



THURBER ENGINEERING LTD.

2023 GROWTH RELATED ROADS DETAILED DESIGN

**PAVEMENT EVALUATION REPORT
PROJECT #: 2020-98**

**CHINGUACOUSY ROAD
FROM MAYFIELD ROAD TO OLD SCHOOL ROAD**

TOWN OF CALEDON, ONTARIO

Report to:

Town of Caledon

c/o

Ainley Group



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1 INTRODUCTION

Thurber Engineering Ltd. (Thurber) was retained by Ainley Group on behalf of The Town of Caledon to complete a pavement investigation on Chinguacousy Road from Mayfield Road (southern project limit) to Old School Road (northern project limit) in Caledon, Ontario. It is understood that the Town of Caledon is implementing a rehabilitation strategy on existing rural roads as part of their 2023 Growth Related Detailed Design project to support the increase in traffic use due to the continued growth of the population of Caledon. It is to be noted that in addition to the pavement investigation, a hydrogeological investigation was also completed and is issued under a separate report cover.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

2 BACKGROUND INFORMATION

Chinguacousy Road currently consists of a two-lane rural roadway, with one lane in the northbound (NB) direction and one in the southbound (SB) direction. Narrow gravel outside shoulders exists for most of the roadway through the project limits, although at localized areas the outside shoulders widen slightly. The posted speed limit on Chinguacousy Road is 80 km/hr. It is understood that widening of the existing roadway is expected throughout the project limits, with consideration of upgrading the corridor to a four-lane urban divided platform.

For the purposes of this field investigation, chainage on Chinguacousy Road was established in the field with Station 10+000 at the intersection of Mayfield Road and increasing northerly to the intersection with Old School Road at Station 13+100. A project key plan is provided in Appendix A.

2.1 2019 Development Charge Study

It is understood that a Development Charge (DC) Background Study was completed in 2019 by Watson and Associates, and the Town of Caledon provided a portion of that study to Thurber. The DC Study provided a recommended "Road Improvement Type" for each road and recommended that Chinguacousy Road receive a "Rural Road Upgrade". The DC study provided a standard pavement design, as well as road and road related work unit quantities and costs, for a Rural Road Upgrade project. This standard pavement design was used to develop the appropriate rehabilitation method for Chinguacousy Road. The DC Study also recommended that



the pavement platform be widened to 10.0 m width, with 3.5 m wide lanes and 1.5 m paved shoulders.

3 FIELD INVESTIGATION

A field investigation was carried out in July 2021 by Thurber, which consisted of a visual pavement surface condition survey, Falling Weight Deflectometer (FWD) testing, asphalt coring and borehole drilling. Typical photographs of the existing roadway condition are provided in Appendix B.

A visual inspection of the pavement surface was completed in accordance with MTO Manual SP- 022, Condition Rating Manual for Flexible Pavement for Municipalities. Results of the visual condition survey are provided in Appendix C.

A total of 16 boreholes were advanced within the project limits, with 11 boreholes advanced in the travel lanes and 5 boreholes advanced in the narrow gravel outside shoulder. A total of 7 pavement cores were extracted in the travel lanes, prior to drilling. Boreholes were advanced at approximately at 200 m intervals and staggered by travel direction. Twelve (12) boreholes were advanced to a depth of 2.1 m as part of the pavement investigation, and 4 boreholes were advanced to a depth of 5.1 m as part of the hydrogeological investigation (under a separate report cover). In addition to the boreholes in the pavement platform, a total of 16 shallow test pits were advanced using a shovel, to a depth of 300 mm in the grassy area adjacent to the pavement edge, for topsoil depth verification. Upon completion of drilling, all boreholes were backfilled with auger cuttings and patched with cold mix asphalt. Pavement core logs with typical photographs are provided in Appendix D, while borehole logs are provided in Appendix E.

Prior to the start of the drilling investigation, public utility clearances were obtained through Ontario One-Call. A Road Occupancy Permit was obtained prior to commencement of drilling. Traffic control was provided by Alliance Traffic Control, and boreholes were advanced using a truck-mounted hydraulic drill rig supplied and operated by Altech Drilling Investigative Services Ltd. The field investigation was carried out under the full-time supervision of Thurber technical staff.

Soil samples were identified, placed in labelled containers, and transported to Thurber's laboratory for further examination. Results of the laboratory testing are provided in Appendix F.

Where samples were selected for possible submission to the laboratory for analytical testing, a portion of the recovered soil sample was placed in laboratory prepared containers and transported to Thurber's laboratory for review and submission to the analytical laboratory.



The structural adequacy of Chinguacousy Road was evaluated by Falling Weight Deflectometer (FWD) testing. The FWD tests were completed at 50 m intervals staggered by travel direction. At each test location, a series of four load applications were applied to the pavement surface. The first application was a "seating" load to ensure the FWD load plate was firmly resting on the pavement surface. The subsequent three loads were approximately 35, 50, and 65 kN. Pavement surface deflections under the load were measured by sensors (velocity transducers) placed at a fixed spacing from the load plate in accordance with the Strategic Highway Research Program (SHRP) testing protocols. Asphalt thickness from the pavement cores and boreholes, along with granular base thickness from the subsurface investigation were used in the analysis of the FWD data. Results of the FWD data analysis are provided in Appendix G.

3.1 Existing Pavement Condition

Approximately 1.9 km length of existing pavement on Chinguacousy Road is considered in **Very Good** condition (new pavement section), with minimal/no pavement distresses observed along this section. The new pavement section extends from Station 10+000 to 11+000, and Station 11+860 to 12+750. The remaining 1.1 km length of the existing pavement is in **Fair** condition (old pavement section) and extends from Station 11+000 to 11+860 and Station 12+750 to 12+900. Predominant pavement distresses observed in the old pavement section included frequent – moderate severity wheel track rutting, potholes, pavement edge cracking and breaks. Other noticeable distresses included intermittent – moderate severity longitudinal and transverse cracking, with intermittent – slight severity ravelling and flushing.

The overall ride quality for Chinguacousy Road in the old pavement section is rated to be 6.5 (out of 10), with a back-calculated average Pavement Condition Index (PCI) value of 73 (out of 100).

3.2 Existing Pavement Structure

3.2.1 Asphalt

In the new pavement section, the asphalt thickness varied from 90 to 110 mm from Station 10+050 to 10+500 and varied from 145 to 150 mm from Station 11+955 to 12+550. The thickness of the surface layers in the asphalt cores varied from 40 to 50 mm, meanwhile the thickness of the binder layer varied from 50 to 105 mm. At one (1) core location at Station 10+500 in the SB lane, delamination was observed between the surface and the binder layer. In the thinner pavement section, the asphalt layer thickness varied from 25 to 35 mm.

Asbestos testing was completed on 4 asphalt core samples extracted on Chinguacousy Road at Stations 10+050, 11+150, 11+955 and 12+900. The testing was completed by ALS Environmental



and test results determined that no asbestos fibres were detected in any of the core samples. Detailed results of the asbestos testing are provided in Appendix H.

3.2.2 Pavement Granular Material

The asphalt layer on Chinguacousy Road was supported by a granular base/subbase layer that extended to depths typically ranging from 370 to 800 mm, below the asphalt surface with an average thickness of 450 mm. The granular base/subbase consisted of predominantly sand with silt with clay, some to trace gravel. Although from Station 11+800 to Station 12+500 the granular base/subbase consisted of sand with gravel, some silt, some to trace clay.

Laboratory test results determined that at all test locations, the granular base/subbase layers observed considerable silt and clay content and did not meet any granular specifications.

3.2.3 Peat

Beneath the granular base/subbase, a coarse fibrous organic material layer was observed at 4 borehole locations, at Stations 10+050, 10+230, 11+300, and 12+900. The peat layer was observed to extend to depths varying from 500 mm to 1.7 m beneath the granular base/subbase layer.

3.2.4 Subgrade Soils

Beneath the peat layer the underlying subgrade soil is mainly comprised of silty clay with sand, to, sandy silt with clay with some to trace gravel. Standard Penetration Tests (SPTs) were completed at several borehole locations and the 'N' values ranged from 4 to 79 blows per 300 mm of penetration, indicating a soft to hard soil consistency.

Particle size analyses indicate that subgrade soils predominantly have a low susceptibility to frost heaves, with a low to moderate potential for soil erodibility. At Station 11+425 in the NB lane from depth 4.5 to 5.1 m laboratory test results indicate the subgrade soil had a moderate susceptibility to frost heave with a moderate soil erodibility. Moisture conditions of the subgrade soils were observed to range from 10 to 19 percent indicating a moist subgrade condition. Atterberg limit testing completed at 3 borehole locations determined that subgrade soils were predominantly classified as a low plastic clay (CL), however at Station 12+750 the soil sample was classified as low plastic clay to low plastic silt (CL-ML).

3.2.5 Topsoil

Topsoil measurements were taken approximately 5 to 7 m offset from the roadway centreline at each borehole location. In general, the topsoil thickness ranged from 100 to 300 mm. The average topsoil thickness was observed to be 130 mm.

3.3 Falling Weight Deflectometer Testing

The analysis of the FWD deflection data was completed in accordance with the procedures outlined in the AASHTO Guide for Design of Pavement Structures (1993). The parameters calculated as part of this analysis include:

Normalized Deflection: The deflection (D_0) measured at the centre of the load plate is a good indicator of overall pavement strength. The deflection at this location is a function of the pavement layer stiffness and the support capacity of the subgrade soil. Because deflection is a function of load and a slight variation in measured load at each test point, a linear extrapolation of the measured deflection is made to adjust deflections at all test locations to a “standard” load level of 40 kN.

Materials Characterization: The pavement thickness data from the boreholes were used in conjunction with the FWD results to estimate the stiffness (strength) of the existing pavement. Pavement layer stiffness back-calculation uses closed form models to estimate layer elastic modulus values, given the layer thickness and FWD data.

The procedure as outlined in the AASHTO 1993 Guide for Design of Pavement Structures, Part III, Chapter 5, was used to determine the properties of the as-constructed flexible pavements. The resultant data includes the composite elastic pavement modulus (E_p) for the combination of all bound layers above the subgrade (e.g., the asphalt concrete and granular bases), and the subgrade elastic modulus (E_s). The subgrade resilient modulus (M_R) is determined by reducing the value of E_s by a conversion factor of 3.

Effective Structural Number: Based on the back-calculated pavement moduli, the effective structural number (SN_{Eff}) of the existing pavement was calculated using the 1993 AASHTO Guide for Design of Pavement Structures procedure.

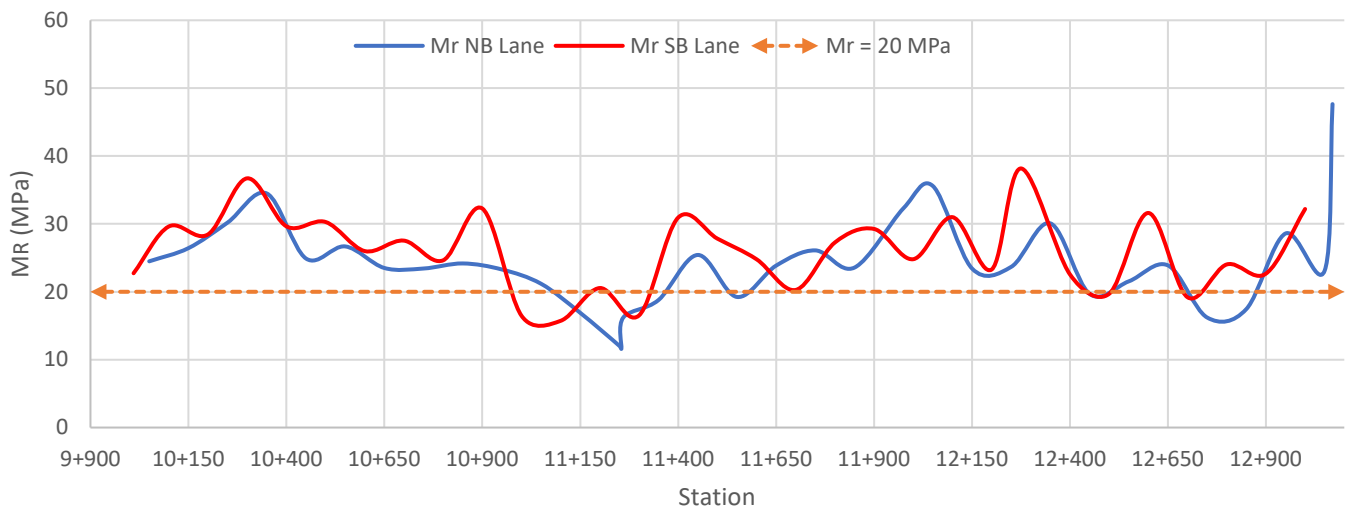
Results of the pavement load/deflection testing along Chinguacousy Road, and data analysis are summarized in Table 3.1, with detailed FWD test results provided in Appendix G.

Table 3.1. Summary of FWD Analysis Results

Direction	D_0 (μm)			M_R (MPa)			E_p (MPa)			SN_{Eff} (mm)		
	Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.
NB	278	1,444	669	12	36	23	139	1,300	454	40	106	68
SB	207	1,081	579	16	48	27	176	1,751	495	45	117	70

The average normalized deflections for the travel lanes in both directions was observed to be 624 μm ; however individual deflections varied from as low as 207 μm to as high as 1,444 μm .

The subgrade strength (M_R) was back-calculated to have an overall average M_R value of 25 MPa, although actual values ranged from 12 to 48 MPa within the project limits. Below is a plot which shows the M_R values of the subgrade strength of Chinguacousy Road.



Back-calculation of the effective structural number (SN_{Eff}) for Chinguacousy Road was observed to range from 40 to 99 mm with an average of 69 mm. It is to be noted that values as high as 111 and 117 mm were observed at Stations 10+800 and 12+800 respectively.

4 PAVEMENT DESIGN ANALYSIS

A pavement design analysis was completed for Chinguacousy Road to determine the pavement structure required to support the anticipated traffic volumes, under the observed conditions. The results of the pavement design analysis are provided in Appendix J.

4.1 Traffic Analysis

Traffic information was provided by the Town of Caledon, which has been summarized in the table below.

Table 4.1. Chinguacousy Road Traffic Information

Survey Date	Two-way AADT	Percentage of Light Trucks	Percentage of Heavy Trucks
2018	2,350	-	4.6
2016	2,067	-	4.6
2014	2,305	-	-

The Average Annual Daily Traffic (AADT) decreased by a significant amount in the year 2016. Therefore, a linear interpolation between the years 2014 to 2018 was used to calculate the average growth rate per year. The growth rate was back calculated to be 0.5 percent per year; however, for pavement design purposes a minimum of 1.0 percent growth rate was assumed. Furthermore, this growth rate was applied to the 2018 AADT to forecast the 2023 AADT which is the assumed construction year. Therefore, the 2023 AADT is calculated to be 2,470.

Since a breakdown of the vehicle classes in the traffic data was not provided, and only a percentage of heavy trucks were provided, therefore an average truck factor of 2.5 was assigned for pavement design purposes.

4.2 ESALs Calculations

The traffic data was used to determine the pavement damage caused by the anticipated traffic volumes. Using axle load equivalency factors (LEF), the pavement damage caused by different axle loads and axle groups are converted to a standard axle load known as Equivalent Single Axle Loads (ESALs). The ESALs calculation was completed in accordance with the MTO Procedures for Estimating Traffic Loads for Pavement Designs. The design ESALs for the 20-year duration is estimated to be 1,142,228.

4.3 AASHTO Pavement Design

The pavement design analysis was carried out using the methodology outlined in the 1993 AASHTO “Guide for the Design of Pavement Structures”, as modified by the Ministry’s “Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions”, and the MTO “Pavement Design and Rehabilitation Manual”.

The AASHTO procedure for the design of flexible pavements determines a required Design Structural Number (SN_{Des}) that characterizes the structural capacity of the pavement layers, for a given set of inputs. The following design inputs were used in the AASHTO design analysis.

Table 4.2. Input Parameters

Parameters	Input Values
Design ESALs	1,142,228
Initial serviceability, (Pi)	4.4
Terminal serviceability (Pt)	2.2
Reliability level (R)	90 %
Overall standard of deviation (So)	0.44

An average subgrade strength of 25 MPa was used in the pavement design, based on the FWD analysis and the observed field conditions to represent the silty clay with sand, soil type.

Based on the design parameters, a required structural design number (SN_{Des}) of 109 mm was calculated, which represents the required strength of the rehabilitated pavement. The SN_{Des} was then distributed among the existing pavement layers to determine the minimum asphalt thickness required to support the anticipated traffic volumes and support conditions.

4.4 Pavement Rehabilitation Alternatives

It is understood that the Town of Caledon had previously completed an assessment of this roadway that provided preliminary pavement design recommendations for the rehabilitation of existing pavements. The preliminary pavement recommendations provided in the 2019 Development Charge (DC) Study, "Rural Road Upgrades" included:

40 mm	Asphalt Surface Course
90 mm	Asphalt Base Course
225 mm	Granular Base Material

It is understood that the recommended pavement rehabilitation strategy for Chinguacousy Road included the removal of existing pavement, followed by the placement of the recommended new pavement structure. A structural assessment was completed for the preliminary pavement design from the DC Study and determined to have a structural capacity (SN_{Des}) of 86 mm, this does not meet the design requirement calculated based on forecasted traffic volumes (SN_{Des}) of 109 mm. Therefore, the structural capacity of the preliminary pavement design is insufficient without additional pavement strength to support anticipated traffic volumes over the local support conditions. In order for the preliminary pavement design included in the DC study to meet the structural requirements for this project, the granular base layer would need to be increased to 400 mm.



4.5 Pulverize Existing Asphalt and New HMA Overlay

A viable rehabilitation strategy in areas where the existing asphalt is very thin is to pulverize (full depth reclamation) the existing asphalt, followed by paving new Hot Mix Asphalt (HMA). This is a viable alternative which recycles the existing asphalt using a pulverizing process on site, followed by grading and compacting, and overlaying with new HMA. The existing asphalt in this section is very thin (30 to 35 mm) and needs to be pulverized and compacted in place, followed by placing a 100 mm thick lift of granular base layer on top. The additional granular base layer is graded and compacted followed by paving with new HMA. The new pavement structure using the pulverization technique from Station 10+950 to 11+600 and Station 12+750 to 13+050 shall consist of:

130 mm	New HMA
100 mm	New Granular Base
100 mm	Pulverizing Depth
	Existing Granular Base/Subbase

4.6 Asphalt Overlay

In the good pavement areas a viable alternative is to pave over the existing roadway with 130 mm of asphalt overlay. Based on the FWD analysis, the design requirement in the new pavement sections require asphalt strengthening. This strategy would require placing new HMA over existing asphalt. The new HMA overlay in the new pavement sections from Station 10+000 to 10+950 and from Station 11+600 to 12+750 shall consist of:

130 mm	New HMA
	Existing Asphalt

It is noted that corridor improvements and pavement widening may be required within these new pavement sections. These design constraints may require considerable adjustment to the existing pavement. Should improvements to the existing pavement require considerable crossfall and profile adjustment, it is recommended consideration be given to apply the pulverize with new HMA option for improved constructability and a consistent pavement platform.

4.7 Full Pavement Reconstruction

In areas where pavement widening or full pavement excavation is required, the following minimum pavement structure is required based on the design analysis.

40 mm	New Asphalt Surface Course
90 mm	New Asphalt Base Course



150 mm	New Granular Base Material
370 mm	New Granular Subbase Material

It is noted that the granular subbase thickness in the developed pavement design does not meet the Town of Caledon standard design for a Collector roadway; therefore, the thickness of the granular subbase should be increased to 450 mm for consistency with standard designs.

5 PAVEMENT RECOMMENDATIONS

5.1 Asphalt Overlay with New HMA

In consideration of the observed pavement conditions, the existing pavement structure and underlying subgrade conditions, it is recommended that the rehabilitation strategy in the new pavement section include overlaying new HMA over existing asphalt. The new pavement structure from Station 10+000 to 10+950 and from Station 11+600 to 12+750 shall consist of:

40 mm	HL 1
90 mm	HDBC (One lift)
	Existing Granular Base/Subbase

The recommended strategy within the above-mentioned roadway section along Chinguacousy Road, utilizes the existing asphalt (which is in very good condition) and pavement structure, and adds new HMA on top to achieve the required strength to support a 20-year design. This is a cost-effective strategy, that eliminates reconstructing the roadway, which would require the removal of the existing pavement structure (asphalt and underlying base/subbase material), followed by rebuilding a new pavement structure. The only drawback to this pavement strategy is a 130 mm grade raise in the profile of the roadway. The construction of this rehabilitation strategy will require the roadway surface to be thoroughly swept, clean, dry, and free of any debris followed by applying tack coat and paving with new HMA.

5.2 Pulverize Existing Asphalt and New HMA Overlay

In the thinner asphalt section, where weaker pavement strength was observed, pavement strengthening is required. It is recommended the existing pavement be pulverized to a depth of 100 mm, with a layer of new granular base material placed prior to asphalt paving. The limits of this rehabilitation strategy extend from Station 10+950 to 11+600 and from Station 12+750 to 13+050 shall consist of:



40 mm	HL 1
90 mm	HDBC (One lift)
100 mm	New Granular Base
100 mm	Pulverized Asphalt
	Existing Granular Base/Subbase

The recommended strategy within the above-mentioned roadway section along Chinguacousy Road, utilizes the existing asphalt layer and pavement structure, and adds a thin granular base layer followed by paving new HMA to achieve the required strength to support a 20-year design. This is a cost-effective strategy, that eliminates reconstructing the roadway, which would require the removal of the existing pavement structure (asphalt and underlying base/subbase material), followed by rebuilding a new pavement structure. The drawback of this rehabilitation strategy incurs a total grade raise of 230 mm. Prior to paving with new HMA, the asphalt surface needs to be pulverized, graded and compacted followed by maintaining a smooth transition due to the additional 100 mm granular base layer.

5.3 Pavement Widening

In consideration of the narrow travel lanes and narrow shoulder width, consideration should be given to widen the existing pavement to provide for on-road bicycle access, improve pavement edge conditions, and provide a more durable, long-lasting pavement. Should widening of the existing pavement be considered, it is recommended that excavation for the new pavement commence at the current pavement edge and extend for the width of the widening. In this area, the surficial topsoil should be removed with the underlying subgrade graded as required.

The grading for the top of subgrade in pavement widening areas must match, or exceed, the thickness of the adjacent existing pavement to maintain lateral drainage at the top of the subgrade. Based on the design requirements, a minimum of 400 mm of Granular A will be required to match the pavement in the widened area. The recommended pavement structure for embankment widening along Bramalea Road shall consist of:

40 mm	HL 1
90 mm	HDBC (in two lifts)
400 mm	Granular A Base (19 mm CRLS)

Excavation for the new pavement should commence at the edge of the pavement with an excavation slope of 1(H): 1(V) to a depth of 1.0 m. The top of subgrade should be graded with a 3 percent slope across the width of the embankment. Fill material in the embankment widening above the top of excavation should comprise select subgrade material (SSM) or granular material, as permitted OPSS.MUNI 1010, and placed to the bottom of the granular base layer.

A typical cross-section for a conventional pavement widening design is provided in Figure 5.1.

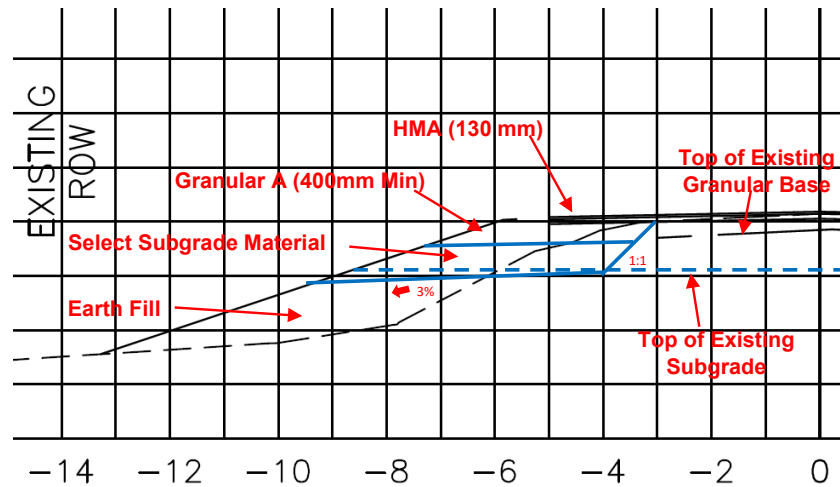


Figure 5.1: Typical Conventional Pavement Widening Cross-Section

5.4 Pavement Platform Reconstruction

It is understood that consideration for corridor improvement is to include reconstruction of the roadway corridor to include a four-lane urban divided platform. Based on the understood corridor expansion and the condition of the existing pavement structure, it is recommended that the new roadway platform be fully reconstructed. The recommended pavement structure for the reconstruction of Chinguacousy Road shall consist of:

40 mm	HL 1
90 mm	HDBC (in two lifts)
150 mm	Granular A Base (19 mm CRLS)
450 mm	Granular B Type I

Depending on the specific design of the new pavement platform, it is possible to rehabilitate existing pavement areas should they align with a directional platform. Rehabilitation of the existing pavement should include pulverizing the existing asphalt with new HMA, as detailed in Section 5.2. Should full reconstruction be required, the granular material in the existing pavement can be reused as granular fill material in the construction of the new pavement platform.



5.5 Pavement Materials

5.5.1 New Hot Mix Asphalt

All new HMA materials should meet the requirements of OPSS.MUNI 310, OPSS.MUNI 1150 and the Town of Caledon Special Provisions, as applicable. All new HMA should be compacted to at least 92 percent of the Maximum Relative Density (MRD) for HL 1 material and 91 percent of the MRD for the HDBC material. An asphalt cement binder grade of PG 58-28 is required for the asphalt mix. A tack coat shall be utilized between the asphalt lifts, all vertical faces, and at all tie- in to existing locations. Recycled Asphalt Pavement (RAP) material may not be used in HL 1 or HDBC asphalt mixes.

5.5.2 New Granular Material

New granular material will be required for the pavement widening, grade raises, and full pavement reconstruction sections. All granular base material should consist of new Granular A 19 mm virgin crusher run limestone in accordance with OPSS.MUNI 1010 and new granular subbase material should meet the OPSS.MUNI 1010 requirements for Granular B, Type 1, as modified by the Town of Caledon Special Provisions.

Placement of the granular material should be completed in accordance with OPSS.MUNI 314 and should be compacted to 100 percent of the Standard Proctor Maximum Dry Density (SPMDD) within 2 percent of Optimum Moisture Content (OMC) in accordance with the requirements of OPSS.MUNI 501.

5.5.3 Existing Granular Material

Laboratory testing of the existing granular base/subbase material does not meet the OPSS standards and specifications due to the high amounts of silt content observed in the granular base/subbase. It is recommended that the existing granular base/subbase material in pavement reconstruction areas be reused as granular fill material in pavement widening or roadway reconstruction areas.

5.6 Drainage

Drainage of the pavement is critical for improved long-term performance. In pavement widening/reconstruction areas, the new pavement structure should be constructed to provide positive cross lateral drainage at the top of the subgrade, as well as at the pavement surface. The top of the subgrade should be sloped at a minimum 3.0 percent grade fall towards the outside ditches or subdrains (where applicable), while the pavement surface should be constructed with a minimum 2 percent crossfall.



In addition to the rehabilitation of the existing pavement, a review of the existing ditches observed many areas where existing ditches have been over-grown with heavy vegetation or where limited ditch depth exists. It is recommended that ditch clean out be considered part of the pavement rehabilitation. In areas where existing ditches are shallow, it should be deepened below the granular base to allow lateral drainage across the pavement platform.

5.6.1 Culvert Installation

New culverts may be required as part of the roadway improvements. Prior to placement of the pipe bedding, the base of the trench should be maintained in a dry condition, free of loose or disturbed material. The pipe must be placed on a uniformly competent subgrade and bedding material. Pipe bedding materials, compaction and cover should follow OPSD 802.030 to 803.034, and/or Town of Caledon specifications.

In areas where a less competent subgrade is encountered, it may be necessary to increase the pipe bedding thickness. Any excessively soft, loose or compressible materials at the pipe subgrade should be sub-excavated and replaced with OPSS Granular A material compacted to at least 95 percent of SPMDD.

Trench backfill materials should be placed and compacted as per OPSS.MUNI 401. Where the trench is located beneath the roadway, OPSS Granular A or B material, or unshrinkable fill should be employed as backfill. Frost tapers should be considered where the depth of the culvert is at or above the frost penetration depth of 1.4 m. The design of frost tapers should be in accordance with OPSD 803.030 and 803.031, with $f = 1.4$ m representing the frost penetration depth and $d = 1.0$ m reflecting the thickness of the existing granular material.

5.7 Erosion Protection

In consideration of the erosion potential at the shoulder rounding should existing shoulders be paved, consideration should be given to seal the granular material on the shoulder rounding in accordance with OPSS.MUNI 305. Alternatively, consideration can be given to using 100 percent RAP material on the surface of the shoulder rounding to reduce potential erosion of the exposed granular material.

5.8 Construction Considerations

The successful performance of the pavement and road works will depend largely on good workmanship and quality control during construction. It is therefore recommended that material testing and inspection be provided by qualified personnel during construction. The inspection and



testing should include observation and inspection of subgrade conditions, granular placement, and asphalt paving inspection as well as onsite recommendation and coordination.

6 ENVIRONMENTAL TESTING

6.1 Environmental Considerations and Analyses

Select soil samples were submitted to a qualified laboratory for analytical testing to assess the environmental quality of the road base and subgrade materials at the sampling locations and to assess preliminary disposal options, if required, for excess excavated granular materials.

The analytical testing was performed by Bureau Veritas Laboratories (BV Labs), an independent laboratory that meets the requirements of Section 47 of O.Reg.153/04, as amended. A summary of the completed analytical testing, sample locations and material types are presented in Table 6.1 below. The laboratory certificates of analysis are presented in Appendix I.

Table 6.1. Samples Selected for Environmental Testing

Borehole Location	Sample ID	Soil Type	Analysis
Station 10+500, SB lane, 1.5m LT CL	Sample CR3, Chinguacousy Rd., 0.60-2.1 m	Silty Clay with Sand	O. Reg. 153/04 Metal and Inorganics and PHCs / BTEX
Station 10+850, SB lane, 3.0m LT CL	Sample CR4, Chinguacousy Rd., 450MM	Silty Clayey Sand with Some Gravel	O. Reg. 153/04 Metal and Inorganics

Additionally, one sample from borehole location Station 10+230, SB, 2.5m LT Centerline (sample ID: Sample CR2, Chinguacousy Rd., 1.7-2.1 m) was submitted for Toxicity Characteristic Leachate Procedure (TCLP) analysis of metals and inorganic parameters, volatile organic compounds, polychlorinated biphenyls, benzo(a)pyrene, and ignitability testing in accordance with O. Reg. 347, as amended, in order to provide preliminary information to classify materials for potential transfer to an Ontario Ministry of Environment, Conservation and Parks (MECP) licenced waste management facility.

It should be noted that excess soil in Ontario is now regulated under O. Reg. 406/19, as amended, made under the Environmental Protection Act, “On-site and Excess Soil Management” that was initially filed on December 4, 2019 (“Excess Soil Regulation”). The regulation does not apply to the reuse of excavated soils on-Site.

To comply with O. Reg. 406/19, as amended, project specific details such as excess soil quantities, soil management strategies and receiving site acceptance criteria are required, which are unknown at this time.



The scope of the required testing and planning documentation can vary significantly depending on the quantity of excess soils that will be generated as a result of the final design. Our current understanding of the Site subsurface material conditions was inferred from a limited number of sampling locations in accessible areas that targeted the preliminary environmental characterization of materials. The spatial and vertical extent of the quality of the materials that may be encountered during construction was not accurately delineated. Without the final design information and management strategies (i.e. on-site or off-site reuse, actual excess soil quantities, reuse site acceptance criteria), the full requirements of the new regulation may not be met. Therefore, the completed analysis should only be regarded as due diligence sampling and testing at this time. Supplemental sampling and testing, as well as planning documentation, beyond the current program may be necessary to meet the requirements of the Excess Soil Regulation.

6.2 Analytical Results and Discussion

In general, visual, and olfactory examination of the soil samples recovered from the field investigation program revealed no unusual staining or odours indicative of hydrocarbon impact or other contamination.

For preliminary characterization of the soil samples the “bulk sample” analytical data was compared to the generic Site Condition Standards provided under O. Reg. 153/04 in MECP’s document “Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of Environmental Protection Act”, April 15, 2011 (“2011 MECP Document”). The analytical results were compared to the MECP’s Table 2: Full Depth Generic Site Condition Standards for Use in a Potable Ground Water Condition for Industrial / Commercial / Community Property Uses for coarse textured soil (MECP Table 2 ICC Standards).

The reported concentrations of the tested parameters from the collected samples on Chinguacousy Road were below MECP Table 2 ICC Standards.

The analytical testing results are provided in the laboratory certificates of analysis in Appendix I.

Based on the preliminary test results, the road base and subgrade materials are anticipated to be acceptable for reuse in engineering applications on site (i.e. site grading fill or backfill) pending geotechnical approval. Once the final design is completed, additional analytical testing of materials may be required based on the desired re-use strategies and volume of material.

Review of the results of the TCLP analyses for fill materials collected from borehole location Station 10+230, SB, 2.5m LT Center Lane OSH (sample ID: Sample CR2, Chinguacousy Rd., 1.7-2.1 m), met the respective Schedule 4 criteria provided under O. Reg. 347, as amended,



therefore materials may generally be disposed of as non-hazardous waste. Additional analytical testing of these materials may be required in order to satisfy the acceptance criteria of the selected waste management facility and anticipated volume of soil to be disposed of.

Additional testing will be required during the detailed design stage to confirm these preliminary recommendations regarding management of excavated soils. In particular, additional testing and preparation of additional planning documents may be necessary to meet the O. Reg. 406/19 "Excess Soil Regulation" requirements if excess soils are to be generated during construction.

Where excavation of existing pavement structures is required, asphalt should be removed separately from granular materials and recycled at an approved recycling facility or disposed of appropriately off-Site. Asphalt should not be mixed with excess excavated soil; fill receivers may not accept excess excavated soils if it contains asphalt.

No statement made herein should be construed as relieving the Contractor's responsibility to comply with all applicable federal and provincial regulations, municipal by-laws and guidelines related to the handling or disposal/discharge of excavated materials and/or extracted groundwater. It should be noted that the current regulatory requirements that were considered in this report are subject to change over time.

7 CLOSURE

The pavement recommendations in this report were developed based on provided information and results of the pavement investigation, supplemented by our experience with the performance and rehabilitation of flexible municipal pavements in Southern Ontario. The information and design recommendations provided in this report are intended for the purposes of the Town of Caledon staff, and their designers.

We trust our report provides the information required and is considered complete. However, should you have any questions regarding this report, please feel free to contact our offices.

STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

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3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

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5. INTERPRETATION OF THE REPORT

- a) **Nature and Exactness of Soil and Contaminant Description:** Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.
- b) **Reliance on Provided Information:** The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.
- c) **Design Services:** The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.
- d) **Construction Services:** During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.



APPENDIX A

Project Key Plan

Chinguacousy Road
From Mayfield Road (Station 10+000) to Old School Road (Station 13+050)
Caledon, Ontario
Project Key Plan





APPENDIX B

Photographs of Typical Conditions

Chinguacousy Road
From Mayfield Road (Station 10+000) to Old School Road (Station 13+050)
Caledon, Ontario
Photographs of Typical Conditions

Typical Photograph # 1

Chinguacousy Road, Station 10+060, NB Lane (Looking Northerly)



Typical Photograph # 2

Chinguacousy Road, Station 10+520, NB Lane (Looking Northerly)



Chinguacousy Road
From Mayfield Road (Station 10+000) to Old School Road (Station 13+050)
Caledon, Ontario
Photographs of Typical Conditions

Typical Photograph # 3

Chinguacousy Road, Station 11+000, NB Lane (Looking Northerly)



Typical Photograph # 4

Chinguacousy Road, Station 11+600, NB Lane (Looking Northerly)



Chinguacousy Road
From Mayfield Road (Station 10+000) to Old School Road (Station 13+050)
Caledon, Ontario
Photographs of Typical Conditions

Typical Photograph # 5

Chinguacousy Road, Station 11+870, NB Lane, Pavement change (Looking Northerly)



Typical Photograph # 6

Chinguacousy Road, Station 12+040, NB Lane (Looking Northerly)



Chinguacousy Road
From Mayfield Road (Station 10+000) to Old School Road (Station 13+050)
Caledon, Ontario
Photographs of Typical Conditions

Typical Photograph # 7

Chinguacousy Road, Station 12+550, NB Lane (Looking Northerly)



Typical Photograph # 8

Chinguacousy Road, Station 12+990, NB Lane (Looking Northerly)





APPENDIX C

Pavement Condition Survey

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

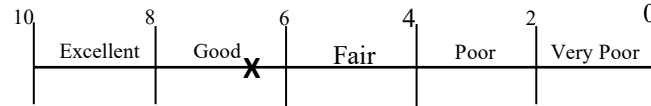
Chingacousy Road

Road No. (Street): Chingacousy Road
Location From: Mayfield Road (Station 10+000)
To: Old School Road (Station 13+050)

Section Length: 3.05 (Km)
Survey Date: July 7, 2021
Traffic Direction: B
B (Both Directions); N (North); S (South); E (East); W (West)

Contract No:
Work Project No: 29719
Class: M
F: Freeway, C: Connecting Link, A: Major Arterial, M: Minor Arterial, R: Residential

Pavement Condition Rating: 70
Riding Condition Rating: 6.5
Evaluated by: Abdul Nasri



Pavement Distress Manifestion			Weighting (wi)	Severity of Distress			Density of Distress (Extent of Occurrence, %)			DMI
				Slight	Moderate	Severe	Intermittent <20	Frequent 20-50	Extensive >50	
Surface Defects	Ravelling	1	3.0	X			X			6.0
	Flushing	2	0.5	X			X			1.0
	Potholes	3	1.0		X			X		4.0
	Pavement Edge Breaks	4	1.5		X			X		6.0
	Manholes & Catchbasins	5	1.0							0.0
Surface Deformations	Rippling and Shoving	6	1.0							0.0
	Wheel Track Rutting	7	3.0		X			X		12.0
	Distortion	8	1.0							0.0
	Utility Trenches	9	1.0							0.0
Cracking	Longitudinal	10	1.0		X		X			3.0
	Transverse	11	1.0		X		X			3.0
	Pavement Edge	12	1.0		X			X		4.0
	Map	13	1.5							0.0
	Alligator	14	3.0							0.0
Ride Comfort Rating (RCR) from 0-10: 6.5 TOTAL DMI 8.1										
Back-calculated PCI Value: 73										

Shoulder Distress Manifestion		Severity of Distress						Density of Distress (Extent of Occurrence, %)					
		Right			Left			Right			Left		
Dominant Type	Distress	Slight	Moderate	Severe	Slight	Moderate	Severe	<20	20-50	>50	<20	20-50	>50
Paved Full	Pavement Edge												
	Paved Shoulder Separation												
Paved Partial	Cracking												
	Breakup and Potholes												
Surface Treated	Distortion												
Primed	Pavement Edge Curb Separation												

Maintenance Treatment									
Pavement		Extent of Occurrence, %			Shoulder		Extent of Occurrence, %		
		<20	20-50	>50			<20	20-50	>50
		1	2	3			1	2	3
Manual Patching		X			Manual Patching				
Machine Patching		X			Manual Spray Patching				
Manual Spray Patching					Manual Chip Seal				
Manual Chip Seal					Crack Rout & Seal				
Machine Chip Seal									
Fog Seal									
Surface Treatment									
Manual Burn & Seal									
Crack Rout & Seal									

Distress comments (Items not covered above): New pavement section was observed from Station 10+000 to 11+000 and 11+860 to 12+750. Minimal distresses were observed in the new pavement areas. Survey is based on old pavement section from Station 11+000 to 11+860 and 12+750 to 13+050. Most distressed pavement section was observed from Station 12+750 to 13+050.



APPENDIX D

Pavement Core Logs and Typical Photographs

Chingacousy Road
From Mayfield Road (Station 10+000) to Old School Road (Station 13+050)
Caledon, Ontario
Pavement Core Logs

Station	Direction	Lane	Asphalt Layer Thickness(mm)			Comments
			Surface	Binder	Total	
10+050	SB	Lane	40	50	90	
10+500	SB	Lane	50	60	110	Delamination @ depth 50 mm
11+150	NB	Lane	30		30	
11+300	SB	Lane	25		25	
11+955	SB	Lane	45	100	145	
12+550	SB	Lane	45	105	150	
12+750	NB	Lane	30		30	
12+900	SB	Lane	35		35	

Chingacousy Road
From Mayfield Road (Station 10+000) to Old School Road (Station 13+050)
Caledon, Ontario
Pavement Core Logs and Typical Photographs



Pavement Core Photo # 1

Chingacousy Road
Station 10+050 – SB Lane

Layer	Thickness (mm)
Surface	40
Binder	50
Total	90

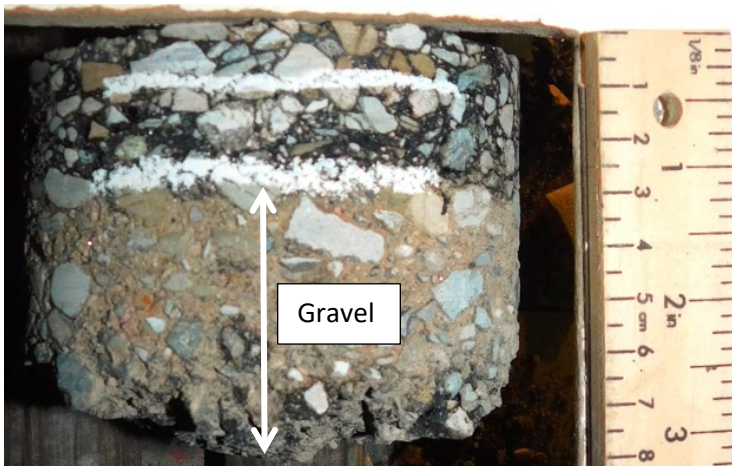


Pavement Core Photo # 2

Chingacousy Road
Station 10+500 – SB Lane

Layer	Thickness (mm)
Surface	50
Binder	60
Total	110

Note: Delamination @ depth 50 mm

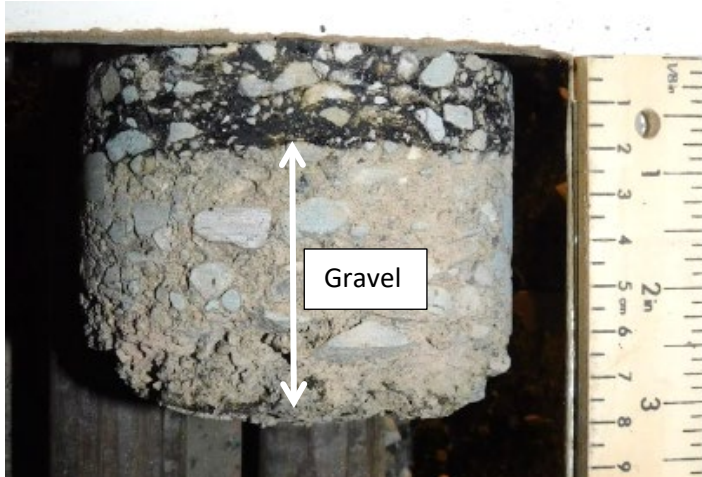


Pavement Core Photo # 3

Chingacousy Road
Station 11+150 – NB Lane

Layer	Thickness (mm)
Surface	30
Total	30

Chingacousy Road
From Mayfield Road (Station 10+000) to Old School Road (Station 13+050)
Caledon, Ontario
Pavement Core Logs and Typical Photographs



Pavement Core Photo # 4

Chingacousy Road
 Station 11+300 – SB Lane

Layer	Thickness (mm)
Surface	25
Total	25

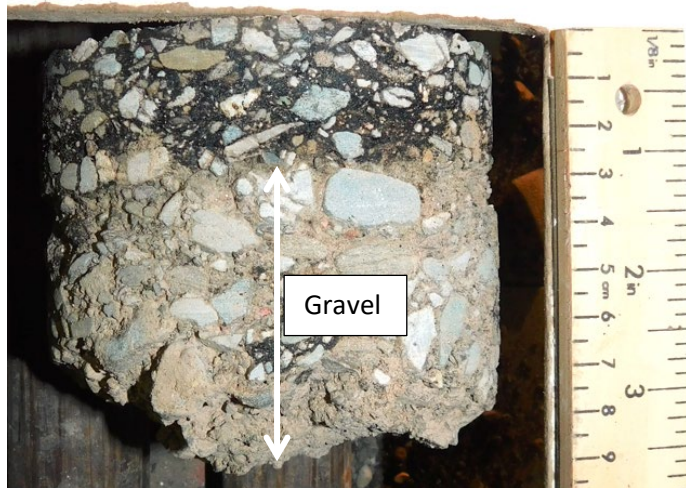


Pavement Core Photo # 5

Chingacousy Road
 Station 11+955 – SB Lane

Layer	Thickness (mm)
Surface	45
Binder	100
Total	145

Chingacousy Road
From Mayfield Road (Station 10+000) to Old School Road (Station 13+050)
Caledon, Ontario
Pavement Core Logs and Typical Photographs



Pavement Core Photo # 7

Chingacousy Road
Station 12+750 – NB Lane

Layer	Thickness (mm)
Surface	30
Total	30



Pavement Core Photo # 8

Chingacousy Road
Station 12+900 – SB Lane

Layer	Thickness (mm)
Surface	35
Total	35



APPENDIX E

Borehole Logs



Chingacousy Road
From Mayfield Road (Station 10+000) to Old School Road (Station 13+050)
Caledon, Ontario
Borehole Logs

Chinguacousy Road

Station 10+050 SB 1.5m LT CL Lane
 0- 90 Asph
 90- 230 Br Sa W Cl W Si Some Gr Dry
 Percent Passing 4.75 mm = 84%
 75 µm = 44%
 5 µm = 23%
 Frost Susceptibility = LSFH
 Soil Erodibility = 0.23

230- 500 Co Fib Org Matl
 500- 1.5 Gry Sa(y) Si W Cl Tr Gr Moist
 1.5- 2.1 Gry Sa(y) Si W Cl Tr Gr (Hard) Moist
 Nvalue=82 blows / 250mm
 Lane Width = 3.4m PP OSH = 1.4m

Station 10+230 SB 2.5m LT CL Lane
 0- 300 Br Sa and Gr Some Si Tr Cl Dry
 w @ 0.2m = 4%

300- 1.7 Co Fib Org Matl
 1.7- 2.1 Gry Si(y) Cl(y) W Sa Some Gr Moist
 (Hard)
 Nvalue=79 blows / 300mm
 w @ 1.9m = 19%
 Percent Passing 4.75 mm = 90%
 75 µm = 66%
 5 µm = 35%
 Frost Susceptibility = LSFH
 Soil Erodibility = 0.26

2.1- 3 Gry Si(y) Cl(y) W Sa Some Gr Moist
 3- 3.6 Br Si(y) Cl(y) W Sa Some Gr Moist
 (Hard)
 Nvalue=50 blows / 125mm
 3.6- 4.5 Br Si(y) Cl(y) W Sa Some Gr Moist
 4.5- 5.1 Gry Si(y) Cl(y) W Sa Some Gr Moist
 (Hard)
 Nvalue=96 blows / 250mm
 Lane Width = 3.4m PP OSH = 90mm

Station 10+500 SB 1.5m LT CL Lane
 0- 110 Asph
 110- 600 Br Sa W Si W Cl Dry
 Percent Passing 4.75 mm = 92%
 75 µm = 51%
 5 µm = 25%
 Frost Susceptibility = LSFH
 Soil Erodibility = 0.24
 600- 1.5 Br Si(y) Cl W Sa Moist
 1.5- 2.1 Br Si(y) Cl W Sa (Hard) Moist
 Nvalue=58 blows / 250mm
 Lane Width = 3.4m PP OSH = 1.0m

Station 10+850 SB 3m LT CL Lane
 0- 30 Asph
 30- 450 Br Sa W Si W Cl Dry
 450- 1.5 Gry Si(y) Cl(y) W Sa Some Gr Moist
 1.5- 2.1 Gry Si(y) Cl(y) W Sa Some Gr Moist
 (Hard)
 Nvalue=50 blows / 100mm
 w @ 1.8m = 14%
 Lane Width = 2.9m PP OSH = 1.4m

Station 11+000 SB 1.5m LT CL Lane
 0- 30 Asph
 30- 540 Br Sa W Si W Cl Tr Gr Dry
 540- 1.5 Br Si(y) Cl(y) W Sa Some Gr Moist
 1.5- 1.5 Br Si(y) Cl(y) W Sa Some Gr Moist
 (Hard)
 Nvalue=50 blows / 25mm
 w @ 1.5m = 6%
 Lane Width = 2.8m PP OSH = 1.2m

Station 11+150 NB 1.5m RT CL Lane
 0- 30 Asph
 30- 370 Br Sa W Cl W Si Tr Gr Dry
 Percent Passing 4.75 mm = 92%
 75 µm = 46%
 5 µm = 26%
 Frost Susceptibility = LSFH
 Soil Erodibility = 0.19
 370- 1.5 Gry Si(y) Cl(y) W Sa Some Gr Moist
 1.5- 2.1 Gry Si(y) Cl(y) W Sa Some Gr Moist
 (V.Stiff)
 Nvalue=17 blows / 300mm
 Lane Width = 3.4m PP OSH = 1.4m

Station 11+300 SB 1.5m LT CL Lane
 0- 25 Asph
 25- 400 Br Sa W Cl W Si Tr Gr Dry
 w @ 0.2m = 9%
 400- 1.5 Co Fib Org Matl
 1.5- 1.9 Gry Si(y) Cl(y) W Sa Some Gr Moist
 (Soft)
 Nvalue=4 blows / 300mm
 1.9- 2.1 Br Si(y) Cl(y) W Sa Some Gr Moist
 w @ 2m = 13%
 Lane Width = 3.2m PP OSH = 1.2m



Chingacousy Road
From Mayfield Road (Station 10+000) to Old School Road (Station 13+050)
Caledon, Ontario
Borehole Logs

Station 11+425	NB 3.5m RT CL	OSH
0- 520	Br Sa W Gr Some Cl Some Si	Dry
520- 1.5	Gry Si and Cl Some Sa	Moist
1.5- 2.1	Gry Si and Cl Some Sa (V.Soft)	Moist
	Nvalue=0 blows / 300mm	
	w @ 1.8m = 4%	
2.1- 3.1	Br Sa W Gr Some Cl Some Si	Moist
3.1- 4.5	Gry Si and Cl Some Sa (V.Stiff)	Moist
	Nvalue=19 blows / 300mm	
4.5- 5.1	Gry Si and Cl Some Sa (V.Stiff)	Moist
	Nvalue=22 blows / 300mm	
	w @ 4.8m = 14%	
	Percent Passing 4.75 mm = 100%	
	75 µm = 88%	
	5 µm = 41%	
	Frost Susceptibility = MSFH	
	Soil Erodibility = 0.32	
	Lane Width = 2.7m PP OSH = 90mm	

Station 11+600	SB 1.5m LT CL	Lane
0- 150	Asph	
150- 600	Br Sa W Cl W Si Tr Gr	Dry
600- 1.5	Br Si(y) Cl W Sa Tr Gr	Moist
1.5- 2.1	Br Si(y) Cl W Sa Tr Gr (Firm)	Moist
	Nvalue=6 blows / 300mm	
	Lane Width = 2.9m PP OSH = 70mm	

Station 11+800	NB 1.5m RT CL	Lane
0- 75	Asph	
75- 1.5	Br Sa W Gr Some Cl Some Si	Moist
	Percent Passing 4.75 mm = 79%	
	75 µm = 21%	
	5 µm = 11%	
	Frost Susceptibility = LSFH	
	Soil Erodibility = 0.12	
1.5- 2.1	Br Si(y) Cl W Sa (Stiff)	Moist
	Nvalue=10 blows / 300mm	
	w @ 1.8m = 15%	
	Percent Passing 4.75 mm = 100%	
	75 µm = 78%	
	5 µm = 40%	
	Frost Susceptibility = LSFH	
	Soil Erodibility = 0.28	
	W _L = 24%	
	W _P = 17%	
	P _I = 7%	
	Lane Width = 3.3m PP OSH = 70mm	

Station 11+955	SB 1.5m LT CL	Lane
0- 150	Asph	

Station 12+000	SB 2m LT CL	Lane
0- 145	Asph	
145- 800	Br Sa and Gr	Dry
800- 1.5	Gry Si(y) Cl Tr Gr	Dry
1.5- 2.1	Gry Si(y) Cl Tr Gr (Firm)	Dry
	Nvalue=7 blows / 300mm	
2.1- 2.6	Gry Si(y) Cl Some Sa Some Gr	Dry
2.6- 3	Br Cl(y) Si Tr Sa Tr Gr	Dry
3- 3.6	Br Cl(y) Si Tr Sa Tr Gr (V.Stiff)	Dry
	Nvalue=29 blows / 300mm	
3.6- 4.5	Br Cl(y) Si Tr Sa Tr Gr	Dry
4.5- 5.1	Gry Si(y) Cl Tr Sa Tr Gr (V.Stiff)	Dry
	Nvalue=18 blows / 300mm	
	Lane Width = 4.9m	

Station 12+290	NB 3m RT CL	OSH
0- 500	Br Sa W Cl W Si Tr Gr	Dry
	Percent Passing 4.75 mm = 93%	
	75 µm = 48%	
	5 µm = 26%	
	Frost Susceptibility = LSFH	
	Soil Erodibility = 0.21	
500- 1.6	Br Sa W Cl W Si Tr Gr	Moist
1.6- 2.1	Br Si(y) Cl W Sa Tr Gr (V.Stiff)	Moist
	Nvalue=19 blows / 300mm	
	w @ 1.9m = 13%	
	Percent Passing 4.75 mm = 98%	
	75 µm = 74%	
	5 µm = 42%	
	Frost Susceptibility = LSFH	
	Soil Erodibility = 0.25	
2.1- 3	Br Si(y) Cl W Sa Tr Gr	Moist
3- 3.6	Br Si(y) Cl W Sa Tr Gr (V.Stiff)	Moist
	Nvalue=34 blows / 300mm	
3.6- 4.5	Br Si(y) Cl W Sa Tr Gr	Moist
4.5- 5.1	Br Si(y) Cl W Sa Tr Gr (V.Stiff)	Moist
	Nvalue=17 blows / 300mm	
	Lane Width = 5.2m PP OSH = 30mm	



Chingacousy Road
From Mayfield Road (Station 10+000) to Old School Road (Station 13+050)
Caledon, Ontario
Borehole Logs

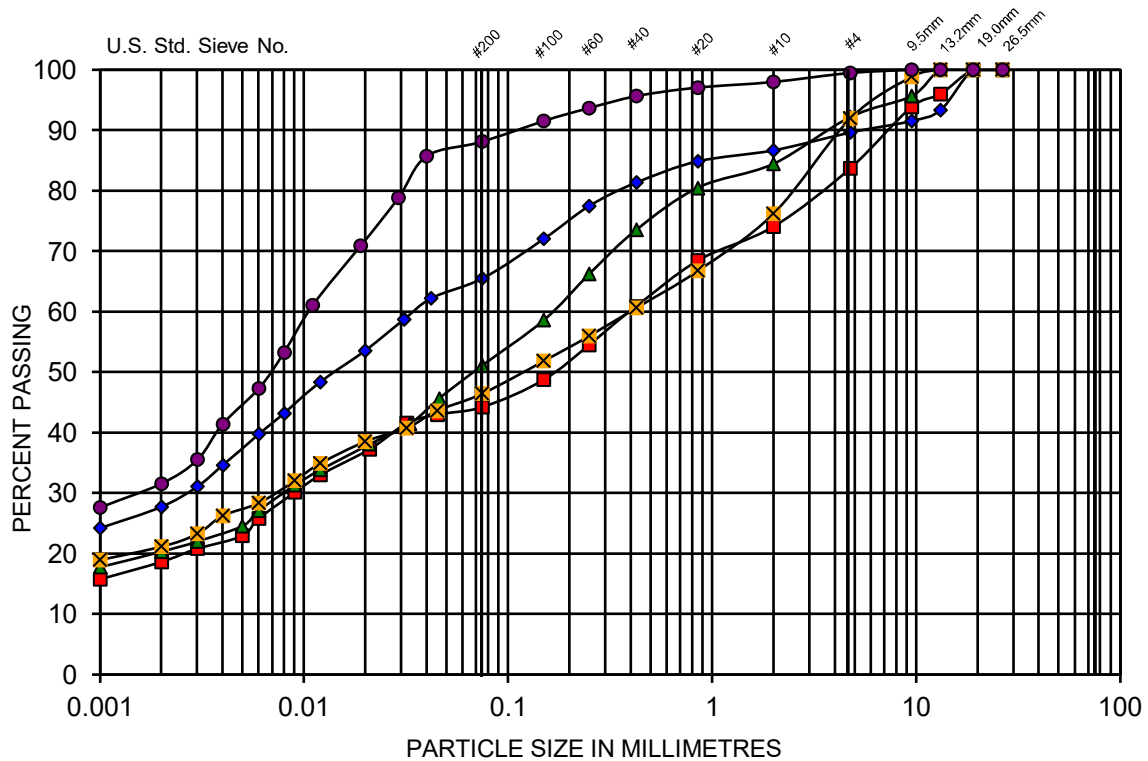
Station 12+550			SB 4m LT CL	OSH	Station 12+900			SB 1.5m LT CL	Lane
0- 580	Br Sa and Gr	Some Si Tr Cl		Dry	0- 35	Asph			
				w @ 0.3m = 11%	35- 550	Br Sa W Si	Some Cl	Some Gr	Dry
580- 1.5	Br Si(y)	Cl W Sa		Moist	550- 1.5	Co Fib	Org Matl		
1.5- 2.1	Br Si(y)	Cl W Sa Tr Gr (V.Stiff)		Moist	1.5- 2.1	Br Sa(y)	Cl W Si Tr Gr (V.Stiff)		Moist
		Nvalue=18 blows / 300mm					Nvalue=17 blows / 300mm		
				w @ 1.8m = 12%					w @ 1.8m = 13%
2.1- 3	Br Si(y)	Cl W Sa Tr Gr		Moist					Percent Passing 4.75 mm = 97%
3- 3.6	Br Si(y)	Cl W Sa Tr Gr (V.Stiff)		Moist					75 µm = 67%
		Nvalue=27 blows / 300mm							5 µm = 44%
3.6- 4.5	Br Si(y)	Cl Some Sa Tr Gr		Moist					Frost Susceptibility = LSFH
4.5- 5.1	Gry Si(y)	Cl(y) W Sa Some Gr (Firm)		Moist					Soil Erodibility = 0.2
		Nvalue=6 blows / 300mm							W _L = 28%
		Lane Width = 5.0m PP OSH = 20mm							W _P = 19%
									P _I = 9%
									Lane Width = 3.6m PP OSH = 50mm
Station 12+750			NB 1.5m RT CL	Lane					
0- 30	Asph								
30- 530	Gry Sa W Si	Some Cl	Some Gr	Dry					
				Percent Passing 4.75 mm = 86%					
				75 µm = 38%					
				5 µm = 18%					
				Frost Susceptibility = LSFH					
				Soil Erodibility = 0.18					
530- 1.5	Dk Br Si(y)	Cl Tr Org		Moist					
1.5- 1.7	Br Sa(y)	Si W Cl Tr Gr		Moist					
1.7- 2.1	Br Sa(y)	Si W Cl Tr Gr (Hard)		Moist					
		Nvalue=37 blows / 300mm							
				w @ 1.9m = 10%					
				Percent Passing 4.75 mm = 95%					
				75 µm = 62%					
				5 µm = 27%					
				Frost Susceptibility = LSFH					
				Soil Erodibility = 0.28					
				W _L = 19%					
				W _P = 13%					
				P _I = 6%					
				Lane Width = 3.0m PP OSH = 1.5m					



APPENDIX F

Laboratory Test Results

Chinguacousy Road PARTICLE SIZE DISTRIBUTION



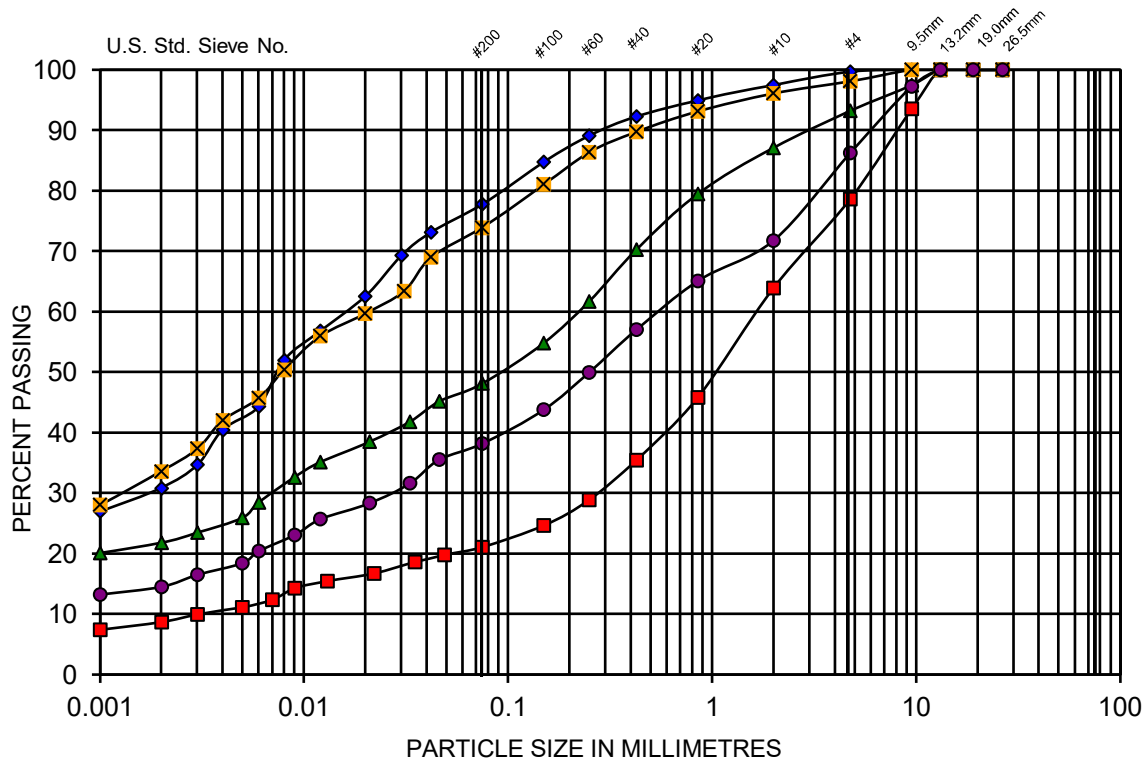
SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	Cob Size
FINE GRAINED	SAND			GRAVEL		

Legend

—■—	Chinguacousy Road 10+050 SB 1.5 LT CL 90-230
—◆—	Chinguacousy Road 10+230 SB 2.5 LT CL 1700-2100
—▲—	Chinguacousy Road 10+500 SB 1.5 LT CL 110-600
—×—	Chinguacousy Road 11+150 NB 1.5 RT CL 30-370
—●—	Chinguacousy Road 11+425 NB 3.5 RT CL 4500-5100



Chinguacousy Road PARTICLE SIZE DISTRIBUTION



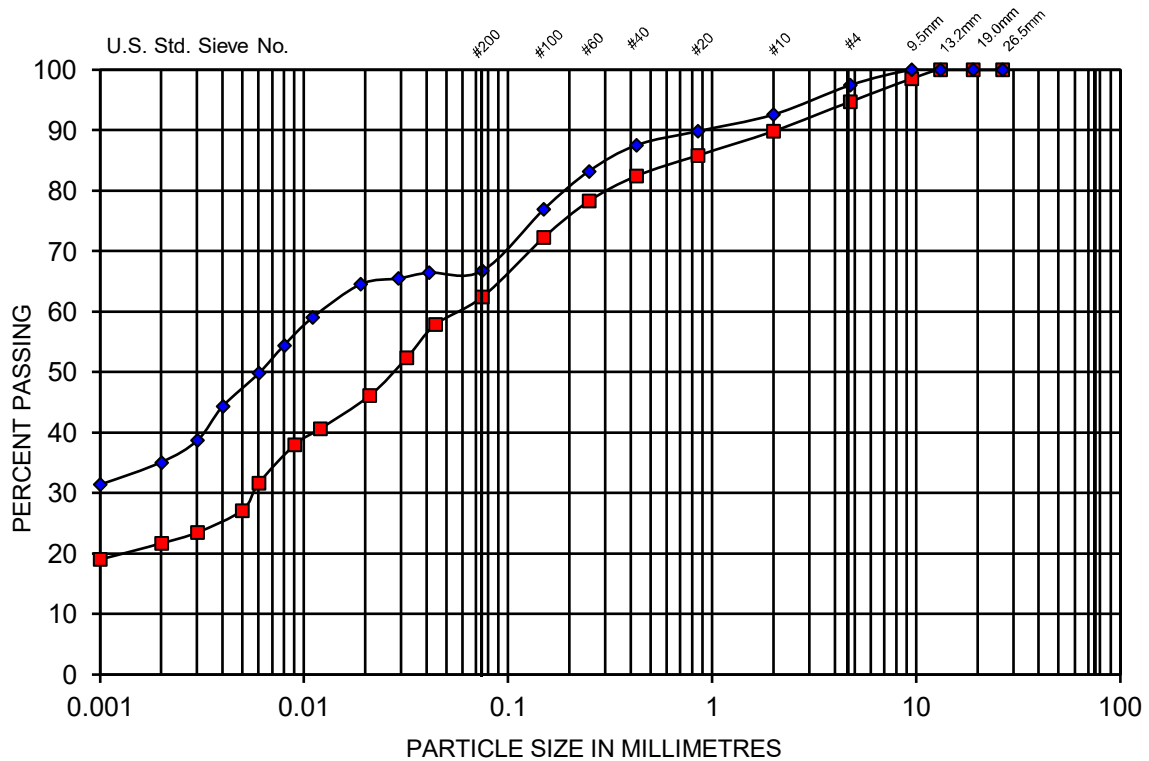
SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	Cob Size
FINE GRAINED	SAND			GRAVEL		

Legend

—■—	Chinguacousy Road 11+800 NB 1.5 RT CL 75-1500
—◆—	Chinguacousy Road 11+800 NB 1.5 RT CL 1500-2100
—▲—	Chinguacousy Road 12+290 NB 3 RT CL 0-500
—×—	Chinguacousy Road 12+290 NB 3 RT CL 1600-2100
—●—	Chinguacousy Road 12+750 NB 1.5 RT CL 30-530

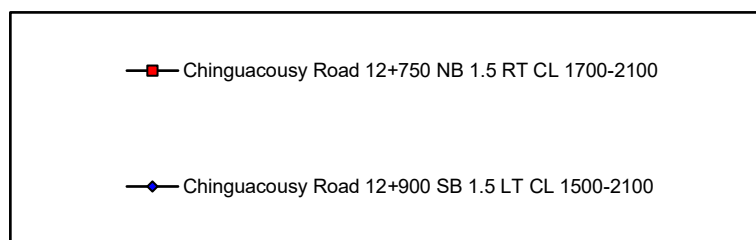


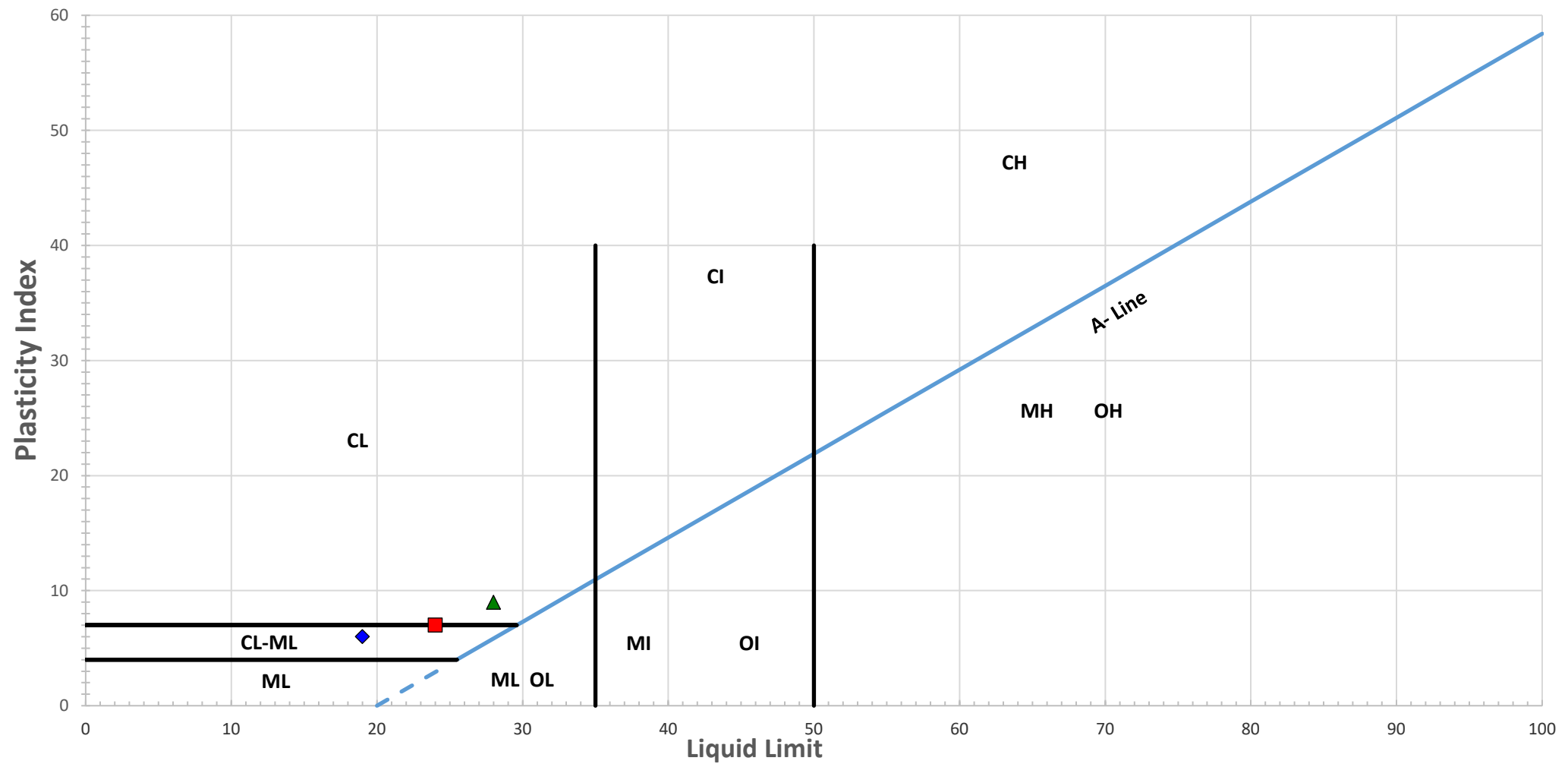
Chinguacousy Road PARTICLE SIZE DISTRIBUTION



SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	Cob Size
FINE GRAINED	SAND			GRAVEL		

Legend





—■— Chinguacousy Road 11+800 1.5 RT CL 1500-2100

—◆— Chinguacousy Road 12+750 1.5 RT CL 1700-2100

—▲— Chinguacousy Road 12+900 1.5 LT CL 1500-2100



Atterberg Limit Determination (LS-703 & 704) Chinguacousy Road

Figure No. 1

Project No.: 29748



APPENDIX G

Falling Weight Deflectometer Test Results



Chinguacousy Road
From Mayfield Road to Old School Road
Caledon, Ontario
Falling Weight Deflectometer Test Results

Station	Direction	Normalized Deflection (μ m)	M _R (MPa)	E _p (MPa)	SN _{Eff} (mm)	SN _{Des} (mm)	SN _{ol} (mm)	Required Asphalt Overlay (mm)
10+010	SB	735	23	254	61	109	48	114
10+050	NB	398	24	716	87	109	23	54
10+100	SB	321	30	888	93	109	16	39
10+150	NB	397	26	694	86	109	24	56
10+200	SB	360	28	747	88	109	21	51
10+250	NB	344	30	804	90	109	19	46
10+300	SB	207	37	1751	117	109	-7	0
10+350	NB	278	34	1051	99	109	11	26
10+400	SB	365	30	702	86	109	23	55
10+450	NB	380	25	770	89	109	21	49
10+500	SB	362	30	692	86	109	24	56
10+550	NB	369	27	763	89	109	21	50
10+600	SB	400	26	649	84	109	25	61
10+650	NB	502	24	474	76	109	34	80
10+700	SB	375	28	705	86	109	23	55
10+750	NB	419	23	673	85	109	24	58
10+800	SB	480	25	489	76	109	33	79
10+850	NB	428	24	624	83	109	27	63
10+900	SB	391	32	584	81	109	28	68
10+950	NB	310	23	1300	106	109	4	9
11+000	SB	1040	16	176	54	109	55	131
11+050	NB	749	21	297	55	109	55	130
11+100	SB	1081	16	195	45	109	64	153
11+150	NB	1065	17	180	44	109	65	156
11+200	SB	808	21	260	50	109	60	142
11+250	NB	1444	12	139	40	109	69	164
11+255	NB	1396	12	154	42	109	68	161
11+260	NB	1138	16	174	44	109	66	157
11+300	SB	1006	17	209	46	109	63	150
11+350	NB	934	19	227	48	109	62	147
11+400	SB	609	31	332	54	109	55	132
11+450	NB	679	25	318	53	109	56	134
11+500	SB	651	28	319	53	109	56	134
11+550	NB	939	19	213	47	109	63	150
11+600	SB	613	25	392	57	109	52	125
11+650	NB	792	24	252	49	109	60	143
11+700	SB	677	20	380	57	109	53	126
11+750	NB	534	26	489	61	109	48	114
11+800	SB	423	27	754	71	109	38	91
11+850	NB	668	24	311	57	109	52	125
11+900	SB	377	29	633	89	109	20	48
11+975	NB	332	32	754	95	109	15	35
12+000	SB	621	25	310	70	109	39	93
12+050	NB	461	36	405	77	109	32	77
12+100	SB	501	31	392	76	109	33	79
12+150	NB	603	23	331	72	109	37	89
12+200	SB	696	23	263	67	109	43	102
12+250	NB	401	24	695	92	109	17	41
12+275	SB	239	38	1207	111	109	-1	0
12+350	NB	524	30	360	74	109	35	84
12+400	SB	629	23	312	71	109	39	93
12+450	NB	758	20	255	66	109	43	104
12+500	SB	717	20	274	68	109	42	100
12+550	NB	640	22	321	71	109	38	91
12+600	SB	319	32	840	98	109	11	27
12+650	NB	548	24	383	76	109	34	81
12+700	SB	683	19	302	70	109	40	94
12+750	NB	1092	16	164	57	109	53	125
12+800	SB	852	24	217	47	109	63	149
12+850	NB	1008	17	199	46	109	64	152
12+900	SB	866	23	214	47	109	63	150
12+950	NB	745	29	243	49	109	61	145
13+000	SB	653	32	279	51	109	59	139
13+050	NB	803	23	250	49	109	60	144
13+070	NB	483	48	364	56	109	54	128



APPENDIX H

Asbestos Test Results



Thurber Engineering Ltd. (Oakville)
ATTN: Abdul Nasri
2010 Winston Park Drive
Unit 103
Oakville ON L6H 5R7

Date Received: 28-DEC-21
Report Date: 31-DEC-21 14:20 (MT)
Version: FINAL

Client Phone: 905-829-8666

Certificate of Analysis

Lab Work Order #: L2675643
Project P.O. #: NOT SUBMITTED
Job Reference: 29748 CALEDON ROADS
C of C Numbers: 17-624303
Legal Site Desc:

Amanda Overholster
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 95 West Beaver Creek Road, Unit 1, Richmond Hill, ON L4B 1H2 Canada | Phone: +1 905 881 9887 | Fax: +1 905 881 8062
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2675643-1 Sampled By: CHINGUAROUSHY RD, CR1 10+050, 0-90MM client on 24-DEC-21 @ 09:00 Matrix: soil								
	Asbestos/Quartz/Other Fibres							
	Asbestos By Point Count	< .1		0.10	%		31-DEC-21	R5684653
	Other Non Fibrous: Filler and Tar	100		1.0	%		31-DEC-21	R5684653
	Report Remarks : No asbestos fibres were observed.							
L2675643-2 Sampled By: CHINGUAROUSHY RD, CR6 11+150, 0-30MM client on 24-DEC-21 @ 09:00 Matrix: soil								
	Asbestos/Quartz/Other Fibres							
	Asbestos By Point Count	< .1		0.10	%		31-DEC-21	R5684653
	Other Non Fibrous: Filler and Tar	100		1.0	%		31-DEC-21	R5684653
	Report Remarks : No asbestos fibres were observed.							
L2675643-3 Sampled By: CHINGUAROUSHY RD, CR11 11+955, 0-145MM client on 24-DEC-21 @ 09:00 Matrix: soil								
	Asbestos/Quartz/Other Fibres							
	Asbestos: Chrysotile (Serpentine)	< .1		0.10	%		31-DEC-21	R5684653
	Other Non Fibrous: Filler and Tar	100		1.0	%		31-DEC-21	R5684653
	Report Remarks : Asbestos was detected in concentrations below the detection limit							
L2675643-4 Sampled By: CHINGUAROUSHY RD, CR15 12+900 ,0-35MM client on 24-DEC-21 @ 09:00 Matrix: soil								
	Asbestos/Quartz/Other Fibres							
	Asbestos By Point Count	< .1		0.10	%		31-DEC-21	R5684653
	Other Non Fibrous: Filler and Tar	100		1.0	%		31-DEC-21	R5684653
	Report Remarks : No asbestos fibres were observed.							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ASBESTOS-PTCT-WP	Bulk	Quantitation of asbestos by point count	EPA/600/R-93/116
Bulk samples are examined under a stereoscopic microscope. Individual fibers or fibre bundles are mounted in refractive index liquids and are observed under a polarized light microscope with a special dispersion staining objective. The dispersion staining colours are compared to reference samples of known asbestiforms.			
Polarized microscopy is not a definitive technique for negative results for non-friable organically bound material (i.e.floor tiles).			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

17-624303

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

- mg/kg - milligrams per kilogram based on dry weight of sample
- mg/kg ww - milligrams per kilogram based on wet weight of sample
- mg/kg lwt - milligrams per kilogram based on lipid weight of sample
- mg/L - unit of concentration based on volume, parts per million.

- < - Less than.
- D.L. - The reporting limit.
- N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



APPENDIX I

Environmental Certificates of Analysis



Thurber Engineering Ltd. (Oakville)
ATTN: Abdul Nasri
2010 Winston Park Drive
Unit 103
Oakville ON L6H 5R7

Date Received: 28-DEC-21
Report Date: 31-DEC-21 14:20 (MT)
Version: FINAL

Client Phone: 905-829-8666

Certificate of Analysis

Lab Work Order #: L2675643
Project P.O. #: NOT SUBMITTED
Job Reference: 29748 CALEDON ROADS
C of C Numbers: 17-624303
Legal Site Desc:

Amanda Overholster
Account Manager

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ADDRESS: 95 West Beaver Creek Road, Unit 1, Richmond Hill, ON L4B 1H2 Canada | Phone: +1 905 881 9887 | Fax: +1 905 881 8062
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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2675643-1 Sampled By: CHINGUAROUSHY RD, CR1 10+050, 0-90MM Matrix: client on 24-DEC-21 @ 09:00 soil								
	Asbestos/Quartz/Other Fibres							
	Asbestos By Point Count	< .1		0.10	%		31-DEC-21	R5684653
	Other Non Fibrous: Filler and Tar	100		1.0	%		31-DEC-21	R5684653
	Report Remarks : No asbestos fibres were observed.							
L2675643-2 Sampled By: CHINGUAROUSHY RD, CR6 11+150, 0-30MM Matrix: client on 24-DEC-21 @ 09:00 soil								
	Asbestos/Quartz/Other Fibres							
	Asbestos By Point Count	< .1		0.10	%		31-DEC-21	R5684653
	Other Non Fibrous: Filler and Tar	100		1.0	%		31-DEC-21	R5684653
	Report Remarks : No asbestos fibres were observed.							
L2675643-3 Sampled By: CHINGUAROUSHY RD, CR11 11+955, 0-145MM Matrix: client on 24-DEC-21 @ 09:00 soil								
	Asbestos/Quartz/Other Fibres							
	Asbestos: Chrysotile (Serpentine)	< .1		0.10	%		31-DEC-21	R5684653
	Other Non Fibrous: Filler and Tar	100		1.0	%		31-DEC-21	R5684653
	Report Remarks : Asbestos was detected in concentrations below the detection limit							
L2675643-4 Sampled By: CHINGUAROUSHY RD, CR15 12+900 ,0-35MM Matrix: client on 24-DEC-21 @ 09:00 soil								
	Asbestos/Quartz/Other Fibres							
	Asbestos By Point Count	< .1		0.10	%		31-DEC-21	R5684653
	Other Non Fibrous: Filler and Tar	100		1.0	%		31-DEC-21	R5684653
	Report Remarks : No asbestos fibres were observed.							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ASBESTOS-PTCT-WP	Bulk	Quantitation of asbestos by point count	EPA/600/R-93/116
Bulk samples are examined under a stereoscopic microscope. Individual fibers or fibre bundles are mounted in refractive index liquids and are observed under a polarized light microscope with a special dispersion staining objective. The dispersion staining colours are compared to reference samples of known asbestiforms.			
Polarized microscopy is not a definitive technique for negative results for non-friable organically bound material (i.e.floor tiles).			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

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17-624303

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Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

- mg/kg - milligrams per kilogram based on dry weight of sample
- mg/kg wwwt - milligrams per kilogram based on wet weight of sample
- mg/kg lwt - milligrams per kilogram based on lipid weight of sample
- mg/L - unit of concentration based on volume, parts per million.

- < - Less than.
- D.L. - The reporting limit.
- N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
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Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



APPENDIX J

Pavement Design Analysis

1997 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare Computer Software Product

Thurber Engineering Ltd.

Flexible Structural Design Module

Chinguacousy Road - Mayfield Road to Old School Road
Pavement Design Analysis 25MPa Subgrade
New Flexible Pavement Design
20 Year Design

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	1,142,228
Initial Serviceability	4.4
Terminal Serviceability	2.2
Reliability Level	90 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	25,000 kPa
Stage Construction	1
Calculated Design Structural Number	109 mm

Simple ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	2,470
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	50 %
Percent Heavy Trucks (of ADT) FHWA Class 5 or Greater	4.6 %
Average Initial Truck Factor (ESALs/truck)	2.5
Annual Truck Factor Growth Rate	0 %
Annual Truck Volume Growth Rate	1 %
Growth	Compound
Total Calculated Cumulative ESALs	1,142,228

Specified Layer Design

<u>Layer</u>	<u>Material Description</u>	Struct Coef. <u>(A_i)</u>	Drain Coef. <u>(M_i)</u>	Thickness <u>(D_i)(mm)</u>	Width <u>(m)</u>	Calculated SN (mm)
1	New HMA	0.42	1	130	-	55
2	New Granular Base	0.14	1	150	-	21
3	New Granular Subbase	0.09	1	370	-	33
Total	-	-	-	650	-	109

Layered Thickness Design

Thickness precision

Actual

<u>Layer</u>	<u>Material Description</u>	Struct Coef. <u>(Ai)</u>	Drain Coef. <u>(Mi)</u>	Spec Thickness <u>(Di)(mm)</u>	Min Thickness <u>(Di)(mm)</u>	Elastic Modulus <u>(kPa)</u>	Width <u>(m)</u>	Calculated Thickness <u>(mm)</u>	Calculated SN <u>(mm)</u>
1	New HMA	0.42	1	-	130	2,750,000	3.75	130	55
2	New Granular Base	0.14	1	150	-	250,000	3.75	150	21
3	New Granular Subbase	0.09	1	-	50	150,000	3.75	371	33
Total	-	-	-	-	-	-	-	651	109

1997 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare Computer Software Product

Thurber Engineering Ltd.

Flexible Structural Design Module

Chinguacousy Road - Mayfield Road to Old School Road
Pavement Design Analysis 25MPa Subgrade
Overlay with New HMA - New Pavement Section
20 Year Design

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	1,142,228
Initial Serviceability	4.4
Terminal Serviceability	2.2
Reliability Level	90 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	25,000 kPa
Stage Construction	1
Calculated Design Structural Number	109 mm

Simple ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	2,470
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	50 %
Percent Heavy Trucks (of ADT) FHWA Class 5 or Greater	4.6 %
Average Initial Truck Factor (ESALs/truck)	2.5
Annual Truck Factor Growth Rate	0 %
Annual Truck Volume Growth Rate	1 %
Growth	Compound
Total Calculated Cumulative ESALs	1,142,228

Specified Layer Design

<u>Layer</u>	<u>Material Description</u>	Struct Coef. <u>(A_i)</u>	Drain Coef. <u>(M_i)</u>	Thickness <u>(D_i)(mm)</u>	Width <u>(m)</u>	Calculated SN <u>(mm)</u>
1	New HMA	0.42	1	130	3.75	55
2	Existing Asphalt	0.31	1	120	3.75	37
3	Existing Granular Material	0.09	0.95	450	3.75	38
Total	-	-	-	700	-	130

Layered Thickness Design

Thickness precision

Actual

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Spec Thickness (Di)(mm)	Min Thickness (Di)(mm)	Elastic Modulus (kPa)	Width (m)	Calculated Thickness (mm)	Calculated SN (mm)
1	New HMA	0.42	1	130	-	2,750,000	3.75	130	55
2	Existing Asphalt	0.31	1	-	120	1,500,000	3.75	120	37
3	Existing Granular Mat...	0.09	0.95	-	50	150,000	3.75	201	17
Total	-	-	-	-	-	-	-	451	109

1997 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare Computer Software Product

Thurber Engineering Ltd.

Flexible Structural Design Module

Chinguacousy Road - Mayfield Road to Old School Road
Pavement Design Analysis 25MPa Subgrade
Pulverize Asphalt and Overlay with New HMA - Old Pavement Section
20 Year Design

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	1,142,228
Initial Serviceability	4.4
Terminal Serviceability	2.2
Reliability Level	90 %
Overall Standard Deviation	0.44
Roadbed Soil Resilient Modulus	25,000 kPa
Stage Construction	1
Calculated Design Structural Number	109 mm

Simple ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	2,470
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	50 %
Percent Heavy Trucks (of ADT) FHWA Class 5 or Greater	4.6 %
Average Initial Truck Factor (ESALs/truck)	2.5
Annual Truck Factor Growth Rate	0 %
Annual Truck Volume Growth Rate	1 %
Growth	Compound
Total Calculated Cumulative ESALs	1,142,228

Specified Layer Design

<u>Layer</u>	<u>Material Description</u>	Struct Coef. <u>(A_i)</u>	Drain Coef. <u>(M_i)</u>	Thickness <u>(D_i)(mm)</u>	Width <u>(m)</u>	Calculated SN <u>(mm)</u>
1	New HMA	0.42	1	130	3.75	55
2	New Granular Base	0.14	1	100	3.75	14
3	Existing Pulverized Asphalt	0.14	1	30	3.75	4
4	Existing Granular Material	0.09	0.95	450	3.75	38
Total	-	-	-	710	-	111

Layered Thickness Design

Thickness precision

Actual

<u>Layer</u>	<u>Material Description</u>	Struct Coef. <u>(Ai)</u>	Drain Coef. <u>(Mi)</u>	Spec Thickness <u>(Di)(mm)</u>	Min Thickness <u>(Di)(mm)</u>	Elastic Modulus <u>(kPa)</u>	Width <u>(m)</u>	Calculated Thickness <u>(mm)</u>	Calculated SN <u>(mm)</u>
1	New HMA	0.42	1	130	-	2,750,000	3.75	130	55
2	New Granular Base	0.14	1	-	100	250,000	3.75	100	14
3	Existing Granular Mat...	0.09	0.95	-	50	150,000	3.75	473	40
Total	-	-	-	-	-	-	-	703	109