GEOTECHNICAL INVESTIGATION

INSTALLATION OF GUARDRAIL ON PIPER STREET, AYR, NORTH DUMFRIES,

Submitted To:

THE CORPORATION OF THE TOWNSHIP OF NORTH DUMFRIES

Submitted By:

SAFFA ENGINEERING INC
14130 –KONRAD CRESCENT
Markham, ON
Canada L3R 0G5

March 2022

SAFFA File No. SEP-330_Phase I

SAFFA Engineering Inc.

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SAFFA Engineering Inc.

LIST OF APPENDICES

1.0 INTRODUCTION

The Township of North Dumfries (the Township) contracted SAFFA Engineering Inc (SAFFA) to conduct geotechnical investigation for the installation of guardrail on southern side of Piper Street at a section between #286 and #326 Piper Street (the Site), Ayr, North Dumfries.

The scope of this investigation is to conduct geotechnical investigation and provide recommendations for installation of guardrail including subsurface soil and groundwater information.

2.0 SITE DESCRIPTION

Piper street is generally in east-west direction of the proposed section of guardrail on the northern bank of Nith River. The street is surrounded by residential properties on the north side and trees & bushes are on the south side. The street is generally 7 m wide and has a walkway on northern side. The Nith River's northern bank has a steep slope covered with grass, trees and shrubs.

There is an existing guardrail on the south side of Piper Street, starting from east of 286 Piper Street all the way to the ramp entrance. The existing guardrail consists of wooden post with W-beam. There is an overhead Hydro Line on the south side runs parallel to Piper Street. Hydro-poles are generally at a distance within 1.5 m from southern edge of the road.

Based on the topographic survey (provided in Appendix A), Piper Street at proposed section is generally flat and elevations varies between EL 292.06 m and EL 292.42 m. The river is approximately at an elevation of 276.86 m. The river bank slope generally varies between 1V:1.10H and 1V:1.33V. However, the area where guardrail is to be constructed is located more towards the steeper side of the slope.

Two site visits were conducted on May 31st, 2021 and August 26, 2021. During these visits, the key features of the river bank slopes were noted and was photographically documented. Some of the site photos taken during these visits are shown in **Appendix A**. In addition to these visits, some photos were also taken on March 9, 2022 to observe river flow in high recharge conditions (Photo 1A and 1B). A detailed report about the site visit will be included in Phase II report. However, some pertinent information related to this report has been given in below.

During the visit it was noted that the slope was generally covered with thick vegetation. And at some places, garbage was dumped near the crest of the slope. The nature of dumped material is unknow but considering the steepness of the slope, the dumped layer is not considered to be thick enough (generally <1.5 m). The probability of the dumped material flowing into the river is highly likely, as some dump remains were found near the toe end of the river (Photo 2 a and b).

3.0 PROPOSED CONSTRUCTION

It is anticipated that the township is planning to install a guardrail on the south side of Piper Street to shield commuting traffic against fall hazard. It is assumed that the proposed guardrail will be installed at distance from the road in conjunction to existing guardrail.

It is assumed that the proposed construction will be at the level similar to the existing grade levels.

4.0 SCOPE OF WORK

The scope of work (SOW) for this project was prepared by SAFFA in coordination with the township. Township of North Dumfries provided authorization to conduct the investigation on July 27, 2021. The scope generally includes drilling of five boreholes, field sampling and testing. Borehole location plan is provided in **Appendix B**. The scope also includes to conduct laboratory testing on the selected soil samples to categorise the soil type.

4.1 Ground Disturbance Checks and Safety

Ontario One Call was made for marking the public utilities. Ground disturbance checks were completed before August 24, 2021. Ontario One Call marked the location of the underground services registered with them. As part of SAFFA's safety program, a toolbox meeting was held at the site before starting the fieldwork. Representatives from both SAFFA and the drilling subcontractor attended the meeting.

4.2 Field Investigation

SAFFA arranged a truck mounted drill rig equipped with 150 mm diameter solid stem auger. Drilling was carried down to a maximum depth of 3.1 m.

The soil sampling and testing sequences are shown on the borehole logs provided in **Appendix C**. In general, standard penetration test (SPT) and disturbed auger samples were obtained at

approximately 0.75 m depth intervals for the determination of in-situ compaction and moisture profiles in each borehole.

The field classification of the soil types was based on the auger cuttings and SPT samples. The retrieved soils samples were logged according to the Modified Unified Soil Classification System, which is described in the Explanation of Terms and Symbols in **Appendix C**. Due to the method by which the soil cuttings are returned to the surface, the depths noted on the borehole logs may vary ± 0.3 m from those recorded.

All boreholes were left open after completion of drilling to observe short term groundwater seepage and sloughing conditions. The boreholes were backfilled with drill cuttings and bentonite. No standpipe piezometers were installed in any of the boreholes.

Soil samples obtained during the field investigation were labelled and sealed in plastic bags to limit moisture loss and transported to SAFFA's Markham laboratory for further visual examination and laboratory testing.

Borehole logs were prepared to record the descriptions and the relative positions of the various soil strata, location of samples obtained, and the results of the field test.

4.3 Laboratory Testing

Visual classification was performed on all soil samples. The geotechnical laboratory testing program consisted of:

- Soil moisture contents on all samples
- Grain size distribution measurements of the material finer than 0.075mm

Laboratory testing results can be found in **Appendix C**.

5.0 RESULTS OF INVESTIGATION

5.1 Subsurface Conditions

5.1.1 Overview

In general, the overburden stratigraphy encountered in the boreholes consisted of:

- A ground surface cover consisting of asphalt in all boreholes (BH01 to BH05); underlain by,
- A granular layer consisted of sandy gravel in all boreholes (BH01 to BH05); underlain by,
- A fill layer consisted of sand and gravel in boreholes BH04 and BH05
- Sand layer in boreholes BH01 to BH03; underlain by

- Gravelly sand layer.

No bedrock was encountered within the maximum termination depth of the boreholes (e.g., 3.1 m below existing grade).

All the boreholes were open and dry on completion of drilling.

The subsurface conditions observed in the boreholes are presented in detail on the Borehole logs provided in **Appendix C**.

5.2 Ground Surface Cover

At all borehole location, the ground surface was consisted of asphalt. The asphalt was in the range of 50 mm to 75 mm in all boreholes drilled at site.

5.3 Granular Fill

The asphalted layer mentioned in the above section was underlain by a layer of granular fill consisting of sandy gravel. Thicknesses of this layer varied between 250 and 310 mm in all boreholes.

Based on visual and textural examination, the granular fill materials were assessed as dry. Moisture content tests carried on samples of the granular material yielded results of 2 %, 2 % and 3 % conducted on the samples recovered from boreholes BH01, BH02 and BH03, respectively.

5.4 Construction Fill

The granular layer mentioned in the above section was underlain by a layer of construction fill consisting of sand and gravel. Thicknesses of this layer was 2.4 m and 1.0 m in boreholes BH04 and BH05, respectively.

Based on visual and textural examination, the construction fill materials were assessed as dry to moist. Moisture content tests carried on samples of the construction fill material yielded results less then 3 %.

5.5 Sand

A brown layer consisted of sand was encountered in boreholes BH01 to BH03 underlying the layers referenced in the above sections. The sand layer extended to 2.0 m, 2.2 m and 2.2 m below grade in boreholes BH01, BH02 and BH03, respectively. Trace to some gravel, trace silt, trace clay was noted in this layer. The layer was found in compact to dense state.

Based on visual and textural examination, the sand was assessed as moist. Moisture content tests carried on samples of sand, yielded results 5%, 3% and 3% in boreholes BH01, BH02 and BH03, respectively.

A grain size distribution testing was carried on a single sample of sand layer. The results are described in the respective log and are shown in the laboratory test results given in **Appendix B**. The results are summarized in **Table 4.2** below.

***Table 4.2**: Summary Sieve Analysis Test Results.*

Borehole /Location	Depth (m)	Soil Type	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
BH02	1.6	Sand	1	97	3	

5.5.1 Gravelly Sand

A brown granular layer consisted of gravelly sand was encountered in all boreholes below the layers referenced in the above sections. The granular layer extended to the maximum depth of investigation.

Based on SPT N-values, gravelly sand was in compact to very dense state of compactness. The visual inspection of soil samples revealed that the native layer was generally in moist conditions with moisture contents generally less than 5 %.

5.6 Groundwater Conditions

All boreholes were open and dry upon completion of drilling. No groundwater piezometer was installed in any of the borehole.

6.0 DISCUSSION AND RECOMMENDATION

At the project site, the pavement layer consisted of asphalt, granular A and granular B and was underlain by native sand to gravelly sand subgrade layer.

All boreholes were dry at drilling completion and no free water was observed in any of the boreholes.

The purpose of this investigation is to investigate subsurface soil and groundwater conditions to safely install guardrail on the southern side of Piper Street. Part of scope is also to assess construction effects involving the installation of the guardrail and provide remedial actions if needed.

6.1 Overview of Guardrail Installation Options

The intended installation methods at the proposed section, W-beam installed on Wooden Post is selected. For reference, an overview of conventional guardrail options is provided herein. Taking into consideration the soil and groundwater conditions referenced herein, slope conditions and flow and speed of commuting traffic, three (3) installation options were considered. The advantages, disadvantages and comparative ranking of the options are summarized in Table 7.1 below;

Table 7.1: Comparison of Guardrail Options

Installation Methods	Advantages	Disadvantages	Ranking
W-Beam	W-beams are the standard traffic and highway safety rails and are constructed in high gauge steel. To protect against environmental conditions, this type of beam is fabricated with zinc coatings and weather (resistant) coated materials. The post can be easily installed by auguring/pushing and grouting. Have performed fairly good under crash testing. Resemble to existing installed guardrail. Have variable options to be used with wooden and steel post. Commercially economical.	Put comparatively extra load on the slope. Will not be effective for very high-speed traffic	1
Box Beam	Have limited barrier deflections under impact and are considered advantageous in hilly roadways. It does not create significant obstacle during snow drift. Comparatively lighter in weight. Covers relatively lesser space	Relatively expansive than W-beam	2
Curved Rial	curved guardrails feature a convex or concave-shaped rail and are used to provide protection on roadways and highways that have a bend radius to them. These units are usually prefabricated to fit the required dimensions of the site where they will be installed. Concave rails are those in which the rail curves in towards the vehicle,	Put comparatively extra load on the slope. Will not be effective for very high-speed traffic. Relatively expansive than W-beam	3

Installation Methods	Advantages	Disadvantages	Ranking
	while convex rails are those that curve away from the vehicle.		

6.2 Construction of Guardrail W-Beam

The subsurface conditions at site generally consists of topsoil underlain by sand to gravelly sand layer down to the maximum investigated depth. Based on the above comparison of various guardrail installation options, it is anticipated that the wooden post W-bean guardrail will be installed at site. For this option, the wooden posts are considered to be installed at 1.9 m spacing along the proposed project length, connected using W-bean and anchored at the ends. The height of the guardrail is expected to be not more than 0.7 m above the grade level. The minimum embedment of each post is anticipated to be 0.9 m below grade. However, the embedment length may vary based on the soil resistance at the particular place.

The soil conditions encountered in the borehole are generally considered suitable to install guardrail post. Since, the soil conditions majorly contained granular material having compact to dense compactness, it is anticipated that the driving of wooden post would provide high resistance.

6.3 Constraint and Limitation

The following constraints and limitations are set forth for consideration by the designer/contractor for installation of guardrail at this project.

- Any/all existing utilities/services must be located and marked in the field prior to commencement of construction. Of particular note are any existing utilities and services in the immediate areas of the alignment of the guardrail. Exposure of utilities/services to provide visual confirmation of location can be considered to confirm that adequate separation is maintained;
- There are Hydro transmission towers within 1 m lateral distance of the proposed guardrail alignment. The guardrail alignment involves installation of wooden post and W-beam. The construction/design of guardrail should be carried out in a way that no post to be installed within the 1 m proximity of the pole and doing so would not be concern to the foundation of the existing pole. In case construction is needed within 1 m distance (Centre to Centre), the hydro pole should be truck anchored;

- The post will be grounded to a certain depth (minimum 0.9 m) to provide sufficient resistance to shield commuting traffic in case of any collision. Considering that the strata is generally granular, therefore installation of post through such kind of soil conditions may involve heavy hammering. The heavy hammering or vibratory driving may pose risk for collapse of the slope. It is therefore, recommended to use a wooden post with conical driving end. The driving of conical post will require less penetration effort. Alternatively, the post may be installed by auguring and grouting method. Preliminary Slope stability analysis has been carried out to assess risk associated to the construction activities. Based on the results of the analysis, it is observed that construction can be carried out safely without posing any serious risk to surrounding slope. The slope stability results will be provided in Phase II report. Regardless of the slope stability results, it is recommended that an utmost care should be taken during construction. Heavy hammering/vibration should be avoided. If needed, a matter should be referred to the SAFFA for further analysis;
- Since groundwater did not encounter in any of the boreholes, therefore, groundwater should not be expected during installation or auguring; and,
- It has been observed that garbage has been dumped at the site (Photo 2 a and b). The depth of the dumped material is unknow, but thickest dumped layer should be expected at the crest (alignment of guardrail), therefore installation of wooden post in the strata that contains dumped material is expected to have more than normal penetration depth in order to achieve the required refusal criteria.

7.0 CLOSURE

The findings and recommendations of this report were based on the results of the field and laboratory investigations, combined with an interpolation of the soil and groundwater conditions between the boreholes. If conditions are encountered that appear to be different from those observed in the boreholes drilled at this site, a qualified Geotechnical Consultant should be notified in order that the recommendations can be reviewed and adjusted if necessary.

Soil conditions by their nature can be highly variable across the site. The placement of fill and prior construction activities on a site can contribute to the variability especially in the near surface soil conditions.

This report was prepared exclusively for the use of the Corporation of The Township of North Dumfries and their agents for the proposed redevelopment of Public Works Depot. The findings

and recommendations of this report are prepared in accordance with generally accepted professional engineering principles and practices.

We trust that the information presented in this report meets your current requirements. Should you have any questions or concerns, please do not hesitate to contact the undersigned.

Respectfully submitted,

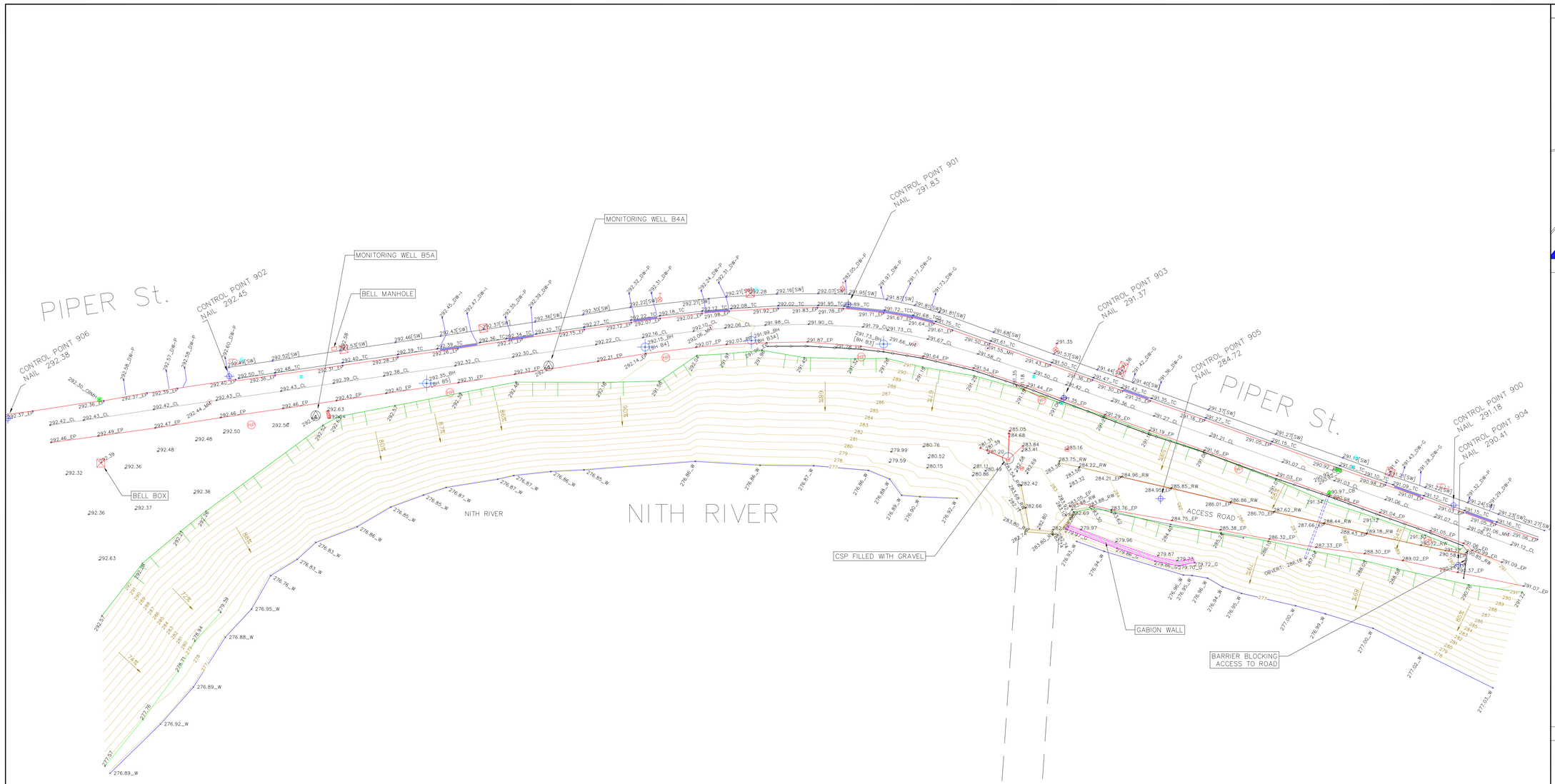
SAFFA Engineering Inc.

Fiaz Ahmad, MASc., EIT
Geotechnical

Fawad Khan, MASc., E.I.T
Technical Professional - Geotechnical

Syed Ahmad, PhD., P. Eng.
Principal, Geotechnical Engineer

Appendix A: Topographic Survey Drawing



CONTROL POINTS

Point #	Northing	Easting	Elevation	
900	4792535.907	543681.383	291.181	Concrete Nail
901	4792575.853	543561.076	291.828	Concrete Nail
902	4792561.540	543438.023	292.453	Concrete Nail
903	4792557.259	543603.899	291.368	Concrete Nail
904	4792524.059	543682.320	290.410	Concrete Nail
905	4792537.206	543623.138	284.715	Concrete Nail
906	4792553.176	543394.032	292.381	Concrete Nail

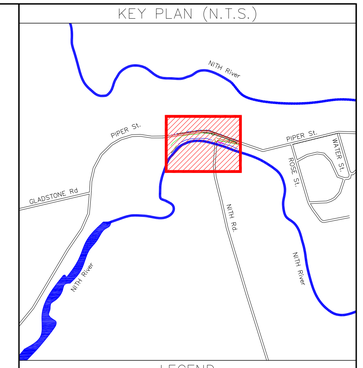
SCALE – 1:400 – ARCH D (2'X3') PLOT

0 5 10 15 20 25 50

METRIC

DISTANCES SHOWN ON THIS PLAN ARE IN METRES.

KEY PLAN (N.T.S.)



LEGEND

- BARRIER
- BORE HOLE
- CATCH BASIN
- CATCH BASIN MANHOLE
- FIRE HYDRANT
- GABION
- GUY WIRE
- HYDRO POLE
- HYDRO VAULT
- MANHOLE
- MONITORING WELL
- POST
- UTILITY PEDESTAL
- UTILITY POLE
- VALVE BOX

BH	BORE HOLE
CB	CATCH BASIN
CBMH	CATCH BASIN MANHOLE
CL	CENTRE LINE OF ROAD
DW–G	DRIVEWAY–GRAVEL
DW–I	DRIVEWAY–INTERLOCK BRICK
DW–P	DRIVEWAY–PAVED
EP	EDGE OF PAVEMENT
G	GABION
MH	MANHOLE
RW	RETAINING WALL TOP
SW	SIDEWALK
TC	TOP BACK OF CURB
TCD	TOP BACK OF DEPRESSED CURB
W	WATER

NOTES

1. SURVEYED: 2021/11/11, 12/01 & 14
2.
3.

REFERENCE

BENCHMARKS : CVGD–1928 '78 ADJ.
Geoid model HT 2.0 GNSS Observations

GEODETIC SYSTEM : UTM Z17 NAD 83 CSRS
via TRIMBLE CANNET GNSS Observations

REVISIONS

NO.	DATE	DESCRIPTION	BY	CKD.
1.				
2.				
3.				

CSS INC.
COMPLETE SURVEY SOLUTIONS
2A–7170 West Credit Ave., Mississauga, ON. L5N 6C6
Tel (905) 821–8696, Fax (905) 821–9078

EXISTING CONDITIONS
AYR: PIPER St. AND SOUTHWARD TO Riv. NITH SHORE
~BETWEEN ROSE St. & GLADSTONE Rd.

NORTH

PROJECT No.: 21–2038	DRAFTED BY: V.A.K.
CLIENTS BASE FILE NAME:	CHECKED BY:
CADD FILE NAME:	DATE: 2021/12/15

Appendix B: Site Photography

Photo 1A: River Flow in September 2021 (Taken from suspension bridge facing west)

Photo 1B: River Flow in March 2022 (Taken from suspension bridge facing west)

Photo 2: Scattered garbage; a) at toe near, b) near crest at shoulder of Piper Street

Appendix C: Borehole Location Plan
Borehole Hole Logs
Grain Size Distribution Analysis

SAFFA Engineering Inc.

Drawing:
Borehole Location Plan

CLIENT: Township of North Dumfries

PROJECT: SEP 330

TITLE: Borehole Location Plan - Guardrail Installation Piper Street

DATE:	JOB No.:	Scale	FIGURE No.:	REV.
March 2022	SEP 330	Not to scale	1	1

Township of North Dumfries	Installation of Guardrail	BOREHOLE NO: **BH01**
Saffa Engineering Inc.	SITE: Piper Street, Ayr, North Dumfries, ON	PROJECT NO: SEP 330
Solid Stem Auger	Piper St, Ayr, ON N: E:	ELEVATION:

SAMPLE TYPE: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: Bentonite | Pea Gravel | Slough | Grout | Drill Cuttings | Sand

◆ POCKET PEN (kPa) ◆ 100 200 300 400

■ BLOW COUNT (N) ■ 20 40 60 80

PLASTIC M.C. LIQUID 20 40 60 80

Depth (m)	SOIL SYMBOL	USCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	BACKFILL DETAILS	OTHER TESTS COMMENTS	Depth (m)
0		ASPH	**60 mm ASPHALT**						0
		GP	**310 mm GRANULAR**: sandy gravel, grey, trace clay, poorly graded		1				
			SAND: trace to some gravel, trace silt. fine to medium, poorly graded, compact, moist, brown		2				
1		SP			3	29			1
2		GP	**GRAVELLY SAND**: trace silt, trace clay, fine to medium grained, compact, moist, brown						2
			- medium to coarse grained		4	20			
3			End of Borehole (BH) at 3.1 m below grade. Borehole was dry upon completion. BH was backfilled with drill cuttings and bentonite and asphalt.						3
4									4
5									5
6									6
7									7
8									8
9									

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SAFFA Engineering Inc

SAFFA Engineering Inc
Markham, Ontario

ENTERED BY: FA	COMPLETION DEPTH: 3.1 m
LOGGED BY: FA	COMPLETION DATE: 8/25/21
REVIEWED BY: FK	Page 1 of 1

Township of North Dumfries	Installation of Guardrail	BOREHOLE NO: **BH02**
Saffa Engineering Inc.	SITE: Piper Street, Ayr, North Dumfries, ON	PROJECT NO: SEP 330
Solid Stem Auger	Piper St, Ayr, ON N: E:	ELEVATION:

SAMPLE TYPE: Shelby Tube; No Recovery; SPT Test (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Slough; Grout; Drill Cuttings; Sand

◆ POCKET PEN (kPa) ◆ 100 200 300 400

■ BLOW COUNT (N) ■ 20 40 60 80

PLASTIC M.C. LIQUID 20 40 60 80

Depth (m)	SOIL SYMBOL	USCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	BACKFILL DETAILS	OTHER TESTS COMMENTS	Depth (m)
0		ASPH	**50 mm ASPHALT**						0
		GP	**300 mm GRANULAR**: sandy gravel, grey, trace clay, poorly graded		1				
1		SP	**SAND**: trace gravel, trace silt, fine to medium, poorly graded, dense, moist, brown		2	34		Gravel = 1 % Sand = 97 % Silt/Clay = 3 %	1
2		GP	**GRAVELLY SAND**: trace silt, trace clay, fine to medium grained, compact, moist, brown						2
3			- medium to coarse grained		3	22			3
			End of Borehole (BH) at 3.1 m below grade. BH caved in at 1.5 m below grade. Borehole was dry upon completion. BH was backfilled with drill cuttings and bentonite and asphalt.						
4									4
5									5
6									6
7									7
8									8
9									

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SAFFA Engineering Inc

SAFFA Engineering Inc
Markham, Ontario

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REVIEWED BY: FK	Page 1 of 1

Township of North Dumfries	Installation of Guardrail	BOREHOLE NO: **BH03**
Saffa Engineering Inc.	SITE: Piper Street, Ayr, North Dumfries, ON	PROJECT NO: SEP 330
Solid Stem Auger	Piper St, Ayr, ON N: E:	ELEVATION:

SAMPLE TYPE: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: Bentonite | Pea Gravel | Slough | Grout | Drill Cuttings | Sand

◆ POCKET PEN (kPa) ◆ 100 200 300 400

■ BLOW COUNT (N) ■ 20 40 60 80

PLASTIC M.C. LIQUID 20 40 60 80

Depth (m)	SOIL SYMBOL	USCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	BACKFILL DETAILS	OTHER TESTS COMMENTS	Depth (m)
0		ASPH	**75 mm ASPHALT**						0
		GP	**300 mm GRANULAR**: sandy gravel, grey, trace clay, poorly graded		1				
1		SP	**SAND**: trace to some gravel, trace silt, fine to medium, poorly graded, dense, moist, brown		2	34			1
2		GP	**GRAVELLY SAND**: trace silt, trace clay, fine to medium grained, compact, moist, brown		3	22			2
3			End of Borehole (BH) at 3.1 m below grade. Borehole was dry upon completion. BH was backfilled with drill cuttings and bentonite and asphalt.						3
4									4
5									5
6									6
7									7
8									8
9									

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SAFFA Engineering Inc

SAFFA Engineering Inc
Markham, Ontario

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Township of North Dumfries	Installation of Guardrail	BOREHOLE NO: **BH04**
Saffa Engineering Inc.	SITE: Piper Street, Ayr, North Dumfries, ON	PROJECT NO: SEP 330
Solid Stem Auger	Piper St, Ayr, ON N: E:	ELEVATION:

SAMPLE TYPE: Shelby Tube; No Recovery; SPT Test (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Slough; Grout; Drill Cuttings; Sand

◆ POCKET PEN (kPa) ◆ 100 200 300 400

■ BLOW COUNT (N) ■ 20 40 60 80

PLASTIC M.C. LIQUID 20 40 60 80

Depth (m)	SOIL SYMBOL	USCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	BACKFILL DETAILS	OTHER TESTS COMMENTS	Depth (m)
0		ASPH	**50 mm ASPHALT**						0
		GP	**250 mm GRANULAR**: sandy gravel, grey, trace clay, poorly graded		1				
1		FILL	**FILL** : sand and gravel, trace silt, trace cobbles, dense, dry to moist, brown		2	31			1
2					3	16			2
3		GP	**SANDY GRAVEL**: trace silt, trace clay, trace cobbles, compact, moist, brown						3
			End of Borehole (BH) at 3.1 m below grade. Borehole was dry upon completion. BH was backfilled with drill cuttings and bentonite and asphalt.						
4									4
5									5
6									6
7									7
8									8
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SAFFA Engineering Inc

SAFFA Engineering Inc
Markham, Ontario

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Township of North Dumfries	Installation of Guardrail	BOREHOLE NO: **BH05**
Saffa Engineering Inc.	SITE: Piper Street, Ayr, North Dumfries, ON	PROJECT NO: SEP 330
Solid Stem Auger	Piper St, Ayr, ON N: E:	ELEVATION:

SAMPLE TYPE: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: Bentonite | Pea Gravel | Slough | Grout | Drill Cuttings | Sand

◆ POCKET PEN (kPa) ◆ 100 200 300 400

■ BLOW COUNT (N) ■ 20 40 60 80

PLASTIC M.C. LIQUID 20 40 60 80

Depth (m)	SOIL SYMBOL	USCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	BACKFILL DETAILS	OTHER TESTS COMMENTS	Depth (m)
0		ASPH	**50 mm ASPHALT**						0
		GP	**250 mm GRANULAR**: sandy gravel, grey, trace clay, poorly graded		1				
1		FILL	**FILL** : sandy gravel, trace silt, trace cobbles, compact, dry, brown						1
			SANDY GRAVEL: trace silt, trace clay, trace cobbles, compact to very dense, moist, brown		2	60			
2		GP							2
					3	21			
3			End of Borehole (BH) at 3.1 m below grade. Borehole was dry upon completion. BH was backfilled with drill cuttings and bentonite and asphalt.						3
4									4
5									5
6									6
7									7
8									8
9									

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Markham, Ontario

ENTERED BY: FA	COMPLETION DEPTH: 3.1 m
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REVIEWED BY: FK	Page 1 of 1

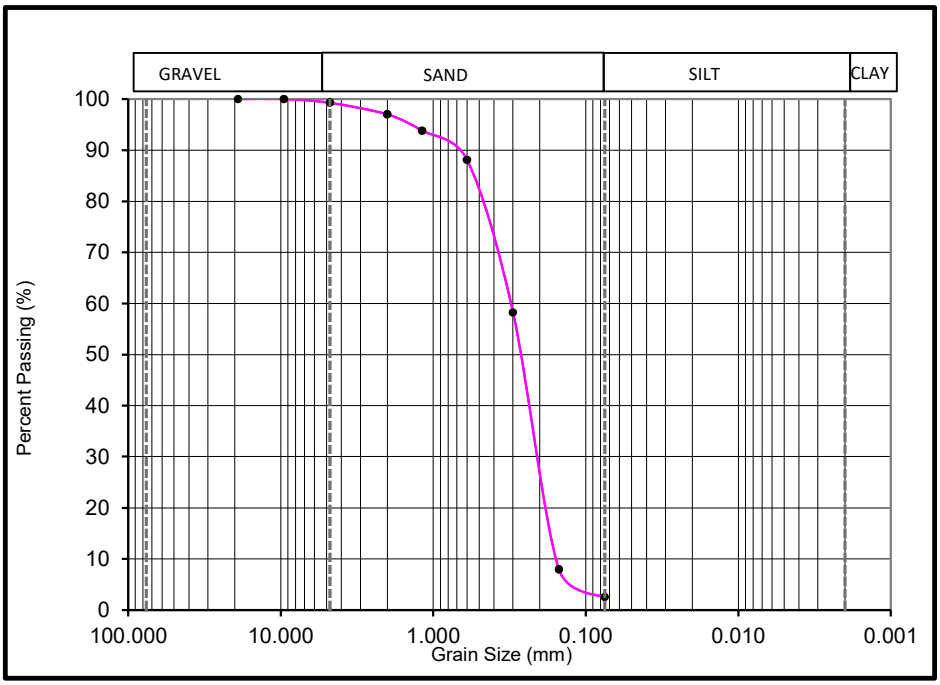
SAFFA Engineering Inc.

Professional Engineers Ontario

Grain Size Distribution Analysis Report

(CSA A23.2-2A / LS-602)

Date:	14-Mar-22		
Client:	Township of North Dumfries	Copies to:	
Address:	Piper Street, Ayr, North Dumfries, ON	Lab #:	21-173
Project:	SEP 330	Test Requested by:	Fiaz
Location:	BH02 (5ft)	Sampled By:	Fiaz
Material Type:	Soil	Date Sampled:	25-Aug-21
Source:	Drilling	Specification:	



Gravel (%)	Sand (%)	Silt (%)	Clay (%)
1	97	3	

Sieve Size (mm)	Percent Passing (%)	
19.00	100	
9.50	100	
4.75	99.3	
2.00	97	
1.180	93.8	
0.600	88.1	
0.300	58.2	
0.150	7.9	
0.075	2.5	
0.0394		
0.0281		
0.0180		
0.0106		
0.0076		
0.0054		
0.0026		
0.0012		

Remarks:

Fawad Khan, MaSc, EIT
Laboratory Manager

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Appendix D: Explanation of Terms and Symbols

EXPLANATION OF TERMS AND SYMBOLS

The terms and symbols used on the borehole logs to summarize the results of field investigation and subsequent laboratory testing are described in these pages.

It should be noted that materials, boundaries and conditions have been established only at the borehole locations at the time of investigation and are not necessarily representative of subsurface conditions elsewhere across the site.

TEST DATA

Data obtained during the field investigation and from laboratory testing are shown at the appropriate depth interval.

Abbreviations, graphic symbols, and relevant test method designations are as follows:

*C	Consolidation test	*ST	Swelling test
D_R	Relative density	TV	Torvane shear strength
*k	Permeability coefficient	VS	Vane shear strength
*MA	Mechanical grain size analysis	w	Natural Moisture Content (ASTM D2216)
	and hydrometer test	w_l	Liquid limit (ASTM D 423)
N	Standard Penetration Test (CSA A119.1-60)	w_p	Plastic Limit (ASTM D 424)
N_d	Dynamic cone penetration test	E_f	Unit strain at failure
NP	Non plastic soil	γ	Unit weight of soil or rock
pp	Pocket penetrometer strength	γ_d	Dry unit weight of soil or rock
*q	Triaxial compression test	ρ	Density of soil or rock
q_u	Unconfined compressive strength	ρ_d	Dry Density of soil or rock
*SB	Shearbox test	C_u	Undrained shear strength
SO_4	Concentration of water-soluble sulphate	→	Seepage
		▼	Observed water level

* The results of these tests are usually reported separately

Soils are classified and described according to their engineering properties and behaviour.

The soil of each stratum is described using the Unified Soil Classification System[1] modified slightly so that an inorganic clay of "medium plasticity" is recognized.

The modifying adjectives used to define the actual or estimated percentage range by weight of minor components are consistent with the Canadian Foundation Engineering Manual[2].

Relative Density and Consistency:

Cohesionless Soils

Relative Density	SPT (N) Value
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

Cohesive Soils

Consistency	Undrained Shear Strength c_u (kPa)	Approximate SPT (N) Value
Very Soft	0-12	0-2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

Standard Penetration Resistance ("N" value)
The number of blows by a 63.6kg hammer dropped 760 mm to drive a 50 mm diameter open sampler attached to "A" drill rods for a distance of 300 mm after an initial penetration of 150 mm.

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1 "Unified Soil Classification System", Technical Memorandum 36-357 prepared by Waterways Experiment Station, Vicksburg, Mississippi, Corps of Engineers, U.S. Army. Vol. 1 March 1953.

2 "Canadian Foundation Engineering Manual", 3rd Edition, Canadian Geotechnical Society, 1992.

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

MAJOR DIVISION			GROUP SYMBOL	GRAPH SYMBOL	COLOUR CODE	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75µm)	GRAVELS MORE THAN HALF THE COARSE FRACTION LARGER THAN 4.75mm	CLEAN GRAVELS (TRACE OR NO FINES)	GW		RED	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 4;\ C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			GP		RED	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY GRAVELS (WITH SOME FINES)	GM		YELLOW	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12 %	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			GC		YELLOW	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7
	SANDS MORE THAN HALF THE COARSE FRACTION SMALLER THAN 4.75mm	CLEAN SANDS (TRACE OR NO FINES)	SW		RED	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 6;\ C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			SP		RED	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY SANDS (WITH SOME FINES)	SM		YELLOW	SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12 %	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			SC		YELLOW	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75µm)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	W_L< 50%	ML		GREEN	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW)	
		W_L< 50%	MH		BLUE	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDS OR SILTY SOILS		
	CLAYS ABOVE "A" LINE NEGLIGIBLE ORGANIC CONTENT	W_L< 30%	CL		GREEN	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY OR SILTY CLAYS, LEAN CLAYS		
		30% <W_L< 50%	CI		GREEN-BLUE	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS		
		W_L> 50%	CH		BLUE	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
	ORGANIC SILTS & CLAYS BELOW "A" LINE	W_L< 50%	OL		GREEN	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	WHENEVER THE NATURE OF THE FINES CONTENT HAS NOT BEEN DETERMINED, IT IS DESIGNATED BY THE LETTER "F", E.G. SF IS A MIXTURE OF SAND WITH SILT OR CLAY	
		W_L> 50%	OH		BLUE	ORGANIC CLAYS OF HIGH PLASTICITY		
HIGHLY ORGANIC SOILS			Pt		ORANGE	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOUR, AND OFTEN FIBEROUS TEXTURE	

SPECIAL SYMBOLS

LIMESTONE		OILSAND	
SANDSTONE		SHALE	
SILTSTONE		FILL (UNDIFFERENTIATED)	

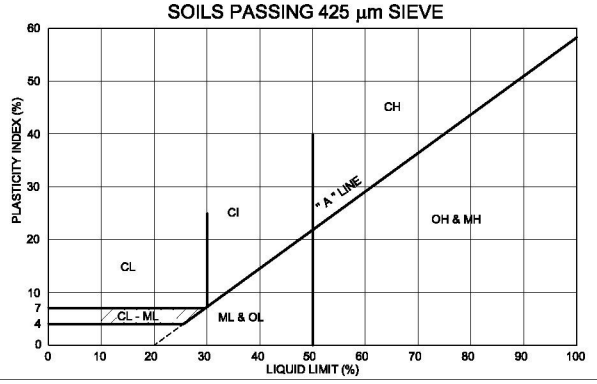
SOIL COMPONENTS

FRACTION	U.S. STANDARD SIEVE SIZE		DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS	
GRAVEL	PASSING	RETAINED	PERCENT	DESCRIPTOR
COARSE	76mm	19mm	35-50	AND
FINE	19mm	4.75mm		
SAND			20-35	Y/EY
COARSE	4.75mm	2.00mm		
MEDIUM	2.00mm	425µm	10-20	SOME
FINE	425µm	75µm		
FINES (SILT OR CLAY BASED ON PLASTICITY)	75µm		1-10	TRACE

OVERSIZED MATERIAL

ROUNDED OR SUBROUNDED:	NOT ROUNDED:
COBBLES 76mm TO 200mm	ROCK FRAGMENTS > 76mm
BOULDERS > 200mm	ROCKS > 0.76 CUBIC METRE IN VOLUME

PLASTICITY CHART FOR SOILS PASSING 425 µm SIEVE



NOTES:

1. ALL SIEVE SIZES MENTIONED ON THIS CHART ARE U.S. STANDARD A.S.T.M. E.11
2. COARSE GRAIN SOILS WITH 5 TO 12% FINES GIVEN COMBINED GROUP SYMBOLS, E.G. GW-GC IS A WELL GRADED GRAVEL SAND MIXTURE WITH CLAY BINDER BETWEEN 5 AND 12% FINES.

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