APPENDIX ‘G’

GEOTECHNICAL REPORT

APPENDIX ‘G’ – GEOTECHNICAL REPORT

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November 30, 2023

Project #
60697893

Ryan Cunningham
AECOM Canada Ltd.
99 Commerce Drive
Winnipeg, MB R3P 0Y7

City of Winnipeg 2023 Regional Streets Renewal: Sargent Avenue - Balmoral to Edmonton Geotechnical Data Report

Dear Ryan Cunningham,

This geotechnical data report provides the results of a geotechnical investigation performed by AECOM Canada Ltd. (AECOM) for the proposed reconstruction of Sargent Avenue from Balmoral Street to Edmonton Street as part of the City of Winnipeg's 2023 Regional Streets Renewal Program. The main objective of the geotechnical investigation was to determine the subsurface conditions below the existing pavement structure.

Four testholes were completed along the roadway section.

1. Testhole Drilling and Sampling

Testhole drilling was carried out by Paddock Drilling Ltd. using a truck-mounted rig equipped with solid stem augers (SSA) under the supervision of AECOM's field personnel. The subsurface exploration program consisted of drilling four testholes advancing to a depth of 2.7 m below the existing road surface. The location of the testholes is provided in **Appendix A**.

Subsurface conditions observed during testhole drilling were visually observed and documented by AECOM geotechnical personnel according to the Unified Soil Classification System (USCS). Representative soil samples were obtained directly from the auger flights. Groundwater, seepage and sloughing conditions were recorded upon completion of drilling.

Testhole logs have been prepared for each testhole to record the descriptions and the relative positions of the soil strata, locations of samples obtained, laboratory test results and other pertinent information. Soil profiles have been prepared for representative sections. The explanation of field and laboratory test data, City of Winnipeg Site Investigation Requirements for Public Works Streets, testhole logs, soil profiles, and testhole summary are included in **Appendix B**.

2. Laboratory Testing

The laboratory testing program was developed to measure the index properties of the soils encountered. The laboratory tests consisted of geotechnical testing on disturbed grab samples. The geotechnical tests were conducted at AECOM's Materials Testing Laboratory in Winnipeg, Manitoba. Detailed laboratory results are presented in **Appendix C**.

The geotechnical laboratory testing program included determination of moisture content, Atterberg Limits, grain size distribution by hydrometer method, standard proctor and California Bearing Ratio (CBR) on samples collected during the field investigation. A summary of the geotechnical testing that was completed is provided in **Table 1**.

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Table 1. Summary of Laboratory Testing

Laboratory Test	Number of Tests	Testing Standard
Moisture content	22	ASTM D2216
Grain Size Distribution (Hydrometer Analysis)	2	ASTM D422
Atterberg Limits	2	ASTM D4318
Standard Proctor	2	ASTM D698
CBR	2	ASTM 1883

Yours sincerely,

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PROVINCE OF MANITOBA
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Appendix A

Testhole Location Plan

PLAN

Scale 1:500

METRIC

WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

B SIZE 11" x 17" (279.4mm x 431.8mm)

PLOT: .

Saved By:

AECOM FILE NAME: AECOMv2-ANSI-DWG-BHL-M.dwt

I/R	YY/MM/DD	ISSUE/REVISION DESCRIPTION	DRN	CHK	DES	ENG	IDR	APP
0	23/10/31	ISSUED FOR REPORT	RAM	RC	RC			

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Winnipeg

City of Winnipeg
2023 Regional Street Renewal Program
Sargent Ave - Balmoral St to Edmonton St
Testhole Locations

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
60697893	SK-02	0

Appendix B

Explanation of Field and Laboratory Data

Site Investigation Requirements for Public Works Street Projects

Testhole Logs

Testhole Summary

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GENERAL STATEMENT

NORMAL VARIABILITY OF SUBSURFACE CONDITIONS

The scope of the investigation presented herein is limited to an investigation of the subsurface conditions as to suitability for the proposed project. This report has been prepared to aid in the evaluation of the site and to assist the engineer in the design of the facilities. Our description of the project represents our understanding of the significant aspects of the project relevant to the design and construction of earth work, foundations and similar. In the event of any changes in the basic design or location of the structures as outlined in this report or plan, we should be given the opportunity to review the changes and to modify or reaffirm in writing the conclusions and recommendations of this report.

The analysis and recommendations presented in this report are based on the data obtained from the borings and test pit excavations made at the locations indicated on the site plans and from other information discussed herein. This report is based on the assumption that the subsurface conditions everywhere are not significantly different from those disclosed by the borings and excavations. However, variations in soil conditions may exist between the excavations and, also, general groundwater levels and conditions may fluctuate from time to time. The nature and extent of the variations may not become evident until construction. If subsurface conditions differ from those encountered in the exploratory borings and excavations, are observed or encountered during construction, or appear to be present beneath or beyond excavations, we should be advised at once so that we can observe and review these conditions and reconsider our recommendations where necessary.

Since it is possible for conditions to vary from those assumed in the analysis and upon which our conclusions and recommendations are based, a contingency fund should be included in the construction budget to allow for the possibility of variations which may result in modification of the design and construction procedures.

In order to observe compliance with the design concepts, specifications or recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated, we recommend that all construction operations dealing with earth work and the foundations be observed by an experienced soils engineer. We can be retained to provide these services for you during construction. In addition, we can be retained to review the plans and specifications that have been prepared to check for substantial conformance with the conclusions and recommendations contained in our report.

EXPLANATION OF FIELD & LABORATORY TEST DATA

The field and laboratory test results, as shown for each hole, are described below.

1. NATURAL MOISTURE CONTENT

The relationship between the natural moisture content and depth is significant in determining the subsurface moisture conditions. The Atterberg Limits for a sample should be compared to its natural moisture content and plotted on the Plasticity Chart in order to determine the soil classification.

2. SOIL PROFILE AND DESCRIPTION

Each soil stratum is classified and described noting any special conditions. The Modified Unified Classification System (MUCS) is used. The soil profile refers to the existing ground level at the time the hole was done. Where available, the ground elevation is shown. The soil symbols used are shown in detail on the soil classification chart.

3. TESTS ON SOIL SAMPLES

Laboratory and field tests are identified by the following and are on the logs:

N - Standard Penetration Test (SPT) Blow Count. The SPT is conducted in the field to assess the in-situ consistency of cohesive soils and the relative density of non-cohesive soils. The N value recorded is the number of blows from a 63.5 kg hammer dropped 760 mm which is required to drive a 51 mm split spoon sampler 300 mm into the soil.

SO_4 - Water Soluble Sulphate Content. Expressed in percent. Conducted primarily to determine requirements for the use of sulphate resistant cement. Further details on the water-soluble sulphate content are given in Section 6.

γ_D - Dry Unit Weight. Usually expressed in kN/m^3.

γ_T - Total Unit Weight. Usually expressed in kN/m^3.

Q_U - Unconfined Compressive Strength. Usually expressed in kPa and may be used in determining allowable bearing capacity of the soil.

C_U - Undrained Shear Strength. Usually expressed in kPa. This value is determined by either a direct shear test or by an unconfined compression test and may also be used in determining the allowable bearing capacity of the soil.

C_{PEN} - Pocket Penetrometer Reading. Usually expressed in kPa. Estimate of the undrained shear strength as determined by a pocket penetrometer.

The following tests may also be performed on selected soil samples and the results are given on separate sheets enclosed with the logs:

- Grain Size Analysis
- Standard or Modified Proctor Compaction Test
- California Bearing Ratio Test
- Direct Shear Test
- Permeability Test
- Consolidation Test
- Triaxial Test

4. SOIL DENSITY AND CONSISTENCY

The SPT test described above may be used to estimate the consistency of cohesive soils and the density of cohesionless soils. These approximate relationships are summarized in the following tables:

Table 1 Cohesive Soils

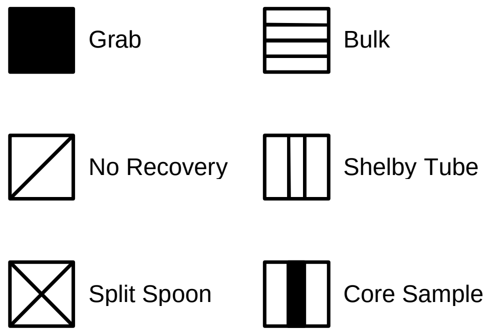
N	Consistency	C_u (kPa) approx.
0 - 1	Very Soft	<10
1 - 4	Soft	10 - 25
4 - 8	Firm	25 - 50
8 - 15	Stiff	50 - 100
15 - 30	Very Stiff	100 - 200
30 - 60	Hard	200 - 300
>60	Very Hard	>300

Table 2 Cohesionless Soils

N	Density
0 - 5	Very Loose
5 - 10	Loose
10 - 30	Compact
30 - 50	Dense
>50	Very Dense

5. SAMPLE CONDITION AND TYPE

The depth, type, and condition of samples are indicated on the logs by the following symbols:



6. WATER SOLUBLE SULPHATE CONCENTRATION

The following table, from CSA Standard A23.1-14, indicates the requirements for concrete subjected to sulphate attack based upon the percentage of water-soluble sulphate as presented on the logs. CSA Standard A23.1-14 should be read in conjunction with the table.

Table 3 Requirements for Concrete Subjected to Sulphate Attack*

Class of exposure	Degree of exposure	Water-soluble sulphate (SO_4)† in soil sample, %	Sulphate (SO_4) in groundwater samples, mg/L‡	Water soluble sulphate (SO_4) in recycled aggregate sample, %	Cementing materials to be used§††	Performance requirements§,§§		
						Maximum expansion when tested using CSA A3004-C8 Procedure A at 23 °C, %		Maximum expansion when tested using CSA A3004-C8 Procedure B at 5 °C, % †††
						At 6 months	At 12 months††	At 18 months‡‡
S-1	Very severe	> 2.0	> 10 000	> 2.0	HS** ,HSb, HSLb*** or HSe	0.05	0.10	0.10
S-2	Severe	0.20–2.0	1500–10 000	0.60–2.0	HS**, HSb, HSLb*** or HSe	0.05	0.10	0.10
S-3	Moderate (including seawater exposure*)	0.10–0.20	150–1500	0.20–0.60	MS, MSb, MSe, MSLb***, LH, LHb, HS**, HSb, HSLb*** or HSe	0.10		0.10

*For sea water exposure, also see Clause 4.1.1.5.
†In accordance with CSA A23.2-3B.
‡In accordance with CSA A23.2-2B.
§Where combinations of supplementary cementing materials and portland or blended hydraulic cements are to be used in the concrete mix design instead of the cementing materials listed, and provided they meet the performance requirements demonstrating equivalent performance against sulphate exposure, they shall be designated as MS equivalent (MSe) or HS equivalent (HSe) in the relevant sulphate exposures (see Clauses 4.1.1.6.2, 4.2.1.1, and 4.2.1.3, and 4.2.1.4).
**Type HS cement shall not be used in reinforced concrete exposed to both chlorides and sulphates, including seawater. See Clause 4.1.1.6.3.

††The requirement for testing at 5 °C does not apply to MS, HS, MSb, HSb, and MSe and HSe combinations made without portland limestone cement.
‡‡ If the increase in expansion between 12 and 18 months exceeds 0.03%, the sulphate expansion at 24 months shall not exceed 0.10% in order for the cement to be deemed to have passed the sulphate resistance requirement.
§§For demonstrating equivalent performance, use the testing frequency in Table 1 of CSA A3004-A1 and see the applicable notes to Table A3 in A3001 with regard to re-establishing compliance if the composition of the cementing materials used to establish compliance changes.
***Where MSLb or HSLb cements are proposed for use, or where MSe or HSe combinations include Portland-limestone cement, they must also contain a minimum of 25% Type F fly ash or 40% slag or 15% metakaolin (meeting Type N pozzolan requirements) or a combination of 5% Type SF silica fume with 25% slag or a combination of 5% Type SF silica fume with 20% Type F fly ash. For some proposed MSLb, HSLb, and MSe or HSe combinations that include Portland-limestone cement, higher SCM replacement levels may be required to meet the A3004-C8 Procedure B expansion limits. Due to the 18-month test period, SCM replacements higher than the identified minimum levels should also be tested. In addition, sulphate resistance testing shall be run on MSLb and HSLb cement and MSe or HSe combinations that include Portland-limestone cement at both 23 °C and 5 °C as specified in the table.
†††If the expansion is greater than 0.05% at 6 months but less than 0.10% at 1 year, the cementing materials combination under test shall be considered to have passed.

7. SOIL CORROSIVITY

The following table, from the Handbook of Corrosion Engineering (Roberge, 1999) indicates the corrosivity rating can be obtained from the soil resistivity, presented on the logs.

Table 4 Corrosivity Ratings Based on Soil Resistivity

Soil Resistivity (ohm-cm)	Corrosivity Rating
>20,000	Essentially non-corrosive
10,000 – 20,000	Mildly corrosive
5,000 – 10,000	Moderately corrosive
3,000 – 5,000	Corrosive
1,000 – 3,000	Highly corrosive
<1,000	Extremely corrosive

8. GROUNDWATER TABLE

The groundwater table is indicated by the equilibrium level of water in a standpipe installed in a testhole or test pit. This level is generally taken at least 24 hours after installation of the standpipe. The groundwater level is subject to seasonal variations and is usually highest in the spring. The symbol on the logs indicating the groundwater level is an inverted solid triangle (▼).

TABLE 1 Soil Classification Chart

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification	
				Group Symbol	Group Name[B]
COARSE-GRAINED SOILS	Gravels (More than 50 % of coarse fraction retained on No. 4 sieve)	Clean Gravels (Less than 5 % fines[C])	Cu ≥ 4.0 and 1 ≤ Cc ≤ 3.0[D]	GW	Well-graded gravel[E]
			Cu < 4.0 and/or [Cc < 1 or Cc > 3.0][D]	GP	Poorly graded gravel[E]
		Gravels with Fines (More than 12 % fines[C])	Fines classify as ML or MH	GM	Silty gravel[E,F,G]
More than 50 % retained on No. 200 sieve			Fines classify as CL or CH	GC	Clayey gravel[E,F,G]
	Sands (50 % or more of coarse fraction passes No. 4 sieve)	Clean Sands (Less than 5 % fines[H])	Cu ≥ 6.0 and 1.0 ≤ Cc ≤ 3.0[D]	SW	Well-graded sand[I]
			Cu < 6.0 and/or [Cc < 1.0 or Cc > 3.0][D]	SP	Poorly graded sand[I]
		Sands with Fines (More than 12 % fines[H])	Fines classify as ML or MH	SM	Silty sand[F,G,I]
			Fines classify as CL or CH	SC	Clayey sand[F,G,I]
FINE-GRAINED SOILS	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K,L,M]
50 % or more passes the No. 200 sieve		organic	$\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OL	Organic clay[K,L,M,N] Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		organic	$\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OH	Organic clay[K,L,M,P] Organic silt[K,L,M,Q]
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A]Based on the material passing the 3-in. (75-mm) sieve.
[B]If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C]Gravels with 5 to 12 % fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay

[D]$Cu = D_{60}/D_{10} \quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[E]If soil contains ≥15 % sand, add "with sand" to group name.
[F]If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[G]If fines are organic, add "with organic fines" to group name.
[H]Sands with 5 to 12 % fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay
[I]If soil contains ≥15 % gravel, add "with gravel" to group name.
[J]If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
[K]If soil contains 15 to <30 % plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L]If soil contains ≥30 % plus No. 200, predominantly sand, add "sandy" to group name.
[M]If soil contains ≥30 % plus No. 200, predominantly gravel, add "gravelly" to group name.
[N]PI ≥ 4 and plots on or above "A" line.
[O]PI < 4 or plots below "A" line.
[P]PI plots on or above "A" line.
[Q]PI plots below "A" line.

C136 Test Method for Sieve Analysis of Fine and Coarse Aggregates
C702 Practice for Reducing Samples of Aggregate to Testing Size
D653 Terminology Relating to Soil, Rock, and Contained Fluids
D1140 Test Methods for Determining the Amount of Material Finer than 75-μm (No. 200) Sieve in Soils by Washing
D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
D2488 Practice for Description and Identification of Soils (Visual-Manual Procedures)
D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
D4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)
D4318 Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
D4427 Classification of Peat Samples by Laboratory Testing

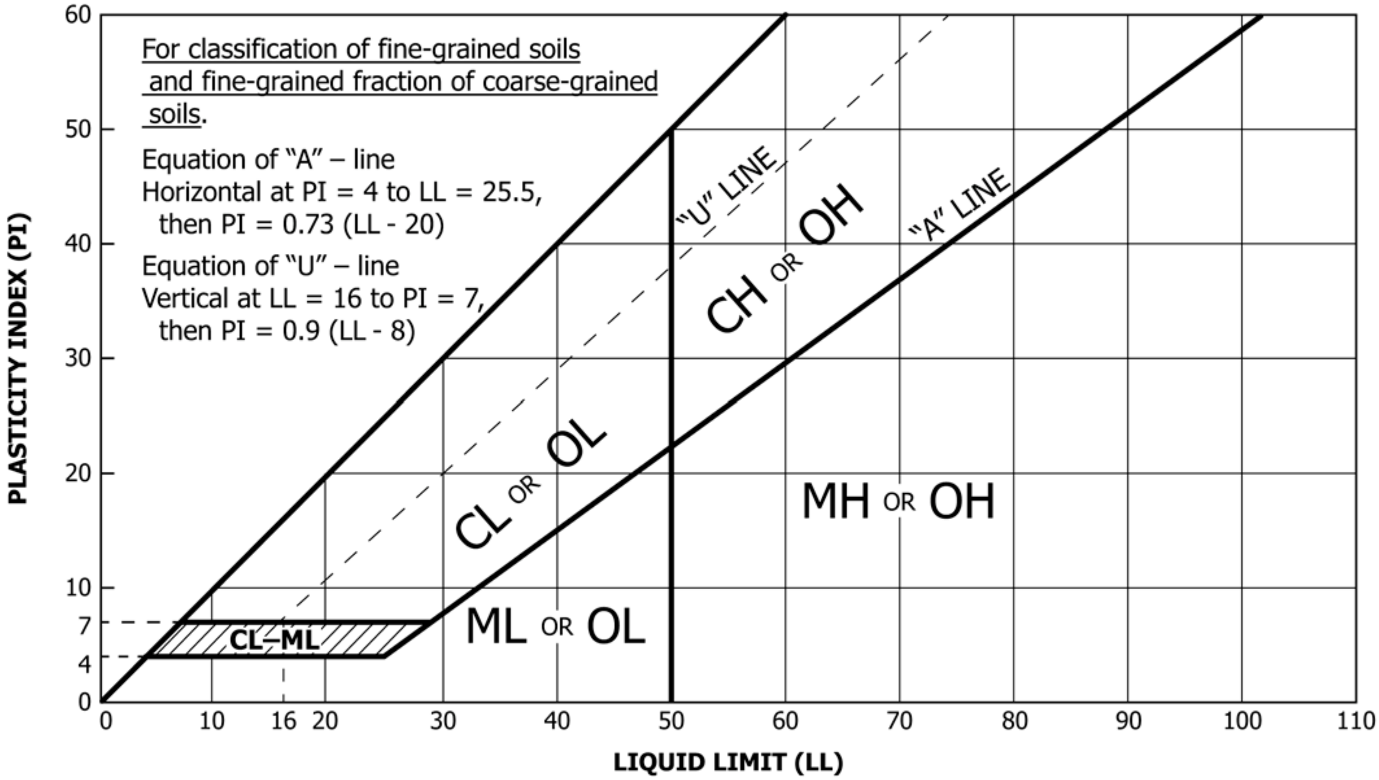
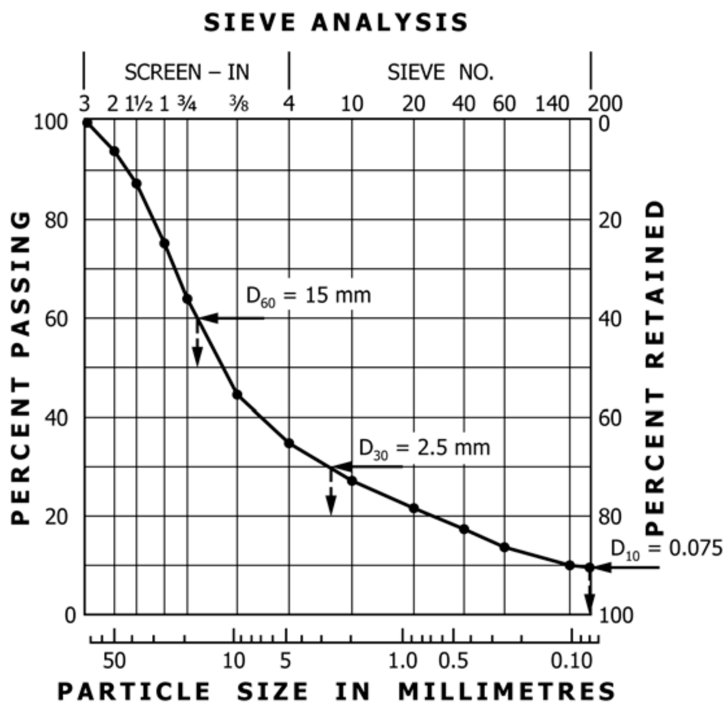


FIG. 4 Plasticity Chart



$$Cu = \frac{D_{60}}{D_{10}} = \frac{15}{0.075} = 200 \qquad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \frac{(2.5)^2}{0.075 \times 15} = 5.6$$

FIG. 5 Cumulative Particle-Size Plot

Site Investigation Requirements for Public Works Street Projects

General

This guideline provides basic principles and requirements for site investigations and testing with which to guide the designer in the preparation of proposals and completion of their investigations. Irrespective of the requirements listed in this document, it is important that the Engineer clearly outlines what assumptions were made in estimating the effort and resources necessary to complete the scope of work. A proposal should be submitted for approval to the City's Project Manager.

When using this guideline, the designer remains responsible for the proposed plan in accordance to good engineering standards that address the specific needs and site conditions of the project. Without limiting that broad and general obligation, this guideline should be the minimum requirement.

Boreholes and pavement core spacing, and material testing guidelines presented in this guide are only applicable to pavement investigations. Site investigation and testing may also be conducted as per common industry practice for other road elements such as sidewalks, boulevards, and medians. The City's Project Manager should be notified of any unusual conditions or difficulties encountered, and any changes made in the investigation program.

New Construction and Reconstruction Projects

The number of boreholes can be calculated using Table 1.

Table 1 : Number of Boreholes and Depths

Lanes/Locals	Industrials and Collectors	Arterials
Number of boreholes = 0.1 × (Street area (m^2))$^{0.45}$ A minimum of two boreholes, 2 m ± 150 mm depth from the bottom of the proposed or the existing pavement per project location.	Number of boreholes = 0.1 × (Street area (m^2))$^{0.46}$ A minimum of three boreholes, 2.5 m ± 150 mm depth from the bottom of the proposed or the existing pavement per project location.	Number of boreholes = 0.1 × (Street area (m^2))$^{0.48}$ A minimum of three boreholes, 2.5 m ± 150 mm depth from the bottom of the proposed or the existing pavement per project location.

[1]If previous soil information is available and relevant, the number of boreholes can be reduced - confirm with the City's Project Manager.
[2]Additional boreholes should be undertaken where adverse soil conditions are expected or encountered during the course of field drilling.

Offset the boreholes as appropriate to provide coverage across the full width of the proposed construction. Boreholes should not be advanced on utility cut patching. The locations of the boreholes should be shown clearly on a scaled plan map of the site under investigation.

The following factors should be considered while selecting borehole locations:

- Visual sub-grade variability;
- Significant pavement failures (rutting, fatigue cracking, settlement and faulting) which are often associated with sub-grade issues to diagnose the cause of these conditions; and,
- Exiting buried infrastructure.

Information regarding the sampler type, date and time of sampling, sample type and color, sample depth, ground water elevations, boreholes location, etc. should be shown in log form using notations and a graphical system. The log form should distinguish between visual evaluations of soil samples in the field versus a more precise laboratory evaluation supported by tests. Detailed boring logs including the results of laboratory tests should be included in the geotechnical report.

Measure and identify pavement materials (thickness and types of pavement structure materials). Photograph core samples recovered from the pavement surface (concrete, asphalt or composite).

Visual identification of the soil must be reported at the following depths from the bottom of the proposed or the existing pavement – 0.6 m, 0.9 m, 1.2 m, 1.6 m, 2.0 m, and 2.5 m (if required). Ensure that each soil type encountered in the boreholes is identified. The visual identification should describe the existing pavement structure, if any, including the materials encountered and the layer thicknesses.

Backfill boreholes with granular fill. Patch pavement surface with an approved cold patch asphalt or rapid set cementitious product to match the surface pavement type.

Where significant embankments are proposed along the roadway, specific testing and recommendations for the fill materials and placement should be made including expected settlements, load compensation requirements, and potential buoyancy of the embankment. The size, complexity and extent of the testing program will depend primarily on the type, height and size of embankment as well as the expected imported soil conditions – confirm with the City's Project Manager.

For embankments less than 100 m in length, a minimum of two boreholes are required. For embankments more than 100 m in length, the spacing between boreholes along the length of the embankment should not exceed 75 m with a minimum of two (2) boreholes. Extend the boreholes depths to a minimum of 2 m ± 150 mm below the proposed sub-grade level. At critical locations and where embankment heights exceed 1.0 m, a minimum of two (2) boreholes are required in the transverse direction to define the existing geological conditions for stability analyses.

Laboratory Testing Program

Determine the moisture content of the soils encountered in every borehole in accordance with ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass, at the following depths from the bottom of the proposed or existing pavement – 0.6 m, 0.9 m, 1.2 m, 1.6 m, 2.0 m, and 2.5 m (if required).

Classify and test the anticipated sub-grade soil in accordance with Table 2. The sub-grade soil is the material on which the pavement structure will be built; 0.6 m, 0.9 m, and 1.2 m may be used for locals, collectors, and arterials, respectively – confirm with the City's Project Manager.

Table 2: Boreholes Testing Frequency

Lanes/Locals	Collectors	Arterials
Number of boreholes = 0.1 × (Street area (m^2))$^{0.4}$ A minimum of two boreholes should be tested per project location.	Number of boreholes = 0.1 × (Street area (m^2))$^{0.41}$ A minimum of three boreholes should be tested per project location.	Number of boreholes = 0.1 × (Street area (m^2))$^{0.42}$ A minimum of three boreholes should be tested per project location.

The testing program should include:

- Particle Size Analysis – ASTM D6913 Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis and ASTM D7928 Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis;
- Atterberg Limits – ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; and,
- California Bearing Ratio (CBR) – ASTM D1883 Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils. CBR test shall be performed at 95 % maximum dry density and optimum water content. All samples shall be soaked prior to testing.

The sub-grade classification should be in accordance with:

- ASTM D3282 - Standard Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes; and,
- ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes.

The designer should consider the site specific factors listed above for borehole locations while selecting testing location and frequency.

More advanced testing may be required depending upon site conditions including direct shear tests, triaxial tests, unconfined compressive tests, permeability tests, consolidation tests, point load tests, slaking tests, pinhole dispersion tests or other tests as deemed appropriate and justified by the designer – confirm with the City's Project Manager.

Rehabilitation Projects

For any rehabilitation projects (Concrete, Asphalt or Composite), measure and identify pavement materials (thickness and types of pavement structure materials). Photograph core samples recovered from the pavement.

For concrete rehabilitation projects, 150 mm-diameter cores shall be taken at joints to identify proper rehabilitation strategies (i.e. mill/fill, partial depth repair, full depth repair). The number and location of cores will be determined by the designer after visiting the site – confirm with the City's Project Manager. A minimum of two (2) cores shall be collected mid-slab to determine the existing pavement thickness and concrete strength in accordance with CSA A23.2-14C – wet condition.

Factors that should be considered while selecting pavement core locations include but are not limited to:

- Significant variation in joint condition;
- Pumping slabs, cracks or distress and perceived moisture issues from side slopes/edge cracking; and,
- Significant changes in pavement structure thickness.

Non-destructive testing (i.e. Falling Weight Deflectometer and Ground Penetrating Radar) can be used to identify layer thicknesses and structural adequacy, load transfer at joints, and appropriate rehabilitation strategies, including partial depth repairs, full depth repairs, slab replacement, and overlays – confirm with the City's Project Manager.

PROJECT: 2023 Regional Streets Renewal	CLIENT: City of Winnipeg	TESTHOLE NO: TH23-01
LOCATION: Sargent Ave. - 3.1m N of S curb, 21.0m W of Edmonton St.		PROJECT NO.: 60697893
CONTRACTOR: Paddock Drilling Ltd.	METHOD: Truck Mounted Rig - 150 mm SSA	ELEVATION (m): -

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

PENETRATION TESTS: Becker; Dynamic Cone; SPT (Standard Pen Test) (Blows/300mm) 0 20 40 60 80 100; Total Unit Wt (kN/m³) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: Torvane; QU/2; Lab Vane; Pocket Pen.; Field Vane (kPa) 50 100 150 200

DEPTH (m)	USCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS
0	ASPH	ASPHALT				
	CONC	CONCRETE				
	CL	Lean CLAY (CL) - brown, firm, moist - intermediate plasticity	GRAB	G1		
			GRAB	G2		
1			GRAB / BULK	G3 B1		[G3]: Liquid Limit: 38.4, Plastic Limit: 13.3; Gravel (%): 0, Sand (%): 1.9, Silt(%): 65.6, Clay(%): 32.5
	CH	Fat CLAY (CH) - brown, firm, moist - high plasticity	GRAB	G4		
			GRAB	G5		
2						
			GRAB	G6		
		END OF TEST HOLE - Testhole terminated at depth of 2.74 m in fat CLAY. - No soil sloughing was observed during or upon completion of drilling. - Testhole backfilled with soil cuttings, then sand and asphalt to original ground surface.				
3						
4						

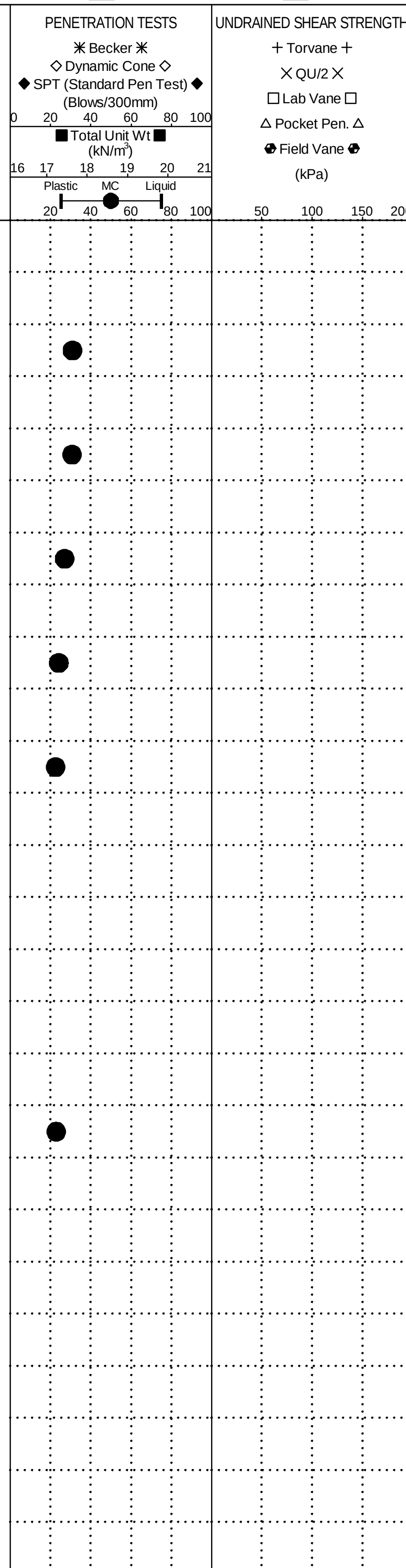
AECOM

LOGGED BY: AB	COMPLETION DEPTH: 2.74 m
REVIEWED BY: German Leal	COMPLETION DATE: 23-4-17
PROJECT ENGINEER: Ryan Cunningham	Page 1 of 1

PROJECT: 2023 Regional Streets Renewal	CLIENT: City of Winnipeg	TESTHOLE NO: TH23-02
LOCATION: Sargent Ave. - 2.7m N of S curb, 52.5m W of Edmonton St.		PROJECT NO.: 60697893
CONTRACTOR: Paddock Drilling Ltd.	METHOD: Truck Mounted Rig - 150 mm SSA	ELEVATION (m): -

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	USCS	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS	DEPTH
0	ASPH		ASPHALT					
	CONC		CONCRETE					
	CH		Fat CLAY (CH) - grey, firm, moist - high plasticity	GRAB	G1			
				GRAB	G2			
1				GRAB	G3			1
	CL		Lean CLAY (CL) - brown, firm, moist - intermediate plasticity	GRAB	G4			
				GRAB	G5			
2								2
				GRAB	G6			
			END OF TEST HOLE - Testhole terminated at depth of 2.74 m in fat CLAY. - No soil sloughing was observed during or upon completion of drilling. - Testhole backfilled with soil cuttings, then sand and asphalt to original ground surface.					
3								3
4								



AECOM

LOGGED BY: AB	COMPLETION DEPTH: 2.74 m
REVIEWED BY: German Leal	COMPLETION DATE: 23-4-17
PROJECT ENGINEER: Ryan Cunningham	Page 1 of 1

PROJECT: 2023 Regional Streets Renewal	CLIENT: City of Winnipeg	TESTHOLE NO: TH23-03
LOCATION: Sargent Ave. - 1.5m N of S curb, 9.0m W of Kennedy St.		PROJECT NO.: 60697893
CONTRACTOR: Paddock Drilling Ltd.	METHOD: Truck Mounted Rig - 150 mm SSA	ELEVATION (m): -

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

PENETRATION TESTS: Becker; Dynamic Cone; SPT (Standard Pen Test) (Blows/300mm) 0 20 40 60 80 100; Total Unit Wt (kN/m³) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: Torvane; QU/2; Lab Vane; Pocket Pen.; Field Vane (kPa) 50 100 150 200

DEPTH (m)	USCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS
0	ASPH	ASPHALT				
	CONC	CONCRETE	GRAB	G1		
	CH	Fat CLAY (CH) - grey, firm, moist - high plasticity	GRAB	G2		
1			GRAB / BULK	G3 B2		
			GRAB	G4		
			GRAB	G5		
2						
			GRAB	G6		
3		END OF TEST HOLE - Testhole terminated at depth of 2.74 m in fat CLAY. - No soil sloughing was observed during or upon completion of drilling. - Testhole backfilled with soil cuttings, then sand and asphalt to original ground surface.				
4						

AECOM

LOGGED BY: AB	COMPLETION DEPTH: 2.74 m
REVIEWED BY: German Leal	COMPLETION DATE: 23-4-17
PROJECT ENGINEER: Ryan Cunningham	Page 1 of 1

PROJECT: 2023 Regional Streets Renewal	CLIENT: City of Winnipeg	TESTHOLE NO: TH23-04
LOCATION: Sargent Ave. - 4.5m N of S curb, 23.0m E of Balmoral St.		PROJECT NO.: 60697893
CONTRACTOR: Paddock Drilling Ltd.	METHOD: Truck Mounted Rig - 150 mm SSA	ELEVATION (m): -

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

PENETRATION TESTS: Becker; Dynamic Cone; SPT (Standard Pen Test) (Blows/300mm) 0 20 40 60 80 100; Total Unit Wt (kN/m³) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: Torvane; QU/2; Lab Vane; Pocket Pen.; Field Vane (kPa) 50 100 150 200

DEPTH (m)	USCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS
0	ASPH	ASPHALT				
	SW	WELL GRADED SAND (base course) - brown	GRAB	G1		
	CH	Fat CLAY (CH) - grey, firm, moist, some silt inclusions - high plasticity	GRAB	G2		
1			GRAB	G3		
		- brown below 1.2 m - trace organics at 1.50 to 1.60m	GRAB	G4		
			GRAB	G5		
2						
			GRAB	G6		[G6]: Liquid Limit: 83.8, Plastic Limit: 23.4; Gravel (%): 0, Sand (%): 0.9, Silt(%): 17.2, Clay(%): 81.9
		END OF TEST HOLE - Testhole terminated at depth of 2.74 m in fat CLAY. - No soil sloughing was observed during or upon completion of drilling. - Testhole backfilled with soil cuttings, then sand and asphalt to original ground surface.				
3						
4						

AECOM

LOGGED BY: AB	COMPLETION DEPTH: 2.74 m
REVIEWED BY: German Leal	COMPLETION DATE: 23-4-17
PROJECT ENGINEER: Ryan Cunningham	Page 1 of 1

LOG OF TEST HOLE 2023 REGIONAL STREETS RNEWAL (SARGENT).GPJ UMA WINN.GDT 23-11-29

City of Winnipeg - 2023 Regional Streets Renewal – Geotechnical Investigation

Table 1. Testhole Summary

Testhole ID	Testhole Location	Pavement Structure			Remarks	Sample Depth (m)	Moisture Content (%)	Hydrometer Analysis				Atterberg Limits		
		Type	Thickness (mm)	Compressive Strength (MPa)				Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit	Plastic Limit	Plasticity Index
TH23-01	Sargent Ave. - 3.1m N of S curb, 21.0m W of Edmonton St.	Asphalt	255	-		0.30	27.5							
						0.60	26.9							
						0.90	26.4	0	1.9	65.6	32.5	38.4	13.3	25.1
		Concrete	105	-		1.30	31.9							
						1.60	41.4							
						2.60	47.2							
TH23-02	Sargent Ave. - 2.7m N of S curb, 52.5m W of Edmonton St.	Asphalt	155	-		0.30	30.9							
						0.60	30.7							
						0.90	27							
		Concrete	155	-		1.30	24.1							
						1.60	22.5							
						2.60	22.8							
TH23-03	Sargent Ave. - 1.5m N of S curb, 9.0m W of Kennedy St.	Asphalt	230	-		0.30								
						0.60	31.7							
						0.90	31.8							
		Concrete	230	-		1.30	28.9							
						1.60	27.8							
						2.60	47.5							
TH23-04	Sargent Ave. - 4.5m N of S curb, 23.0m E of Balmoral St.	Asphalt	280	-		0.30	40							
						0.60	31.6							
						0.90	33.5							
		Concrete	0	-		1.30	32.5							
						1.60	49.3							
						2.60	40	0	0.9	17.2	81.9	83.8	23.4	60.4

Appendix C

Laboratory Test Results

AECOM

AECOM Canada Ltd.
Winnipeg Geotechnical Laboratory
99 Commerce Drive
Winnipeg, Manitoba
R3P 0Y7
Phone: 204 477 5381 Fax: 204 284 2040

Project Name:	2023 Regional Streets Renewal	Supplier:	AECOM
Project Number:	60697893	Specification:	N/A
Client:	City Of Winnipeg	Field Technician:	EManimbao
Sample Location:	Sargent Ave, Winnipeg, MB	Sample Date:	April 17, 2023
Sample Depth:	Varies	Lab Technician:	LBoughton
Sample Number:	Varies	Date Tested:	April 20, 2023

Moisture Content (ASTM D2216-10)

Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

Location	Sample	Depth (m)	**Moisture Content (%)**
TH23-01	G1	0.30 - 0.46 m	**27.5%**
	G2	0.61 - 0.76 m	**26.9%**
	G3	0.91 - 1.07 m	**26.4%**
	G4	1.22 - 1.37 m	**31.9%**
	G5	1.52 - 1.68 m	**41.4%**
	G6	2.59 - 2.74 m	**47.2%**
	B1	0.61 - 1.52 m	**-**
TH23-02	G1	0.30 - 0.46 m	**30.9%**
	G2	0.61 - 0.76 m	**30.7%**
	G3	0.91 - 1.07 m	**27.0%**
	G4	1.22 - 1.37 m	**24.1%**
	G5	1.52 - 1.68 m	**22.5%**
	G6	2.59 - 2.74 m	**22.8%**
TH23-03	G1	0.30 - 0.46 m	**-**
	G2	0.61 - 0.76 m	**31.7%**
	G3	0.91 - 1.07 m	**31.8%**
	G4	1.22 - 1.37 m	**28.9%**
	G5	1.52 - 1.68 m	**27.8%**
	G6	2.59 - 2.74 m	**47.5%**
	B2	0.61 - 1.52 m	**-**
TH23-04	G1	0.30 - 0.46 m	**-**
	G2	0.61 - 0.76 m	**40.0%**
	G3	0.91 - 1.07 m	**31.6%**
	G4	1.22 - 1.37 m	**33.5%**
	G5	1.52 - 1.68 m	**32.5%**
	G6	2.59 - 2.74 m	**49.3%**

Location	Sample	Depth (m)	**Moisture Content (%)**

GRAIN SIZE DISTRIBUTION
(ASTM D422-63)

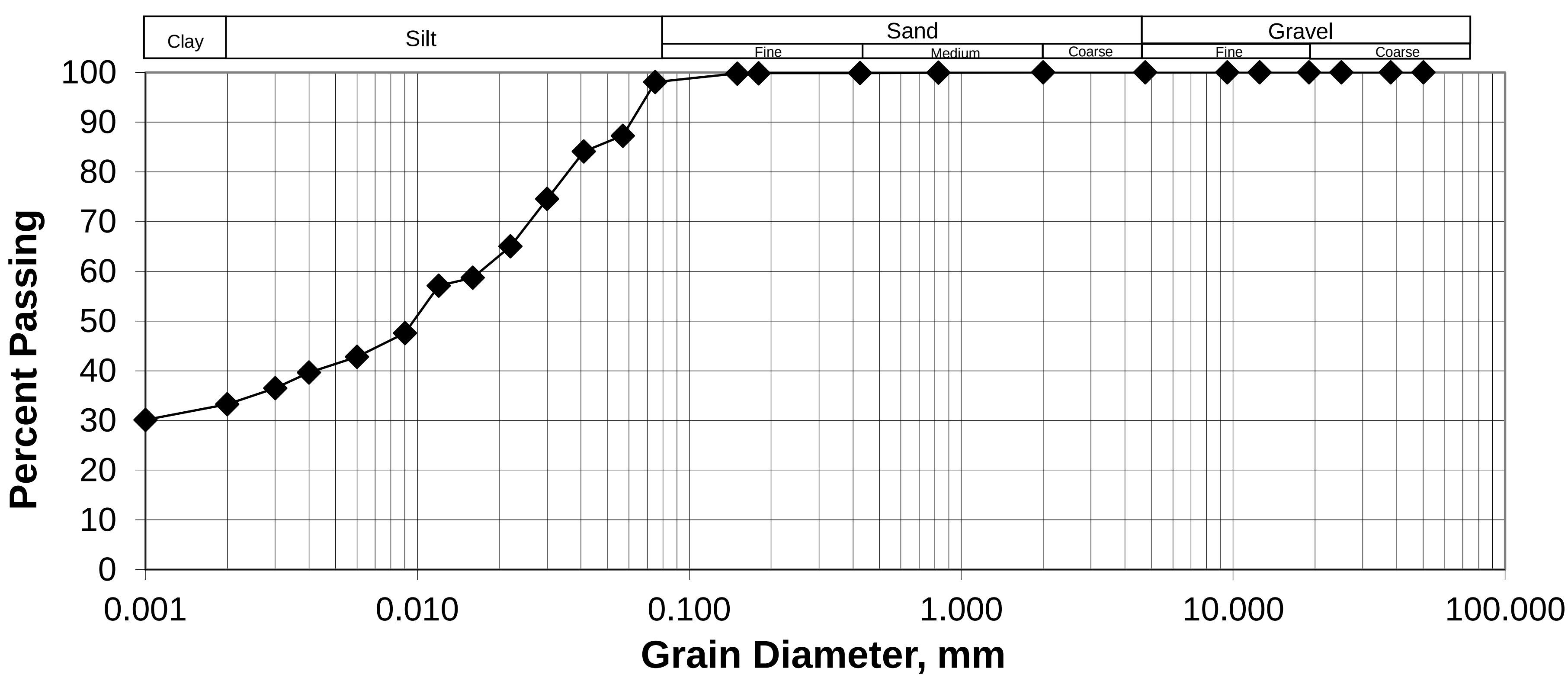
AECOM
WINNIPEG GEOTECHNICAL LABORATORY
99 Commerce Dr., Winnipeg, MB R3P 0Y7 Canada
tel (204) 477-5381 **fax** (431) 800-1210

CERTIFIED BY CCIL

Job No.:	60689096	Hole No.:	TH23-01
Client:	CoW	Sample No.:	G3
Project :	2023 Regional Streets Renewal (Sargent)	Depth:	0.91 - 1.07 m
Date Tested:	25-Apr-23	Date Sampled:	Varies
Tested By:	LBoughton	Sampled By:	AECOM

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	4.75	100.0	0.0750	98.1
38.0	100.0	2.00	100.0	0.0570	87.3
25.0	100.0	0.825	100.0	0.0410	84.1
19.0	100.0	0.425	99.9	0.0300	74.6
12.5	100.0	0.18	99.9	0.0220	65.1
9.5	100.0	0.15	99.8	0.0160	58.7
4.75	100.0	0.075	98.1	0.0120	57.1
				0.0090	47.6
				0.0060	42.8
				0.0040	39.6
				0.0030	36.5
				0.0020	33.3
				0.0010	30.1

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.0%**	**Silt**	**64.8%**
Sand	**1.9%**	**Clay**	**33.3%**

GRAIN SIZE DISTRIBUTION
(ASTM D422-63)

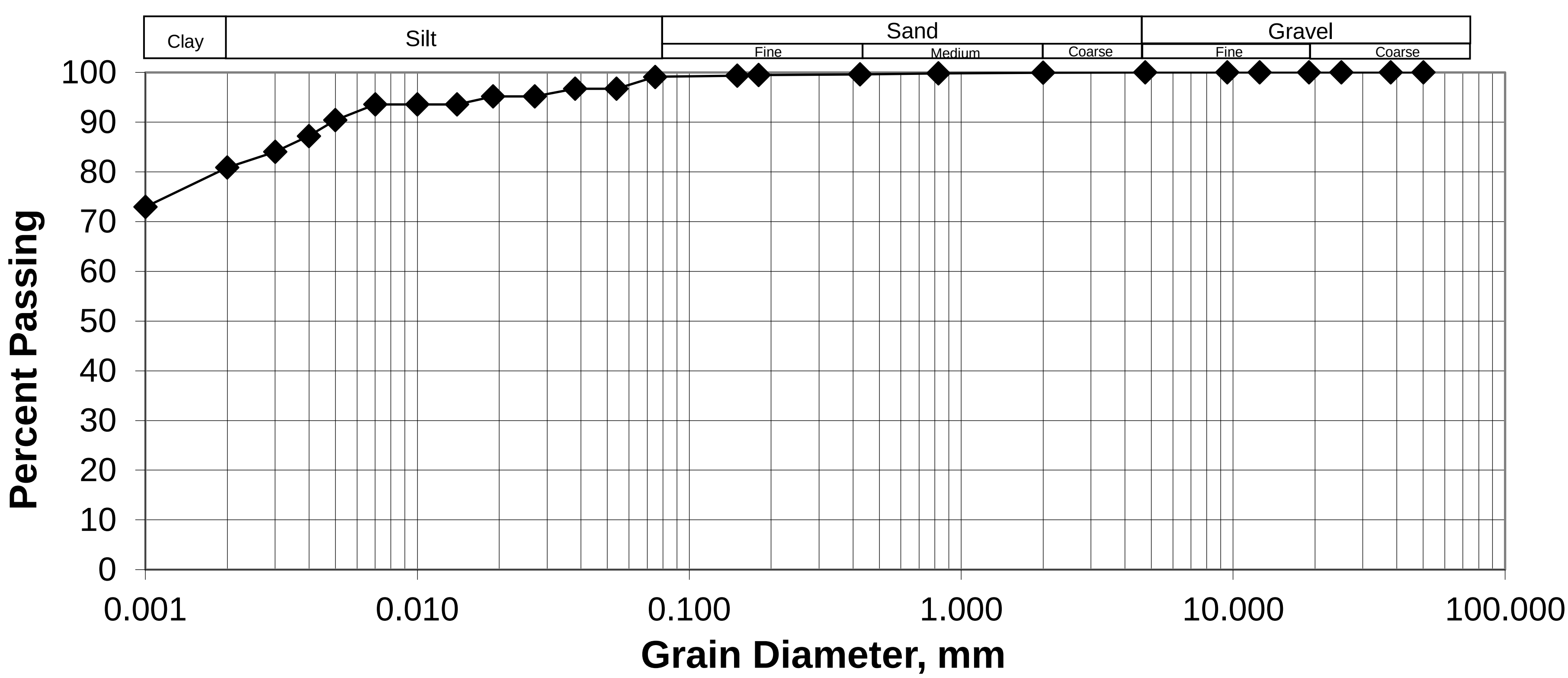
AECOM
WINNIPEG GEOTECHNICAL LABORATORY
99 Commerce Dr., Winnipeg, MB R3P 0Y7 Canada
tel (204) 477-5381 **fax** (431) 800-1210

CERTIFIED BY CCIL

Job No.:	60689096	Hole No.:	TH23-04
Client:	CoW	Sample No.:	G6
Project :	2023 Regional Streets Renewal (Sargent)	Depth:	2.59 - 2.74 m
Date Tested:	25-Apr-23	Date Sampled:	Varies
Tested By:	LBoughton	Sampled By:	AECOM

GRAVEL SIZES		**SAND SIZES**		**FINES**	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	4.75	100.0	0.0750	99.1
38.0	100.0	2.00	99.9	0.0540	96.7
25.0	100.0	0.825	99.8	0.0380	96.7
19.0	100.0	0.425	99.6	0.0270	95.2
12.5	100.0	0.18	99.5	0.0190	95.2
9.5	100.0	0.15	99.3	0.0140	93.6
4.75	100.0	0.075	99.1	0.0100	93.6
				0.0070	93.6
				0.0050	90.4
				0.0040	87.2
				0.0030	84.1
				0.0020	80.9
				0.0010	72.9

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.0%**	**Silt**	**18.2%**
Sand	**0.9%**	**Clay**	**80.9%**

AECOM Canada Ltd.
Winnipeg Geotechnical Laboratory
99 Commerce Drive
Winnipeg, Manitoba
R3P 0Y7
Phone: 204 477 5381 Fax: 204 284 2040

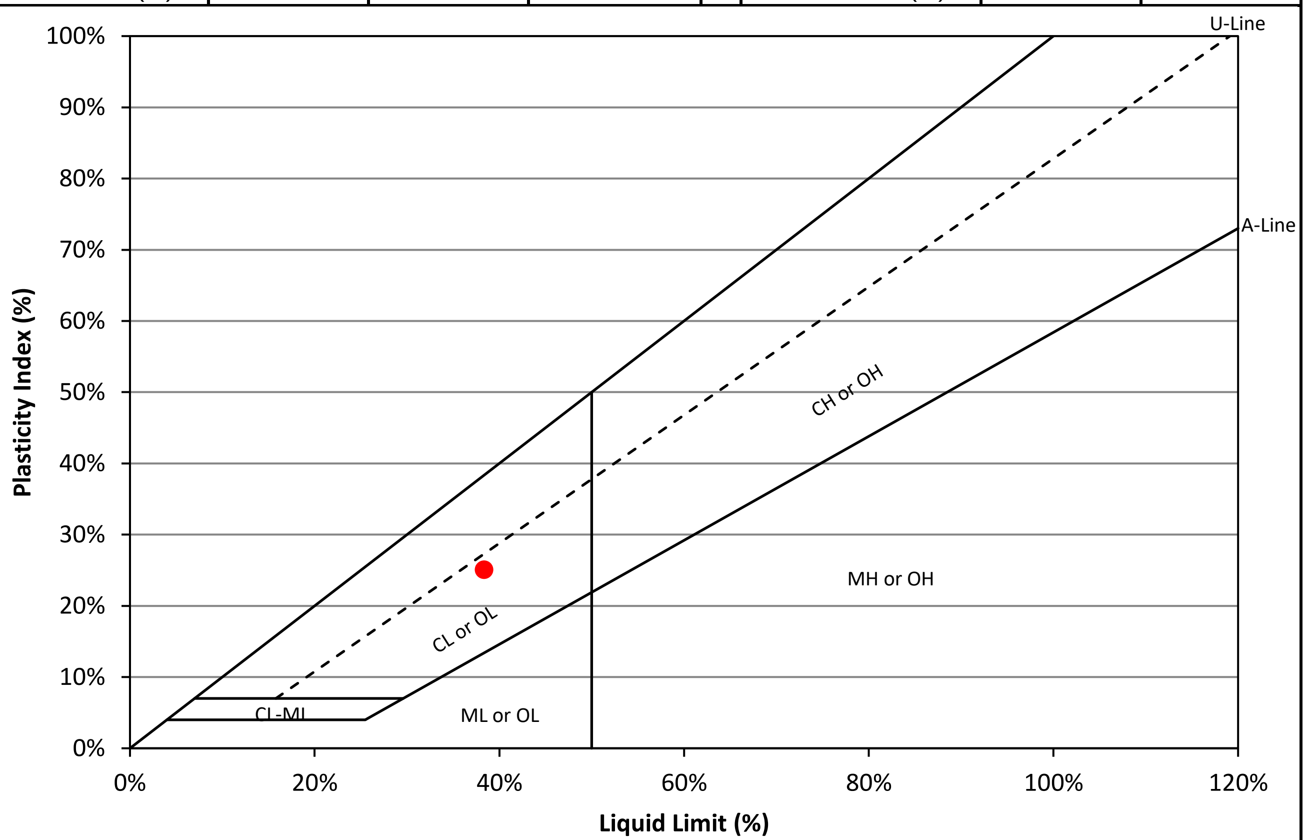
Project Name:	2023 Regional Streets Renewal (Sargent)	Supplier:	AECOM
Project Number:	60697893	Specification:	N/A
Client:	City of Winnipeg	Field Technician:	EManimbao
Sample Location:	TH23-01	Sample Date:	April 17, 2023
Sample Depth:	0.91 - 1.07 m	Lab Technician:	LBoughton
Sample Number:	G3	Date Tested:	April 25, 2023

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	35	20	15
Wet Sample (g)	11.3	15.2	14.7
Dry Sample (g)	8.3	10.9	10.5
Water Content (%)	37.0%	38.9%	40.7%

Plastic Limit		
Trial	1	2
Wet Sample (g)	5.3	5.0
Dry Sample (g)	4.7	4.4
Water Content (%)	13.2%	13.4%



Liquid Limit (%): 38.4%	Plastic Limit (%): 13.3%	Plasticity Index (%): 25.1%

AECOM Canada Ltd.
Winnipeg Geotechnical Laboratory
99 Commerce Drive
Winnipeg, Manitoba
R3P 0Y7
Phone: 204 477 5381 Fax: 204 284 2040

CERTIFIED BY CCIL

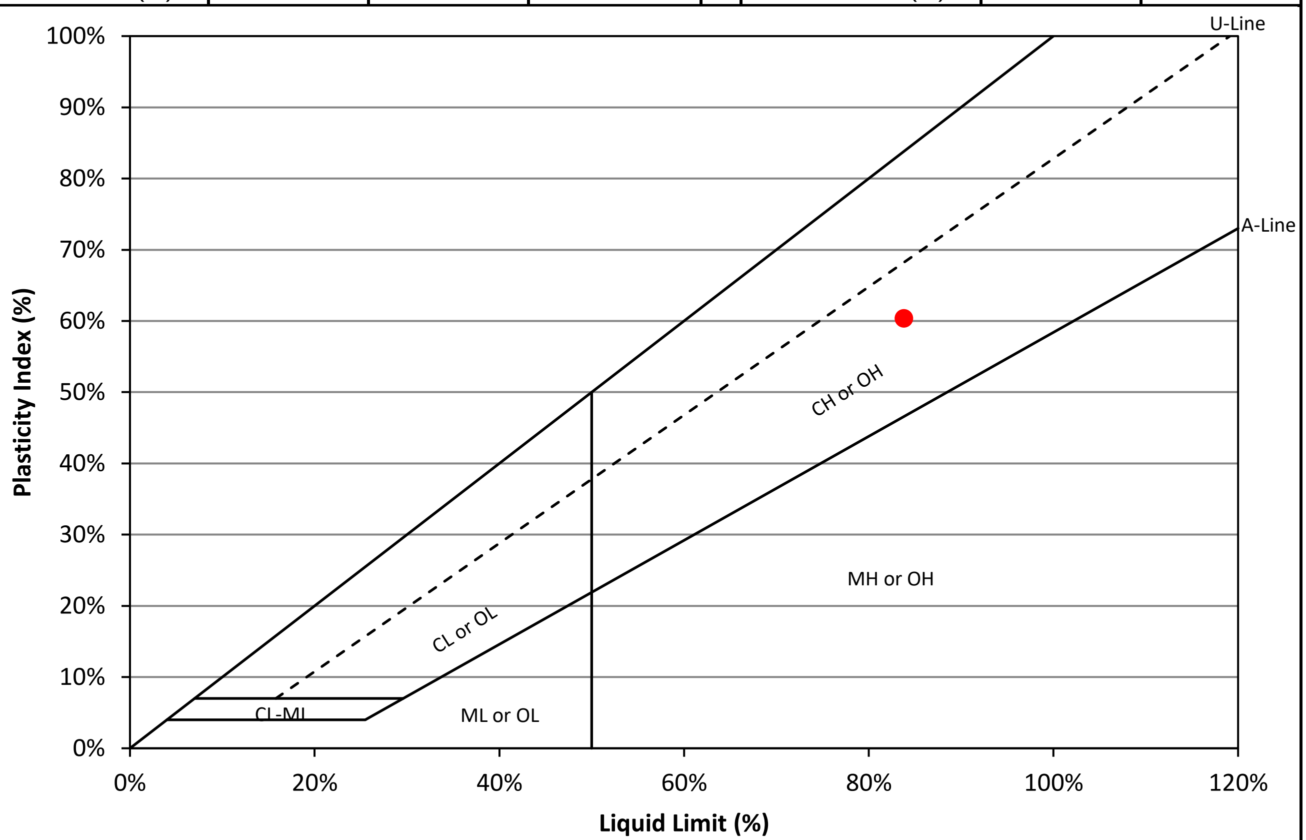
Project Name:	2023 Regional Streets Renewal (Sargent)	Supplier:	AECOM
Project Number:	60697893	Specification:	N/A
Client:	City of Winnipeg	Field Technician:	EManimbao
Sample Location:	TH23-04	Sample Date:	April 17, 2023
Sample Depth:	2.59 - 2.74 m	Lab Technician:	LBoughton
Sample Number:	G6	Date Tested:	April 25, 2023

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	35	25	15
Wet Sample (g)	10.5	11.9	11.3
Dry Sample (g)	5.8	6.5	6.0
Water Content (%)	80.5%	84.3%	88.5%

Plastic Limit		
Trial	1	2
Wet Sample (g)	5.8	5.8
Dry Sample (g)	4.7	4.7
Water Content (%)	23.5%	23.4%



Liquid Limit (%): 83.8%	Plastic Limit (%): 23.4%	Plasticity Index (%): 60.4%

CALIFORNIA BEARING RATIO (CBR) TEST

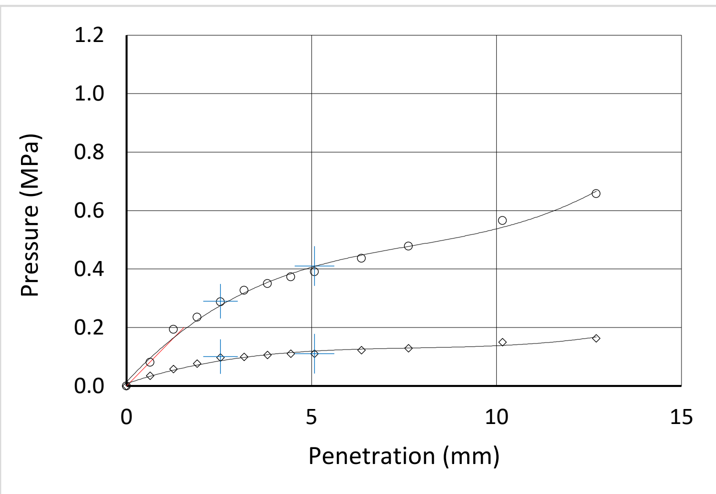
ASTM D1883

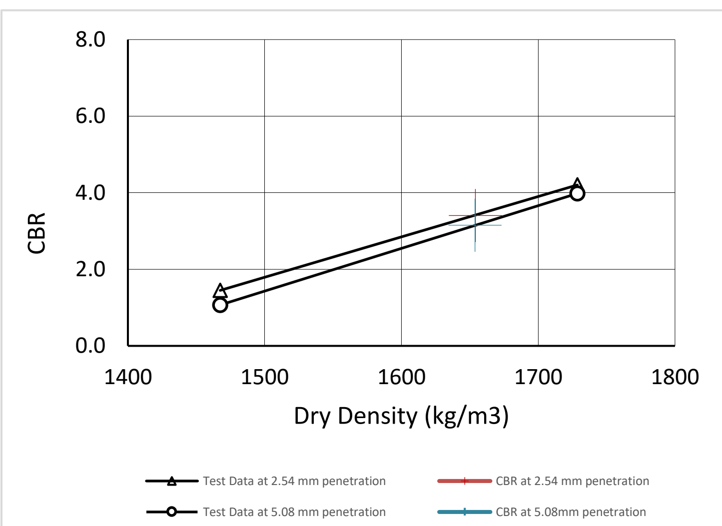
AECOM

Client: City of Winnipeg	Test Hole ID: TH23-01	
Project Name: 2023 Regional Streets Renewal	Sample ID: B1	Sample Depth (m): 1.0 - 1.20
Project Number: 60697893	Soil Description: Fat CLAY (CH)	
Location: Sargent Avenue, Winnipeg, MB	Tested By: ND	Tested Date: August 29, 2023

PROCTOR DATA		CBR DATA	10 blows	25 blows	56 blows
Optimum Moisture Content (%)	16.1	Moisture Content, MC (%)		16.5%	16.1%
Maximum Dry Density (kg/m3)	1741	Wet Density (kg/m3)		1709.0	2007.5
Proctor Test Method	Standard	Dry Density (kg/m3)		1467.5	1728.6
Tested by:	Enrico Manimbao	Compaction Degree (%)		84%	99%
Remark:		Surcharge Weight (g)		4506	4506
Soaked CBR at 95% of SPMDD		Soaked for (days)		4	4
		Swell (%)		3.5%	2.0%

PENETRATION DATA





Penetration (mm)	Pressure (MPa)		
0		0.0	0.0
0.635		0.03	0.08
1.27		0.06	0.19
1.905		0.08	0.23
2.54		**0.10**	**0.29**
3.175		0.10	0.33
3.81		0.11	0.35
4.445		0.11	0.37
5.08		**0.11**	**0.39**
6.35		0.12	0.44
7.62		0.13	0.48
10.16		0.15	0.57
12.7		0.16	0.66
Corrected Pressure (MPa)			
at 2.54 mm		0.10	0.29
at 5.08 mm		0.11	0.41
Corrected Bearing Ratio			
at 2.54 mm		1.4	4.2
at 5.08 mm		1.1	4.0

Standard pressure: 6.9 Mpa at 2.54 mm penetration

10.3 Mpa at 5.08mm penetration

CBR Value

CBR at	**95 % of**	**maximum dry density**
Dry density, kg/m3:		**1654**
CBR at 2.54 mm:		**3.4**
CBR at 5.08 mm:		**3.15**

Note

Proctor used was identified as Proctor No. 1932, sample TH23-01; B1. Note that the sample at 25 blows is a reused soil sample.

Reviewed and Approved by:

German Leal, M.Eng., P.Eng.

Geotechnical Discipline Lead

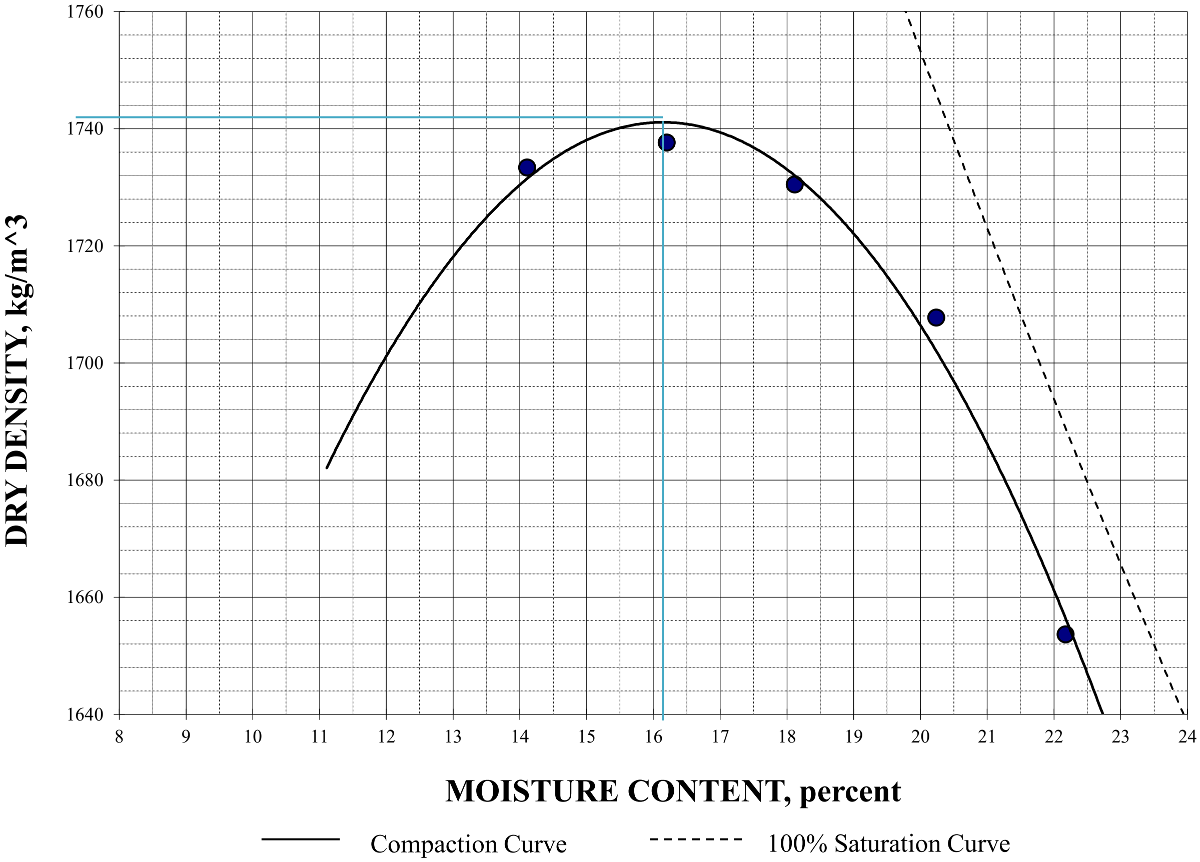
FORM: CBR_2P-TH23-01;B1_rev1.xlsx
DATE: 2023-09-13

AECOM	**AECOM WINNIPEG GEOTECHNICAL LABORATORY** 99 Commerce Drive, Winnipeg, Manitoba, R3P 0Y7 **tel** (204) 477-5381 **fax** (431) 800-1210

Client:	City of Winnipeg	**Job No:**	60697893
Project:	2023 Regional Streets	**Sample:**	Fat Clay (CH)
Lab No.	Sargent (TH23-01; B1)	**Supplier:**	AECOM
Date Tested:	28-Apr-23	**Source:**	Winnipeg, MB

ASTM D698

TRIAL NUMBER	1	2	3	4	5
Wet Unit Weight (kg/cu.m.)	1978	2019	2044	2053	2020
Dry Unit Weight (kg/cu.m.)	1733	1738	1730	1708	1654
Moisture Content (%)	14.1	16.2	18.1	20.2	22.2



Description / Remarks:	
As received moisture content (%)	N/A
Specific Gravity (Assumed)	2.7
Method Used	A
Method of Preparation	Moist
Type of Rammer	Manual

MAXIMUM DRY DENSITY**: 1741 KG/M^3**

OPTIMUM MOISTURE (%): **16.1**

PROCTOR NO: 1932

CALIFORNIA BEARING RATIO (CBR) TEST

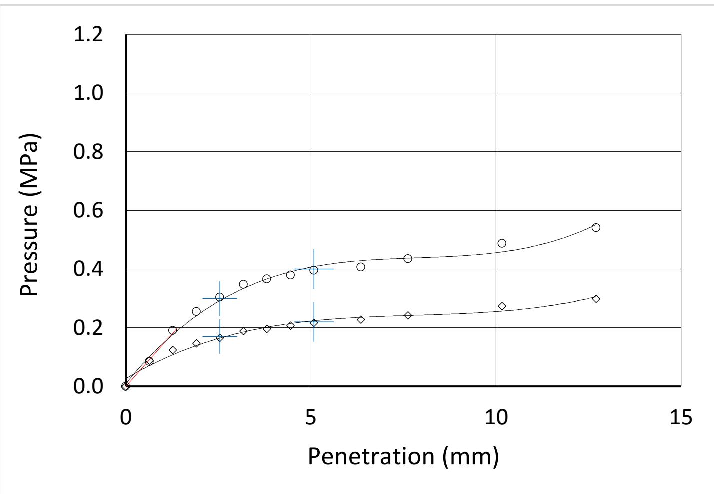
ASTM D1883

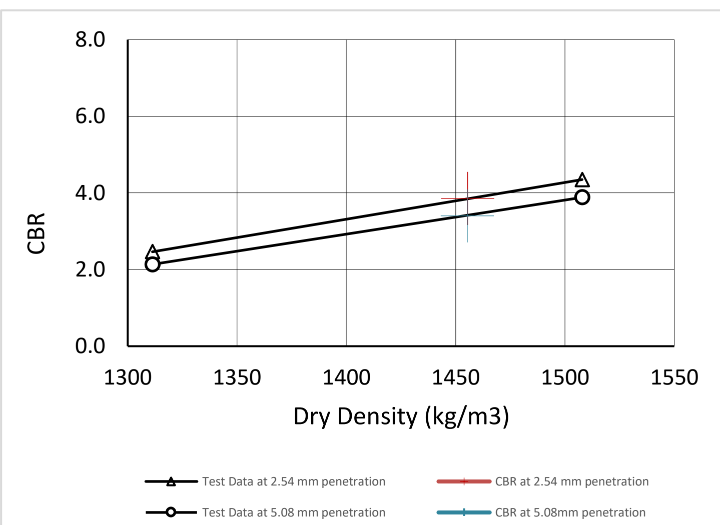
AECOM

Client: City of Winnipeg	Test Hole ID: TH23-03	
Project Name: 2023 Regional Streets Renewal	Sample ID: B2	Sample Depth (m): 1.0 - 1.20
Project Number: 60697893	Soil Description: Fat CLAY (CH)	
Location: Sargent Avenue, Winnipeg, MB	Tested By: ND	Tested Date: August 29, 2023

PROCTOR DATA		CBR DATA	10 blows	25 blows	56 blows
Optimum Moisture Content (%)	24.4	Moisture Content, MC (%)		24.9%	24.2%
Maximum Dry Density (kg/m3)	1532	Wet Density (kg/m3)		1637.4	1873.4
Proctor Test Method	Standard	Dry Density (kg/m3)		1311.3	1507.8
Tested by:	Enrico Manimbao	Compaction Degree (%)		86%	98%
Remark:		Surcharge Weight (g)		4506	4506
Soaked CBR at 95% of SPMDD		Soaked for (days)		4	4
		Swell (%)		2.6%	1.8%

PENETRATION DATA





Penetration (mm)	Pressure (MPa)		
0		0.0	0.0
0.635		0.09	0.09
1.27		0.12	0.19
1.905		0.15	0.26
2.54		**0.17**	**0.30**
3.175		0.19	0.35
3.81		0.20	0.37
4.445		0.21	0.38
5.08		**0.22**	**0.40**
6.35		0.23	0.41
7.62		0.24	0.43
10.16		0.27	0.49
12.7		0.30	0.54
Corrected Pressure (MPa)			
at 2.54 mm		0.17	0.30
at 5.08 mm		0.22	0.40
Corrected Bearing Ratio			
at 2.54 mm		2.5	4.3
at 5.08 mm		2.1	3.9

Standard pressure: 6.9 Mpa at 2.54 mm penetration

10.3 Mpa at 5.08mm penetration

CBR Value

CBR at	**95 % of**	**maximum dry density**
Dry density, kg/m3:		**1455**
CBR at 2.54 mm:		**3.85**
CBR at 5.08 mm:		**3.4**

Note

Proctor used was identified as Proctor No. 1931, sample TH23-03; B2. Note that the sample at 25 blows is a reused soil sample.

Reviewed and Approved by:

German Leal, M.Eng., P.Eng.

Geotechnical Discipline Lead

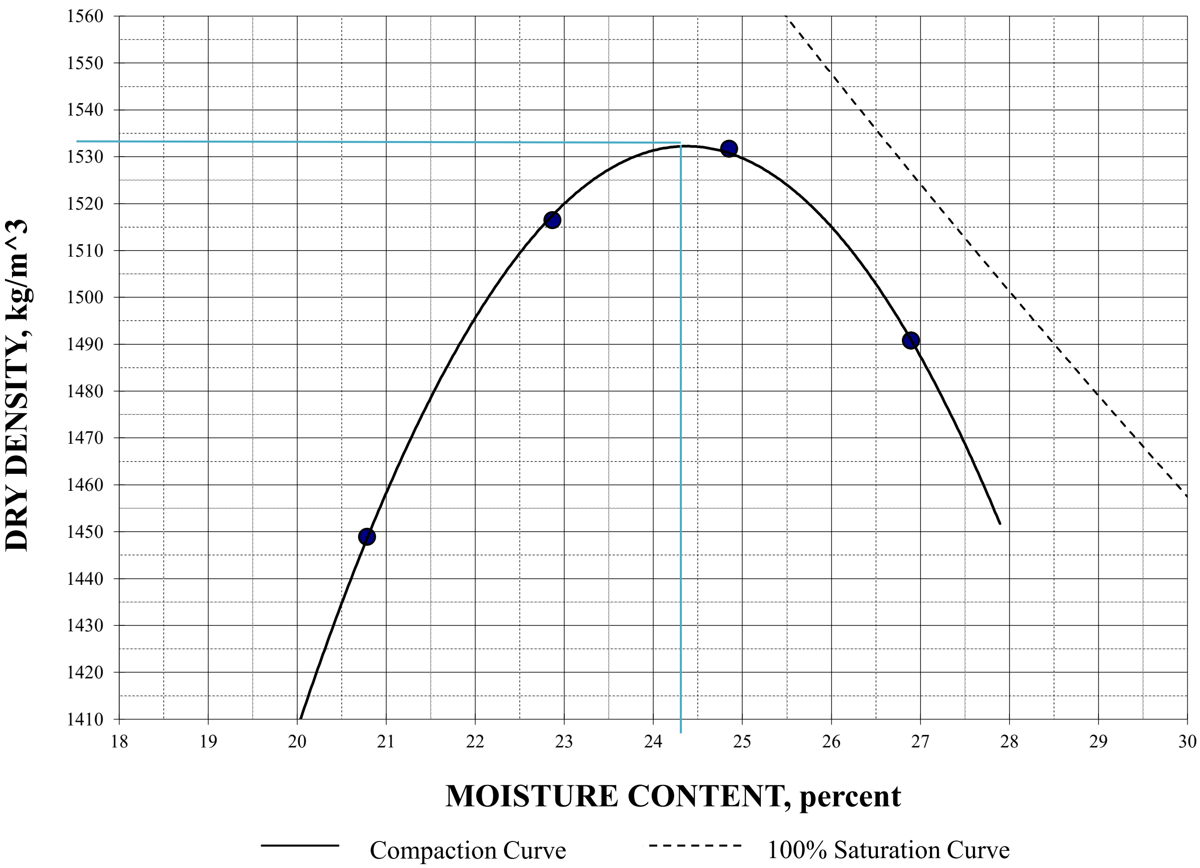
FORM: CBR_2P-TH23-03;B2_rev1.xlsx
DATE: 2023-09-13

AECOM WINNIPEG GEOTECHNICAL LABORATORY
99 Commerce Drive, Winnipeg, Manitoba, R3P 0Y7
tel (204) 477-5381 **fax** (431) 800-1210

Client:	City of Winnipeg	**Job No:**	60697893
Project:	2023 Regional Streets	**Sample:**	Fat Clay (CH)
Lab No.	Sargent (TH23-03; B2)	**Supplier:**	AECOM
Date Tested:	28-Apr-23	**Source:**	Winnipeg, MB

ASTM D698

TRIAL NUMBER	1	2	3	4	5
Wet Unit Weight (kg/cu.m.)	1750	1863	1912	1892	
Dry Unit Weight (kg/cu.m.)	1449	1516	1532	1491	
Moisture Content (%)	20.8	22.9	24.9	26.9	



Description / Remarks:

As received moisture content (%)	N/A
Specific Gravity (Assumed)	2.59
Method Used	A
Method of Preparation	Moist
Type of Rammer	Manual

MAXIMUM DRY DENSITY**: 1532 KG/M^3**
OPTIMUM MOISTURE (%): **24.4**

PROCTOR NO: 1931

AECOM

AECOM Canada Ltd.
99 Commerce Drive
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Canada

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November 30, 2023

Project #
60697893

Ryan Cunningham
AECOM Canada Ltd.
99 Commerce Drive
Winnipeg, MB R3P 0Y7

City of Winnipeg 2023 Regional Streets Renewal: Edmonton Street - Ellice to Cumberland Geotechnical Data Report

Dear Ryan Cunningham,

This geotechnical data report provides the results of a geotechnical investigation performed by AECOM Canada Ltd. (AECOM) for the proposed rehabilitation of Edmonton Street from Ellice Avenue to Cumberland Avenue as part of the City of Winnipeg's 2023 Regional Streets Renewal Program. The information collected describes the existing pavement structure. Five coreholes were core down up to the existing pavement structure.

1. Coring and Sampling

Coring was carried out by Paddock Drilling Ltd. using a truck-mounted rig equipped with solid stem augers (SSA) under the supervision of AECOM's field personnel. The geotechnical program consisted of coring five coreholes advancing up to the end of the existing pavement structure. Pavement cores were extracted at each coreholes and pavement thickness were measured within the augered holes. The location of the coreholes is provided in **Appendix A**.

Photos of the pavement cores have been prepared for each coreholes for visual presentation and to show the relative positions of the existing pavement structure. The City of Winnipeg Site Investigation Requirements for Public Works Streets, photos of the cores and the corehole summary are included in **Appendix B**.

2. Laboratory Testing

The laboratory testing program was developed to measure the strength of the existing pavement structure. The laboratory tests consisted of compressive strength tests on the core samples. The core samples were taken to Eng-Tech Consulting Limited's Materials Testing Laboratory in Winnipeg, Manitoba for testing. Detailed laboratory results are presented in **Appendix C**.

The laboratory testing program included determination of compressive strength on the core samples collected during the field investigation. A summary of the laboratory testing that was completed is provided in **Table 1**.

Table 1. Summary of Laboratory Testing

Laboratory Test	Number of Tests	Testing Standard
Concrete Compressive Strength	2	CSA A23.2-9C

Yours sincerely,

Ann Bonifacio, E.I.T.
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PROVINCE OF MANITOBA
G.E. LEAL NINO
Member
32421
REGISTERED PROFESSIONAL ENGINEER
Nov 30/2023

Appendix A

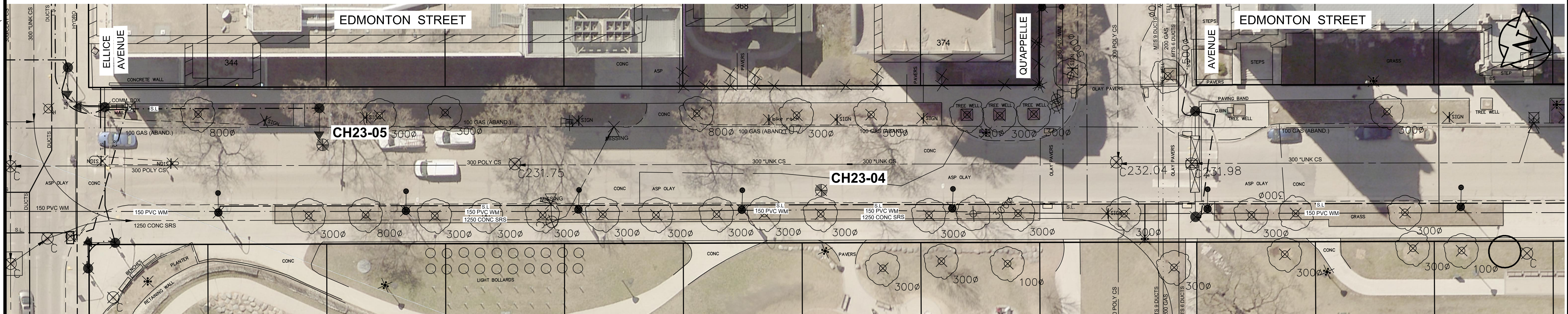
Corehole Location Plan

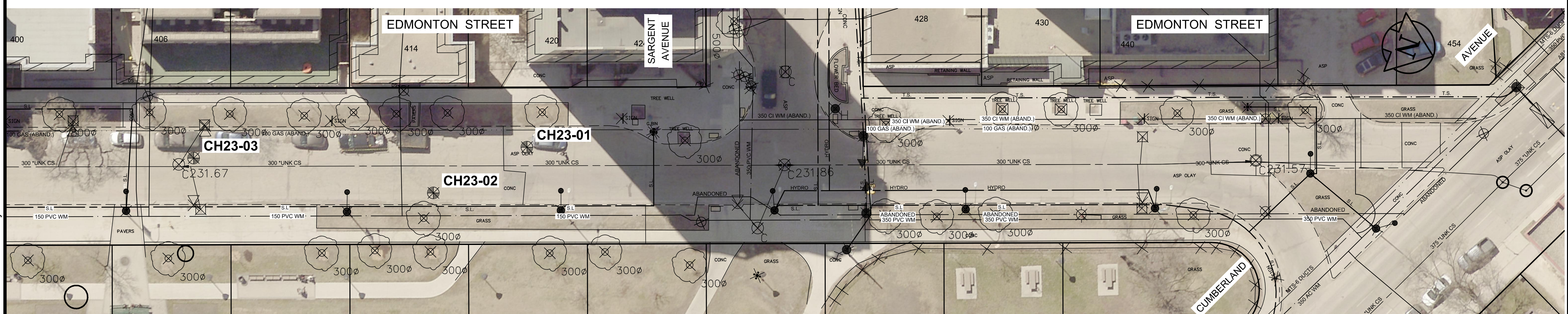
B SIZE 11" x 17" (279.4mm x 431.8mm)

PLOT: .

Saved By:

AECOM FILE NAME: AECOMv2-ANSI-DWG-BHL-M.dwt





PLAN

Scale 1:500

METRIC

WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

I/R	YY/MM/DD	ISSUE/REVISION DESCRIPTION	DRN	CHK	DES	ENG	IDR	APP
0	23/10/31	ISSUED FOR REPORT	RAM	RC	RC			

AECOM

Winnipeg

City of Winnipeg
2023 Regional Street Renewal Program
Edmonton St - Ellice Ave to Cumberland Ave
Pavement Core Locations

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
60697893	SK-03	0

Appendix B

Site Investigation Requirements for Public Works Street Projects

Photographs of Pavement Core Samples

Corehole Summary

Site Investigation Requirements for Public Works Street Projects

General

This guideline provides basic principles and requirements for site investigations and testing with which to guide the designer in the preparation of proposals and completion of their investigations. Irrespective of the requirements listed in this document, it is important that the Engineer clearly outlines what assumptions were made in estimating the effort and resources necessary to complete the scope of work. A proposal should be submitted for approval to the City's Project Manager.

When using this guideline, the designer remains responsible for the proposed plan in accordance to good engineering standards that address the specific needs and site conditions of the project. Without limiting that broad and general obligation, this guideline should be the minimum requirement.

Boreholes and pavement core spacing, and material testing guidelines presented in this guide are only applicable to pavement investigations. Site investigation and testing may also be conducted as per common industry practice for other road elements such as sidewalks, boulevards, and medians. The City's Project Manager should be notified of any unusual conditions or difficulties encountered, and any changes made in the investigation program.

New Construction and Reconstruction Projects

The number of boreholes can be calculated using Table 1.

Table 1 : Number of Boreholes and Depths

Lanes/Locals	Industrials and Collectors	Arterials
Number of boreholes = 0.1 × (Street area (m^2))$^{0.45}$ A minimum of two boreholes, 2 m ± 150 mm depth from the bottom of the proposed or the existing pavement per project location.	Number of boreholes = 0.1 × (Street area (m^2))$^{0.46}$ A minimum of three boreholes, 2.5 m ± 150 mm depth from the bottom of the proposed or the existing pavement per project location.	Number of boreholes = 0.1 × (Street area (m^2))$^{0.48}$ A minimum of three boreholes, 2.5 m ± 150 mm depth from the bottom of the proposed or the existing pavement per project location.

[1]If previous soil information is available and relevant, the number of boreholes can be reduced - confirm with the City's Project Manager.
[2]Additional boreholes should be undertaken where adverse soil conditions are expected or encountered during the course of field drilling.

Offset the boreholes as appropriate to provide coverage across the full width of the proposed construction. Boreholes should not be advanced on utility cut patching. The locations of the boreholes should be shown clearly on a scaled plan map of the site under investigation.

The following factors should be considered while selecting borehole locations:

- Visual sub-grade variability;
- Significant pavement failures (rutting, fatigue cracking, settlement and faulting) which are often associated with sub-grade issues to diagnose the cause of these conditions; and,
- Exiting buried infrastructure.

Information regarding the sampler type, date and time of sampling, sample type and color, sample depth, ground water elevations, boreholes location, etc. should be shown in log form using notations and a graphical system. The log form should distinguish between visual evaluations of soil samples in the field versus a more precise laboratory evaluation supported by tests. Detailed boring logs including the results of laboratory tests should be included in the geotechnical report.

Measure and identify pavement materials (thickness and types of pavement structure materials). Photograph core samples recovered from the pavement surface (concrete, asphalt or composite).

Visual identification of the soil must be reported at the following depths from the bottom of the proposed or the existing pavement – 0.6 m, 0.9 m, 1.2 m, 1.6 m, 2.0 m, and 2.5 m (if required). Ensure that each soil type encountered in the boreholes is identified. The visual identification should describe the existing pavement structure, if any, including the materials encountered and the layer thicknesses.

Backfill boreholes with granular fill. Patch pavement surface with an approved cold patch asphalt or rapid set cementitious product to match the surface pavement type.

Where significant embankments are proposed along the roadway, specific testing and recommendations for the fill materials and placement should be made including expected settlements, load compensation requirements, and potential buoyancy of the embankment. The size, complexity and extent of the testing program will depend primarily on the type, height and size of embankment as well as the expected imported soil conditions – confirm with the City's Project Manager.

For embankments less than 100 m in length, a minimum of two boreholes are required. For embankments more than 100 m in length, the spacing between boreholes along the length of the embankment should not exceed 75 m with a minimum of two (2) boreholes. Extend the boreholes depths to a minimum of 2 m ± 150 mm below the proposed sub-grade level. At critical locations and where embankment heights exceed 1.0 m, a minimum of two (2) boreholes are required in the transverse direction to define the existing geological conditions for stability analyses.

Laboratory Testing Program

Determine the moisture content of the soils encountered in every borehole in accordance with ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass, at the following depths from the bottom of the proposed or existing pavement – 0.6 m, 0.9 m, 1.2 m, 1.6 m, 2.0 m, and 2.5 m (if required).

Classify and test the anticipated sub-grade soil in accordance with Table 2. The sub-grade soil is the material on which the pavement structure will be built; 0.6 m, 0.9 m, and 1.2 m may be used for locals, collectors, and arterials, respectively – confirm with the City's Project Manager.

Table 2: Boreholes Testing Frequency

Lanes/Locals	Collectors	Arterials
Number of boreholes = 0.1 × (Street area (m^2))$^{0.4}$ A minimum of two boreholes should be tested per project location.	Number of boreholes = 0.1 × (Street area (m^2))$^{0.41}$ A minimum of three boreholes should be tested per project location.	Number of boreholes = 0.1 × (Street area (m^2))$^{0.42}$ A minimum of three boreholes should be tested per project location.

The testing program should include:

- Particle Size Analysis – ASTM D6913 Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis and ASTM D7928 Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis;
- Atterberg Limits – ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; and,
- California Bearing Ratio (CBR) – ASTM D1883 Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils. CBR test shall be performed at 95 % maximum dry density and optimum water content. All samples shall be soaked prior to testing.

The sub-grade classification should be in accordance with:

- ASTM D3282 - Standard Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes; and,
- ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes.

The designer should consider the site specific factors listed above for borehole locations while selecting testing location and frequency.

More advanced testing may be required depending upon site conditions including direct shear tests, triaxial tests, unconfined compressive tests, permeability tests, consolidation tests, point load tests, slaking tests, pinhole dispersion tests or other tests as deemed appropriate and justified by the designer – confirm with the City's Project Manager.

Rehabilitation Projects

For any rehabilitation projects (Concrete, Asphalt or Composite), measure and identify pavement materials (thickness and types of pavement structure materials). Photograph core samples recovered from the pavement.

For concrete rehabilitation projects, 150 mm-diameter cores shall be taken at joints to identify proper rehabilitation strategies (i.e. mill/fill, partial depth repair, full depth repair). The number and location of cores will be determined by the designer after visiting the site – confirm with the City's Project Manager. A minimum of two (2) cores shall be collected mid-slab to determine the existing pavement thickness and concrete strength in accordance with CSA A23.2-14C – wet condition.

Factors that should be considered while selecting pavement core locations include but are not limited to:

- Significant variation in joint condition;
- Pumping slabs, cracks or distress and perceived moisture issues from side slopes/edge cracking; and,
- Significant changes in pavement structure thickness.

Non-destructive testing (i.e. Falling Weight Deflectometer and Ground Penetrating Radar) can be used to identify layer thicknesses and structural adequacy, load transfer at joints, and appropriate rehabilitation strategies, including partial depth repairs, full depth repairs, slab replacement, and overlays – confirm with the City's Project Manager.

Figure 1. CH23-01 – Edmonton Street (Ellice-Cumberland)

Figure 2. CH23-02 – Edmonton Street (Ellice-Cumberland)

Figure 3. CH23-03 – Edmonton Street (Ellice-Cumberland)

Figure 4. CH23-04 – Edmonton Street (Ellice-Cumberland)

Figure 5. CH23-05 – Edmonton Street (Ellice-Cumberland)

City of Winnipeg

2023 Regional Streets Renewal – Geotechnical Investigation

Corehole Summary

Table 1. Corehole Summary

Corehole ID	Corehole Location	Pavement Structure		
		Type	Thickness (mm)	Compressive Strength (MPa)
CH23-01	Edmonton Street – 2.7 m E from W curb, 23 m S from Sargent Avenue	Asphalt	155	-
		Concrete	210	-
CH23-02	Edmonton Street – 1.5 m W from E curb, 35 m S from Sargent Avenue	Asphalt	-	-
		Concrete	220	56.49
CH23-03	Edmonton Street – 4.0 m E from W curb, 8.0 m from Knox Entry Employment building entrance	Asphalt	-	-
		Concrete	235	-
CH23-04	Edmonton Street – 1.6 m W from E curb, 28 m S from Qu'Appelle Avenue	Asphalt	40	-
		Concrete	200	52.22
CH23-05	Edmonton Street – 2.4 m E from W curb, 300 m N from Ellive Avenue	Asphalt	-	-
		Concrete	200	-

Appendix C

Laboratory Test Results

ENG-TECH
Consulting Limited

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engtech@mymts.net
www.eng-tech.ca

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R3P 0Y7

File No.: 23-027-01
Ref. No.: 23-27-1-1

Attention: Enrico Manimbao, C.E.T., E.I.T.
Project: PROJECT NO. 60697893; 2023 REGIONAL STREET RENEWALS, SARGENT AVENUE AND EDMONTON STREET

Date Cored: Apr 18/23 | Cored By: Client |

Date Received: Apr 19/23 | Received By: ENG-TECH (Kevin Dowbeta) | Structure: Pavement

Age of Concrete: - | Concrete Design Strength: 32 MPa | Direction of Load: Perpendicular

Core Conditioning: As per CSA A23.2-14C Clause 7.3.1 (moist) | Test Method: CSA A23.2-9C

Strength Specification: Minimum 85% of design strength on an average of 3 cores - no single core less than 75% as per CSA A23.1 Clause 4.4.2.2.2.2

Core No.	Client Core I.D.	Location	Length Cored (mm)	Length Tested (mm)	Average Diameter (mm)	Date Tested (m/d/y)	Compressive Strength (MPa)	Type of Fracture	Tested By ENG-TECH
1	CH23-02	Edmonton Street	215	177	94	Apr 21/23	56.49*	1	Rey Batac
2	CH23-04	Edmonton Street	204	173	94	Apr 21/23	52.22*	1	Rey Batac
3	CH23-03	Sargent Avenue	219	182	94	Apr 21/23	45.16*	1	Rey Batac
4	CH23-04	Sargent Avenue	230	196	94	Apr 21/23	46.48	4	Rey Batac

Reporting of these results constitutes a testing service only. Engineering interpretation or evaluation of the test results is provided only on written request.
*Denotes corrected strength for Length/Diameter ratio less than 2.0 to 1.0. Type of fracture indicated when cylinder fails to meet 85% of design strength or if different than CSA A23.2-19-9C Table 3 Type 1.

Comments:

Deviations from test procedure: None

Email: enrico.manimbao@aecom.com

ENG-TECH Consulting Limited

Per

Darci Babisky, C.E.T.
Operations Manager - Laboratory
Ph: (204) 233-1694 Fx: (204) 235-1579

Supplementary information may be provided upon request.
Restrictions and additional fees may apply.

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