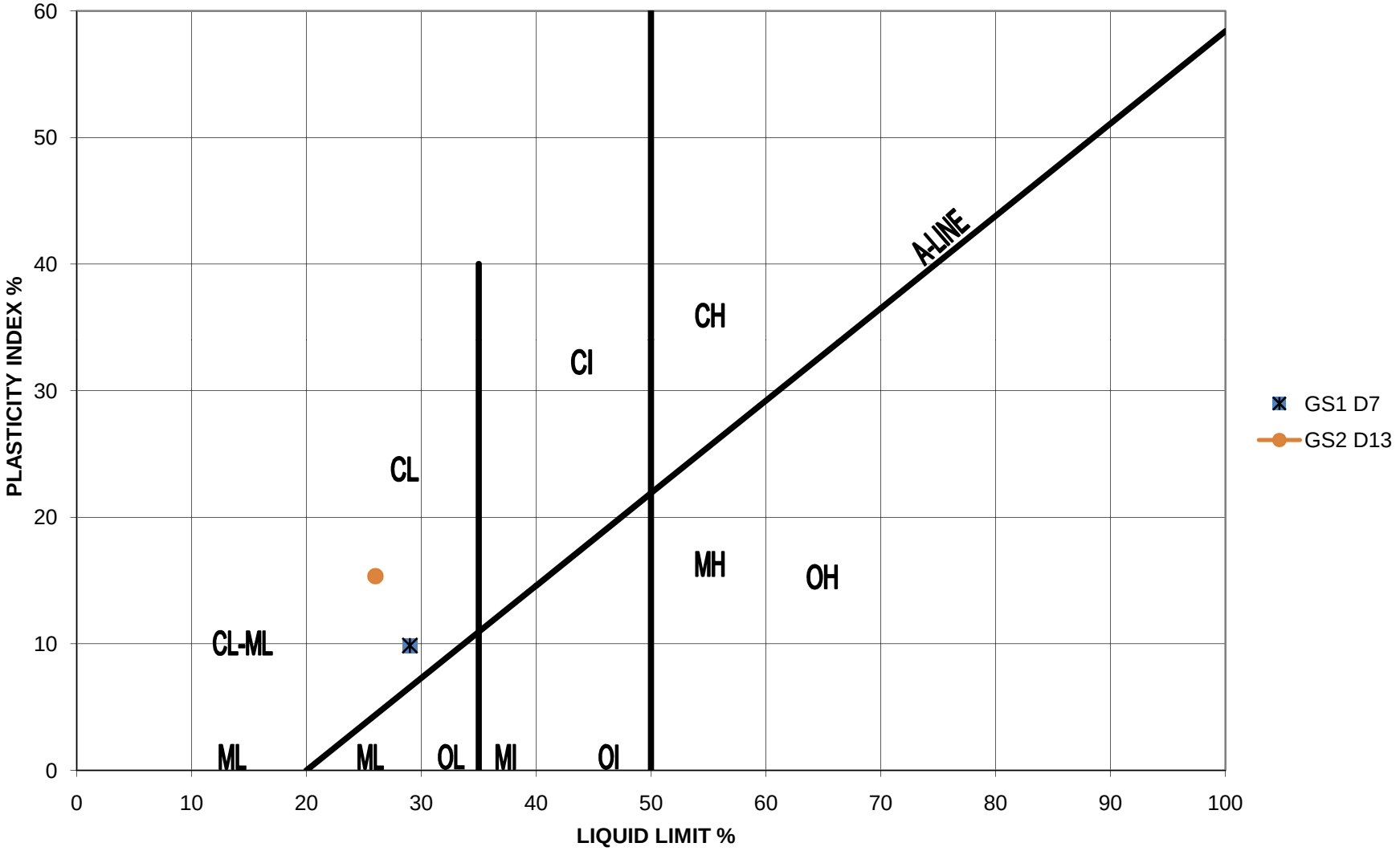


MIT Classification System

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

Project Name:	Mayfield Road		**Project No.:**	101-17262-00	**Figure B9**
Location ID.:	D13	**Sample No./Depth:**	GS2	**Remarks:**	Clayey sand and silt, trace gravel

Mayfield Rd 101-17262-00
Atterberg Limits Plasticity Chart
Figure B10



H:\Proj\GENIVAR 2011\101-17262-00 Mayfield Rd\Tech\Lab\Atterberg Limits D7 GS1 03.08.12

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: Widening of Mayfield Road
Location: Mayfield Road from Chniguacousy Road to Hurontario Street

Flexible Pavement Design/Evaluation

Structural Number	162.14		**Soil Resilient Modulus**	35.00	**MPa**
Design ESALs	33,557,300		**Initial Serviceability**	4.50	
Reliability	90.00	**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	1.00	180.00	75.60
Granular "A"	0.14	1.00	150.00	21.00
Granular "B"	0.09	1.00	750.00	67.50
	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	164.10

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: Widening of Mayfield Road
Location: Mayfield Road from Hurontario Street to Heart Lake Road

Flexible Pavement Design/Evaluation

Structural Number	187.53		**Soil Resilient Modulus**	20.00	**MPa**
Design ESALs	29,215,100		**Initial Serviceability**	4.50	
Reliability	90.00	**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	1.00	220.00	92.40
Granular "A"	0.14	1.00	150.00	21.00
Granular "B"	0.09	1.00	830.00	74.70
	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	188.10

Appendix D

Pavement Structure Distress Manifestations – Figure A1

Section 1

Ministry of Transportation
Ontario

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

Location From: Chingua Cousy Road **To:** 50 m East of McLaughlin Road

LHRS BEGINS ____ OFFSET ____ km **Section Length** 1.4 km LENGTH **District** ____

Survey Date YEAR 11 MONTH 2 **PCR** 90 **RCR** 8.0 **Traffic Direction** B (B : BOTH DIRECTIONS, N : NORTH BOUND, S : SOUTH BOUND, E : EAST BOUND, W : WEST BOUND) **Highway** 14

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								
PAVED PARTIAL	✓	Pavement Edge/ Curb Separation								
		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

Section 2

Ministry of Transportation
Ontario

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

Location From: 50 m East of McLaughlin Rd **To:** 250 m West of Hurontario Street

LHRS ____ BEGINS ____ OFFSET km **Section Length** 1.1 LENGTH km **District** ____

Survey Date 11 YEAR 2 MONTH **PCR** 55 **RCR** 5.5 **Traffic Direction** B (B: BOTH DIRECTIONS; N: NORTH BOUND; S: SOUTH BOUND; E: EAST BOUND; W: WEST BOUND) **Highway** 14

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

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								
		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

Section 3

Ministry of Transportation
Ontario

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

Location From: 250 m West of Huvontario St. **To:** 150 m West of Kennedy Road

LHRS ____ BEGINS ____ OFFSET km **Section Length** 1.5 km LENGTH **District** ____

Survey Date 11 YEAR 2 MONTH **PCR** 90 **RCR** 8.5 **Traffic Direction** B (B : BOTH DIRECTIONS; N : NORTH BOUND; S : SOUTH BOUND; E : EAST BOUND; W : WEST BOUND) **Highway** 14

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

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

Section 4

Ministry of Transportation
Ontario

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

Location From: 150 m West of Kennedy Rd **To:** 700 m West of Heart Lake Road (Property # 3742)

LHRS BEGINS ____ OFFSET ____ km **Section Length** 0.9 km LENGTH **District** ____

Survey Date 11 YEAR 2 MONTH **PCR** 55 **RCR** 5.5 **Traffic Direction** B (B : BOTH DIRECTIONS; N : NORTH BOUND; S : SOUTH BOUND; E : EAST BOUND; W : WEST BOUND) **Highway** 14

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

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

Section 5

Ministry of Transportation
Ontario

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

Location From: (Property #3742), 700 m West of Heart Lake **To:** Heart Lake Road

LHRS ____ BEGINS ____ OFFSET km **Section Length** 0.7 km LENGTH **District** ____

Survey Date 11 YEAR 2 MONTH **PCR** 85 **RCR** 8.0 **Traffic Direction** B (B : BOTH DIRECTIONS; N : NORTH BOUND; S : SOUTH BOUND; E : EAST BOUND; W : WEST BOUND) **Highway** 14

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

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 FULL		Pavement Edge/ Curb Separation								
PAVED PARTIAL	✓	Distortion								
SURFACE TREATED		Breakup/Separation								
SURFACE TREATED		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					
PAVEMENT	Machine Patching					
PAVEMENT	Spray Patching					
PAVEMENT	Rout and Seal Cracks					
PAVEMENT	Chip Seal					
SHOULDERS	Manual Patching					
SHOULDERS	Machine Patching					
SHOULDERS	Rout and Seal Cracks					
SHOULDERS	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 E

Site Photographs

Mayfield Road\Section 1: Mayfield Rd. and Chinguacousy Rd Intersection, Looking towards West

Mayfield Road\Section 1: Looking towards West

Mayfield Road\Section 1: Looking towards West

Mayfield Road\Section 1: Looking towards West

Mayfield Road\Section 2: Looking towards West, 400 m West of Hurontario Street

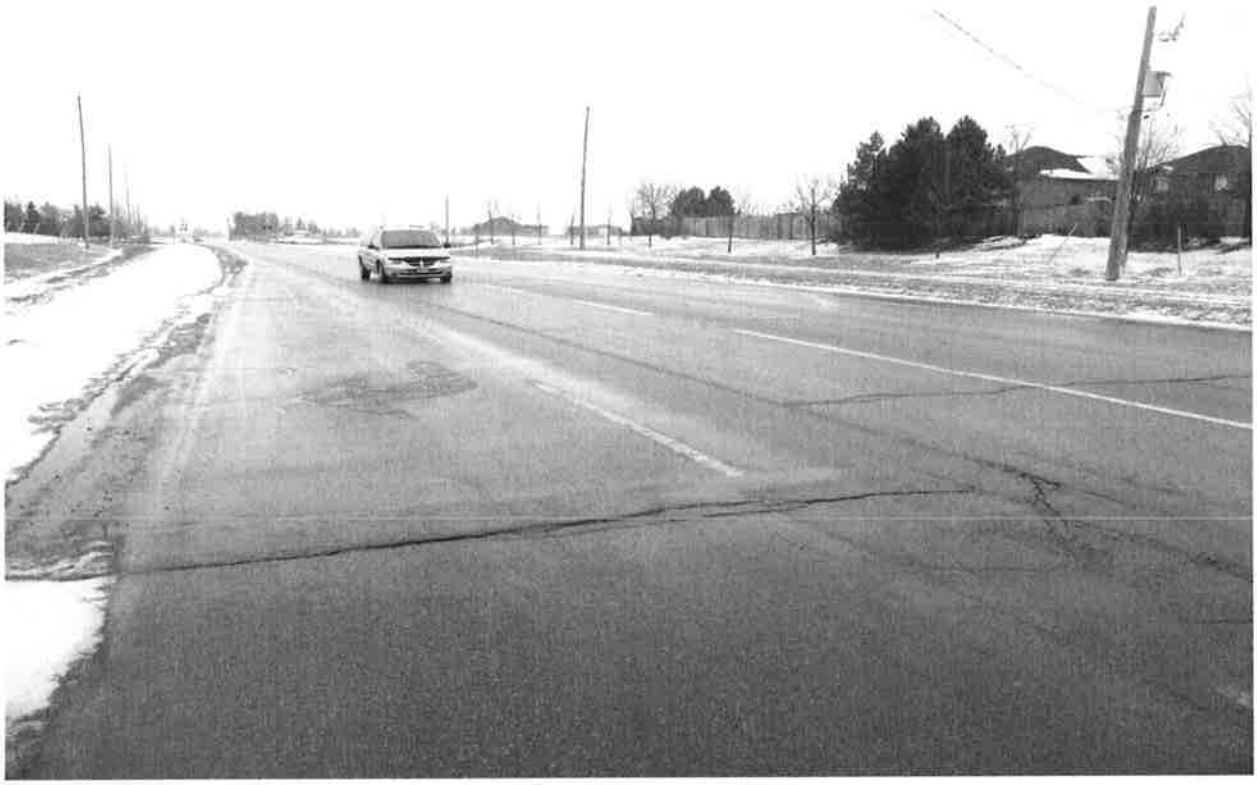
Mayfield Road\Section 2: Looking towards West, 500 m West of Hurontario Street

Mayfield Road\Section 2: Looking towards West

Mayfield Road\Section 2: Looking towards West

Mayfield Rd. and Robertson Davies Rd. Intersection\Section 2: Looking towards West

Mayfield Road\Section 2: Looking towards West\Railway Crossing



Mayfield Road\Section 2: Looking towards West\400 m East of McLaughlin Rd.

Mayfield Road\Section 2: Cracks on the Pavement

Mayfield Road\Section3: Looking towards West

Mayfield Road\ Section3: 200 m East of Kennedy Rd.,Looking towards West

Mayfield Road Rd \Section3: 500 m West of Kennedy Looking towards West

Mayfield Road\Section3: Looking towards West

Mayfield Road\Section 3: 700 m West of Kennedy Road Looking towards West\Embankment Fill for Structural Bridge crossing Tributary

Mayfield Road \ Section 3 :700 m West of Kennedy Road, Looking towards West\Structural Bridge crossing a Tributary

Mayfield Road\ Section 3: Looking towards West\Embankment Fill west of the Structural Bridge \ South side of Mayfield, West of the Bridge

Mayfield Road\Section 3: Looking towards West

Mayfield Road\ Section 3: Looking towards West

Mayfield Rd\Section 3: Looking towards West, 250 m East of Hurontario Street

Mayfield Road\Section 3: Looking towards West, 200 m East of Hurontario St.\ Gas Station at the Northeast corner of Mayfield and Hurontario St. Intersection

Mayfield Road\Section 3: Mayfield Road and Hurontario Street Intersection

Mayfield Road\Section4: Looking towards East\Steel Sheet Piles at the North Side of Mayfield Rd. as Retaining walls for the road Embankment (Approx. 400 m long)

Mayfield Road\Section4: Looking towards West\Steel Sheet Piles at the North Side of Mayfield Rd and Wetland Area to the North OF Mayfield Rd and East of Kennedy Rd.

Mayfield Road\Section4: Looking towards West\ Culverts and wetland at the Northeast Corner of Mayfield and Kennedy Rd. Intersection.

Mayfield Road\Section4: Concrete culvert and Storm Water Management Pond at the Northeast Corner of Mayfield Rd. and Kennedy Rd. Intersection.

Mayfield Road\Section4: Looking Towards East\Widening Construction for the Southside of Mayfield, East of Kennedy Rd.

Mayfield Road\Section4: Looking towards East \ Mayfield Rd. and Kennedy Rd. Intersection.

Mayfield Road\Section4: Looking towards West \ from Kennedy Road to 150 m Westerly\see cracks and distortion area\ new Subdivision will be constructed at the Northside of Mayfield Rd., West of Kennedy Rd.

Mayfield Road, 150 m West of Kennedy Rd.\Section4: Looking towards North

Mayfield Road\Section4: Looking towards West

Mayfield Road\Section4: Looking towards West

Mayfield Road\Section4\ Maintenance Treatment

Mayfield Road\Section4: Looking towards West\cracks and Distortion Area \See Noise Wall along the South Side of Mayfield Road

Mayfield Road\Section5: Looking Towards West

Mayfield Road\Section 5: Looking Towards West

Mayfield Road\Section 5: Small Pond at the southwest corner of Mayfield Rd. and Heart Lake Intersection.

Mayfield Road\Section 5: Looking Towards West\Wetland Area at the North side of Mayfield Rd. , about 400 m West of Heart Lake Rd.

Mayfield Road\Section 5: Wetland Area at the North side of Mayfield Rd.

Mayfield Road\Section 5: Looking towards West\South side of Mayfield Rd., High Fill Embankment