GEOTECHNICAL INVESTIGATION AND SLOPE STABILITY ASSESSMENT PROPOSED SPEEDVALE BRIDGE UNDERPASS AND MULTI-USE TRAIL LINKAGE GUELPH, ONTARIO

Submitted to:

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Attention: Mr. Andrew Janes, P.Eng, Manager of Design, Engineering Services

Submitted by:

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May, 2017
Project Reference Number: TB173002

TABLE OF CONTENTS

Page

1.0 AUTHORITY 2
2.0 INTRODUCTION 2
2.1 Project Description 2
3.0 TERMS OF REFERENCE 3
4.0 GEOLOGICAL SETTING 3
5.0 METHOD OF INVESTIGATION 3
5.1 Field Work 4
5.2 Laboratory Program 4
5.3 Engineering Analysis 5
6.0 GENERAL SUBSURFACE CONDITIONS 5
6.1 Pavement and Shoulder Structure 5
6.2 Topsoil 5
6.3 Fill 5
6.4 Sand and Gravel, Sandy Gravel 5
6.5 Sand 6
6.6 Silty Sandy Gravel 6
6.7 Silty Sand / Sandy Silt 6
6.8 Gravelly Sand and Silt 6
6.9 Bedrock 6
6.10 Groundwater Conditions 7
7.0 DISCUSSION AND RECOMMENDATIONS 7
7.1 Background Review 7
7.2 Visual Slope Inspection 8
7.3 Toe Erosion Allowance 8
7.4 Stable Slope Allowance 9
7.5 Erosion Access Allowance 10
7.6 Pertinent Comments 10
8.0 CLOSURE 11

LIST OF FIGURES

FIGURE 1 SITE LOCATION PLAN
FIGURE 2 BOREHOLE LOCATION PLAN

LIST OF APPENDICES

Appendix A Reference Drawings
Appendix B Record of Borehole Logs
Appendix C Geotechnical Laboratory Results
Appendix D Slope Stability Rating Chart and SLOPE/W Analyses
Appendix E Report Limitations

1.0 AUTHORITY

Authorization to proceed with the geotechnical investigation for the above referenced project was received in the form of a Purchase Order 1702493 from the City of Guelph to Amec Foster Wheeler Foster Wheeler dated February 9, 2017.

2.0 INTRODUCTION

Amec Foster Wheeler Environment and Infrastructure, a division of Amec Foster Wheeler Americas Limited ('Amec Foster Wheeler') was engaged by the City of Guelph (the 'City' or 'Client') to carry out a slope stability assessment for the proposed Speedvale Bridge underpass and multi-use trail linkage located along the west bank of the Speed River, north of Speedvale Avenue East in the City of Guelph, Ontario. It is understood that the assessment is required to support the design of a proposed retaining wall to allow for the construction of the trail in order to obtain the approval of the Grand River Conservation Authority to execute the required work on lands falling under their jurisdiction.

The present investigation by Amec Foster Wheeler obtained subsurface information pertaining to the project site by means of visual site observations and sampled boreholes. The data was then used to perform analyses and to provide geotechnical recommendations related to the stability of the existing slope on the project site, and general comments related to foundation design and construction.

2.1 Project Description

At the time of writing this report, it is understood that the proposed trail is in its preliminary stages and that the trail alignment and retaining wall design have not been finalized. The purpose of the geotechnical investigation was to carry out a slope stability review of the existing bank for the construction of the proposed trail, and provide recommendations for future slope stability, surface erosion, the need of stabilization and maintenance requirements. The geotechnical investigation consisted of drilling three (3) boreholes located near the top of the slope to provide parameters for slope stability analysis and design

The location of the site is north of Speedvale Avenue East, along the west bank of the Speed River extending approximately 350 m from Speedvale Avenue to Riverside Park as indicated on the Site Location Plan on Figure 1. The location of the drilled boreholes can be found on the Borehole Location Plan on Figure 2. The height of the slope is approximately 9 m. The toe of the slope has been assumed to be the bottom of the river channel as river bank and bottom of the slope is retained by a concrete retaining wall.

The City provided Drawings LP1 to LP9 from Aboud & Associates Inc., Landscape Designers. These drawings show options being considered for the trail linkage north and south of Speedvale

Avenue. The main slope stability concern is the steep slopes on the north side of Speedvale Avenue, especially in the vicinity of Section C-C' shown on Drawings LP1-LP5 and the associated cross-section shown on Drawing LP9. These drawings are attached in Appendix A for reference.

3.0 TERMS OF REFERENCE

The findings of the investigation, together with Amec Foster Wheeler's comments and recommendations, are presented in this report. The anticipated construction conditions are also discussed but only to the extent that they may influence the design decisions. Any construction methods discussed express Amec Foster Wheeler's opinions only and are not intended to direct contractors on how to carry out the construction. Contractors should also be aware that the data and the interpretation presented in this report may not be sufficient to assess all the factors that may have an effect on construction.

This report was prepared with the assumption that the design will be in accordance with applicable standards and codes, regulations of authorities having jurisdiction, and good engineering practices.

Further, the recommendations and opinions expressed in this report are only applicable to the proposed project as described above.

There should also be an ongoing liaison with Amec Foster Wheeler during both the design and construction phases of the project to ensure that the recommendations in this report have been interpreted and implemented correctly. Also, if any further clarification and/or elaboration concerning the geotechnical aspects of this project are needed, Amec Foster Wheeler should be contacted immediately.

4.0 GEOLOGICAL SETTING

The site is located within the headwaters of the Speed River Watershed. Preliminary Map P.189, Pleistocene Geology of the Guelph Area Ontario published by the Ontario Division of Mines (1963), indicates that surficial soils at the Site consist of outwash gravel and Wentworth Till –buff or pink sandy till. Paleozoic Geology of the Guelph Area, published by the Ontario Division of Mines (1974), indicates that the bedrock in the area consists of brown or tan dolostone of the Guelph Formation.

5.0 METHOD OF INVESTIGATION

The investigation was carried out to obtain information about the soils encountered at the site by means of sampled boreholes. Consequently, laboratory testing and engineering analysis was carried out to assess the overall stability of the slope.

5.1 Field Work

Fieldwork for this project was carried out on March 29, 30 and 31, 2017. It consisted of advancing three (3) machine-drilled boreholes, as indicated on Figure 2, Borehole Location Plan.

Amec Foster Wheeler personnel located and marked the borehole locations in the field. Prior to the drilling operation, underground service clearances were completed by the appropriate public and private utility service companies. The number of boreholes and their locations were outlined in Amec Foster Wheeler's proposal dated February 6, 2017. The boreholes were drilled as close as possible to the proposed locations. The locations of the boreholes were adjusted in the field based on proximity to locates or for safety and access.

Experienced field personnel from Amec Foster Wheeler laid out all the boreholes. These boreholes were put down along the top of the existing slopes, as indicated on Figure 2. The boreholes were extended to depths of between 9.2 and 13.9 metres below existing grade. Boreholes 1 and 2 were cored, 1.9 m and 3.2 m respectively, to prove bedrock. Borehole 3 was drilled to a depth of 9.2 m and a groundwater monitoring well installed. The borehole elevations were surveyed to a geodetic datum by Automated Engineering Technologies Ltd.

All boreholes were put down using a track mounted drill rig. The drill rig was adapted for soil sampling purposes, outfitted with 200 mm diameter hollow stem augers. Soil samples were taken by driving a standard split spoon-sampling device in accordance with the requirements of the Standard Penetration Test (ASTM D1586). Upon recovery, each sample was examined, identified and placed in a sealed container for return to an Amec Foster Wheeler laboratory for further examination and routine moisture content determination. Experienced personnel from Amec Foster Wheeler supervised the drilling, performed preliminary sample identification, and prepared field borehole logs.

Groundwater conditions were monitored during and upon completion of the excavation of each borehole. Two monitoring events of the well installed in Borehole 3 were performed.

Upon completion of the drilling, the non-instrumented boreholes were backfilled with the extracted soils and bentonite.

5.2 Laboratory Program

The soil samples collected in the field were returned to an Amec Foster Wheeler laboratory for further identification and examination. Routine moisture content determination was carried out on all the samples. In addition three samples were selected for sieve analysis. The results are indicated on the attached Record of Borehole Logs in Appendix B. The geotechnical laboratory test results can be found in Appendix C

All soil samples will be retained for three months after the report is issued to the Client. The soil samples would then be discarded unless Amec Foster Wheeler is instructed otherwise.

5.3 Engineering Analysis

The information obtained from the field and laboratory program was used to carry out office studies and analysis to derive an understanding of the slope's future performance if the proposed plans are implemented. The engineering analysis included the following tasks:

- Background review of previous geotechnical reports in the project area.
- Visual slope stability condition assessment.
- Slope stability analyses using industry accepted software.
- Preparation of a report including discussion with respect to the Grand River Conservation Authority (GRCA) regulation 150/06

Details of the observations made and results of the analyses performed are discussed in the following sections of this report.

6.0 GENERAL SUBSURFACE CONDITIONS

For a description of the general subsurface conditions encountered at each location during this investigation, reference should be made to the attached Record of Borehole Logs in Appendix A.

A review of the borehole logs indicates that the general subsurface conditions were as follows:

6.1 Pavement and Shoulder Structure

Boreholes Nos.17-01 and 17-02 encountered 125 mm and 100 mm of asphalt respectively. Underlying the asphalt in the boreholes, 200 mm and 460 mm of granular road base was encountered, respectively. In Borehole No. 17-02, a layer of buried asphalt was encountered that was 75mm thick.

6.2 Topsoil

Borehole No. 17-03 encountered 200 mm of surficial topsoil.

6.3 Fill

The pavement structure in Boreholes Nos. 17-01 and 17-02, and the topsoil in Borehole No. 17-03, was underlain by sand to silty sand/sandy silt fills.

The fill extended to depths between 0.4 m and 3.1 m below existing grade. The dark brown sand and silty sand to sandy silt fill contained traces of gravel, organics and rootlets. The fill was very loose to loose with SPT 'N' values of between 2 and 5 blows for 300 mm of penetration. Water contents measured in the fill samples recovered from the boreholes ranged from 17% to 28%.

6.4 Sand and Gravel, Sandy Gravel

The fill in the Borehole No. 17-01, and the sand in Borehole No. 17-03 was underlain by brown sand and gravel which generally contained trace to some of silt. The sand and gravel extended to a depth of 2.1 m below grade in Borehole No. 17-01 and from 3.7 m to 5.2 m below grade in

Borehole No. 17-03. The sand and gravel was compact to very dense with SPT 'N' values of 27 blows for 300 mm of penetration to 70 blows for 280mm of penetration. Natural water contents ranged between 4% and 5%.

The fill in Borehole No. 17-02, was underlain by brown sandy gravel which generally contained traces of silt. The sandy gravel extended to a depth of 5.9 m below grade. The sandy gravel was dense to compact with SPT 'N' values of between 19 and 43 blows for 300 mm of penetration. Natural water contents ranged between 3% and 4%.

6.5 Sand

The sand and gravel in borehole 17-01, the sandy silt in Borehole No. 17-02 and the fill and the gravely sand and silt in Borehole No. 17-03 were underlain by brown sand which generally contained trace to some silt and gravel. The sand in Borehole No. 17-01 extended to a depth of 7.0 m below existing grade. The sand in Borehole No. 17-02 extended to a depth of 10.2 m below existing grade. There were two layers of sand in Borehole No. 17-03, one extending from 3.1 to 3.7 m below existing grade and one extending 5.9 to 9.2 m below existing grade. The sand was loose to very dense with SPT 'N' values of 8 blows for 300 mm of penetration to 50 blows for 80 mm of penetration. Natural water contents ranged between 3% and 32%.

6.6 Silty Sandy Gravel

The sand in Borehole No. 17-01, was underlain by brown silty sandy gravel. The silty sandy gravel extended to a depth of 12.0 m below existing grade. The material was dense to very dense with SPT 'N' values of 43 blows for 300 mm of penetration to 50 blows for 30 mm of penetration. Natural water contents ranged between 5% and 9%.

6.7 Silty Sand / Sandy Silt

The sandy gravel in Borehole No. 17-02, was underlain by brown silty sand. The silty sand extended to a depth of 7.1 m below existing grade. The material was dense with a SPT 'N' value of 38 blows for 300 mm of penetration. Natural water content measured in the recovered sample was 12%.

The silty sand in Borehole No. 17-02, was underlain by grey sandy silt. The sandy silt extended to a depth of 8.5 m below existing grade. The material was dense with a SPT 'N' value of 48 blows for 300 mm of penetration. Natural water content measured in the recovered sample was 13%.

6.8 Gravelly Sand and Silt

The sand and gravel in Borehole No. 17-03, was underlain by brown gravely sand and silt. The gravely sand and silt extended to a depth of 5.9 m below existing grade. The material was dense with a SPT 'N' value of 40 blows for 300 mm of penetration. Natural water content measured in the recovered sample was 5%.

6.9 Bedrock

The silty sandy gravel in Borehole No. 17-01, the sand in Boreholes Nos. 17-02 and 17-03 was underlain by beige Dolostone which extended to at least the maximum depths investigated. The bedrock was verified in Boreholes Nos. 17-01 and 17-02 through coring.

The depth of the bedrock encountered in the boreholes varied from 9.2 to 12 m below existing grade. The top of the bedrock varied in elevation from 320.0 to 322.1 m geodetic

It should be noted that auger refusal was encountered in Borehole No. 17-03 at elevation of 321.3 m, geodetic. Auger refusal was due to inferred bedrock

The bedrock consisted of brown Dolostone (Guelph Formation). The Total Core Recovery (TCR) was 100%, and the Rock Quality Designation (RQD) ranged from 86% to 100% indicating rock of excellent quality.

6.10 Groundwater Conditions

The ground water observed in the boreholes upon completion as well as the well monitoring events are listed in the table below.

Borehole	Groundwater Level Upon Completion (m below grade)	Water Level April 21, 2017 (m below grade)	Water Level April 26, 2017 (m below grade)	Note
17-01	3.4	-	-	Water level likely influenced by rock coring
17-02	7.6	-	-	Water level likely influenced by rock coring
17-03	8.5	8.0	7.3	

It should be noted that the ground water at the site would fluctuate seasonally and can be expected to be somewhat higher during the spring months and in response to major weather events.

7.0 DISCUSSION AND RECOMMENDATIONS

7.1 Background Review

In July, 2013, the City retained AMEC Environment & Infrastructure (AMEC), a predecessor of Amec Foster Wheeler to complete a geotechnical Investigation along Speedvale Avenue between Woolwich Street and Manhattan Court. The original investigation was completed to support the construction of a new watermain, sewer, and road upgrades as well as bridge reconstruction along Speedvale Avenue. The results of AMEC's investigation are presented in the report entitled "*Geo-Environmental Investigation, Road & Bridge Reconstruction, Speedvale Avenue, Guelph, Ontario*" (AMEC, 2013).

In February 2016, Amec Foster Wheeler was retained by the City to assess the condition and stability of the existing retaining wall and to provide geotechnical design parameters for the backfill behind the wall on which the proposed trail may be built. Investigation for this study consisted of five (5) hand-dug test pits and the results of the study are presented in the report entitled *"Geotechnical Investigation Speedvale Trail Speed River from Speedvale Avenue to Riverside Park, Guelph, Ontario"* (Amec Foster Wheeler Project No. TPB165099).

Review of the abovementioned reports indicates that the general stratigraphy at the site consists of sand and gravel deposits with varying amounts of silt, cobbles and boulders overlying brown

to tan dolostone bedrock of the Guelph Formation, consistent with the findings of the subject investigations.

7.2 Visual Slope Inspection

The visual slope condition assessment was carried out by experienced Amec Foster Wheeler geotechnical engineers familiar with slope inspections, using the procedure outlined in the Ontario Ministry of Natural Resources (MNR) *"Technical Guide – River and Stream Systems: Erosion Hazard Limit".* The inspection was carried out on April 26, 2017 during warm sunny and calm weather conditions and the inspection report is provided in Appendix D.

The purpose of the visual inspection was to observe/inspect the existing slope conditions, and to identify any potential areas of concern observed on the slope from a geotechnical perspective. In particular, the inspection included the examination of:

- evidence of slope instability;
- evidence of water course features;
- evidence of seepage on the slope;
- the condition of the vegetation coverage on the slope; and
- evidence of erosion at the slope toe.

Observations and the use of topographic plans during and after the site visits indicate that the highest and steepest part of the slope occurs approximately midway between Speedvale Avenue and Riverside Park where the slope is about nine (9) metres high and overall slope configuration consists of a slope inclination of 1.75H : 1V. From there it tapers to about 5 m high with 2H : 1V slopes southwards to Speedvale Avenue and to 4 m high and 3.5H : 1V northwards to Riverside Park.

The slope is well vegetated with shrubs and mature trees with some fallen trees in random directions, probably due to windfall. There were no signs of instability or erosion along the slopes but in the central zone the crest of the slope was fortified with gabions to allow for civic development closer to the physical top of slope or to prevent future erosion.

A score of 38 was obtained using the Slope Stability Rating Chart published in the MNR Technical Guide which is presented in Appendix D. This indicates that the slope has a moderate potential for instability, and a detailed investigation and slope stability analysis is justified in accordance with the aforementioned Technical Guide.

7.3 Toe Erosion Allowance

The allowance for toe erosion is determined by the classification of the watercourse, the proximity of the watercourse to the toe of the slope and the susceptibility of the slope material to erosion.

The toe of the slope along the entire study area is protected by a concrete retaining wall. Due to the low susceptibility of the retaining wall to erosion, and based on previous site inspections of the retaining wall conditions, toe erosion is considered to be negligible.

7.4 Stable Slope Allowance

In general, the stability component of the geotechnical setback is dictated by the existing surface and subsurface conditions of the slope such as slope geometry, soil strength, groundwater conditions and vegetation, as well as surcharge loading at the crest of the slope. The stability component may be derived based on generalized guidelines involving a setback gradient line which is dependent on subsoil stratigraphy and is drawn upward from the stable toe of the slope to intersect the tableland or crest. If site-specific subsurface information is obtained to define the soil stratigraphy and design parameters, as is the case for this site, the stability component may be derived from a detailed stability analysis using appropriate analytical methods. The intersection of the stable slope alignment and the ground surface is considered as the Stable Top of Slope.

Amec Foster Wheeler carried out a detailed slope stability analysis of the slope. Section C-C" as shown on the Aboud and Associates Inc. Drawings was used to construct a model representing the steepest slope in the study area. The stratigraphy was based on the borehole data from the current and historical reports in the area. The founding conditions of the existing concrete retaining wall are not known so the analyses considered both possibilities of the wall being founded on bedrock or alternatively on the very dense overlying soil.

For this site, the geotechnical stability component of the setback has been assessed by carrying out limit equilibrium slope stability analyses using the industry-accepted program SLOPE/W, developed by Geo-Slope International Ltd., using the Morgenstern-Price method of analysis.

The following geotechnical parameters were used in the effective stress stability analysis, based on the SPT "N" values measured in the boreholes, accepted correlations in literature, and Amec Foster Wheeler's experience with the soil in this area.

Table 7.1 - Summary of Soil Parameters Assigned for Slope Stability Analysis

Soil Description	Approximate Geodetic Elevation (masl)	SPT N_{avg} (blows per 300 mm)	Unit Weight (kN/m^3)	Estimated Angle of Internal Friction $\phi^{/}$ (º)	Estimated Cohesion Intercept $c^{/}$ (kPa)
Pavement Structure/Fill	332.3 to 331.4	13	18	28	0
Dense Sandy Gravel	331.4 to 326.4	31	18	32	0
Silty Sand	326.4 to 325.2	38	19	33	0
Sandy Silt	325.2 to 323.8	48	20	34	0
Fine Sand	323.8 to 322.1	81	21	35	0
Dolostone Bedrock	Below 322.1	>50	Impenetrable		
Concrete Wall	Toe of Slope		25	High Strength	

The slope models developed are shown in Appendix D and the analyses indicate that the factor of safety (FS) varies between 1.2 and 1.5 depending on the slip surface configuration and retaining wall foundation considered as shown in Table 7.2 below.

Table 7.2 – Slope Stability Analyses Results

Figure No.	Case Considered	Factor of Safety	Recommended Factor of Safety
3	Shallow Slip Surface	1.2	1.4
4	Deep-Seated Failure Surface, Toe Wall founded on Bedrock	1.5	1.5
5	Deep Seated Failure Surface, Toe Wall founded on Soil	1.3	1.5
6	Deep-Seated Failure Surface, Toe of Slope Cut for Trail	1.0	1.5

The stability component of the geotechnical setback is based on the family of "slip surfaces", or potential failure surfaces. Minimum safety factors of 1.4 to 1.5 are recommended for the required stable slope allowances for infrastructure and public use above and below the slope. The results of slope stability analysis indicate that the most critical case is for a shallow slip surface on the existing slope as the factor of safety against slope failure is about 1.2. The inclination angle of the stable slope for the site could be considered to be the existing 1.75H : 1V provided that it can be verified that the concrete retaining wall at the toe of the slope is founded on bedrock. If this is the case then the Physical Top of Slope can be considered to be the Stable Top of Slope. The analyses also showed that if the toe of the slopecut to construct the proposed trail the factor of safety calculated is 1.0 which means that the slope would be in imminent risk of failing.

7.5 Erosion Access Allowance

The erosion access allowance is the minimum required allowance from the greater of the physical or stable top of the slope and depends on the watercourse features. Since substantial urban development has already taken place in the potentially impacted area it is assumed that any emergency access required for repairs or maintenance have already been taken into account.

7.6 Pertinent Comments

GRCA Regulation 150/06 Section 7.1.2 stipulates that for development of public infrastructure within GRCA regulated areas the following requirements pertinent to slope stability be met:

a) the risk to public safety is not increased,
b) susceptibility to natural hazards is not increased or new hazards created,
c) works are constructed, repaired and/or maintained according to accepted engineering principles and approved engineering standards or to the satisfaction of the GRCA, whichever is applicable based on the scale and scope of the project.

Based on our slope stability analyses construction of the proposed multi-use trail north of Speedvale Avenue involving alteration of the existing slope would most likely have a detrimental impact on the stability of the steep slope in the vicinity of Section C-C' as shown on the Aboud & Associates drawings. The stability of the existing slope is marginal as the computed factor of safety is currently less than the recommended minimum factor of safety and any alteration of the

slope to accommodate an upper retaining wall and a path on grade above the existing retaining wall would exacerbate the risk, probably to the point of failure as indicated by Figure 6 where the factor of safety is 1.0.

Amec Foster Wheeler considers the concept shown as Option B on Aboud & Associates Drawing LP9 to be the more prudent approach where caisson piers can be drilled near the toe of the slope without major disturbance to the existing slope.

Amec Foster Wheeler should be retained to review any further development of the design drawings to confirm that the recommendations in this report have been correctly interpreted. We would be pleased to provide any further information or analysis that may be needed during design and to advise on the geotechnical aspects of specifications for inclusion in contract documents.

8.0 CLOSURE

The Report Limitations, as quoted in Appendix E, are an integral part of this report.

Please be advised that the content of this report is based on the available information for this project at the time of writing. Should any design criteria change or be altered, Amec Foster Wheeler must be advised immediately to reassess the recommendations stated in the report. We otherwise trust that this report is complete to meet your present needs.

Please don't hesitate to contact the undersigned should further assistance be required.

Amec Foster Wheeler Environment & Infrastructure
A division of Amec Foster Wheeler Americas Limited

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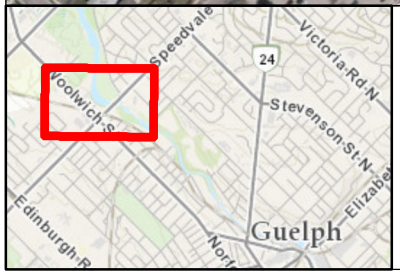

LEGEND

- Site Location
- Waterbody
- Railway

NOTES:

LOCATION OF FEATURES ARE APPROXIMATE

This drawing should be read in conjunction with the Amec Foster Wheeler Environment & Infrastructure Report No. SWC167252.

Conditions encountered in the field may be different from the interpreted information presented on this figure.

SOURCE: Google Earth, 2015.

CLIENT: City of Guelph

Drawn By: LJM	Checked By: TR
Revision: A	Projection: UTM Zone 17N
SCALE: 1:4,000	

N W E S

Slope Stability Assessment Proposed Speedvale Bridge Underpass and Multi-Use Trail Linkage
Guelph, ON

Site Location Plan

PROJECT N°: TB173002

DATE: April, 2017

FIGURE: 1

Amec Foster Wheeler Environment & Infrastructure
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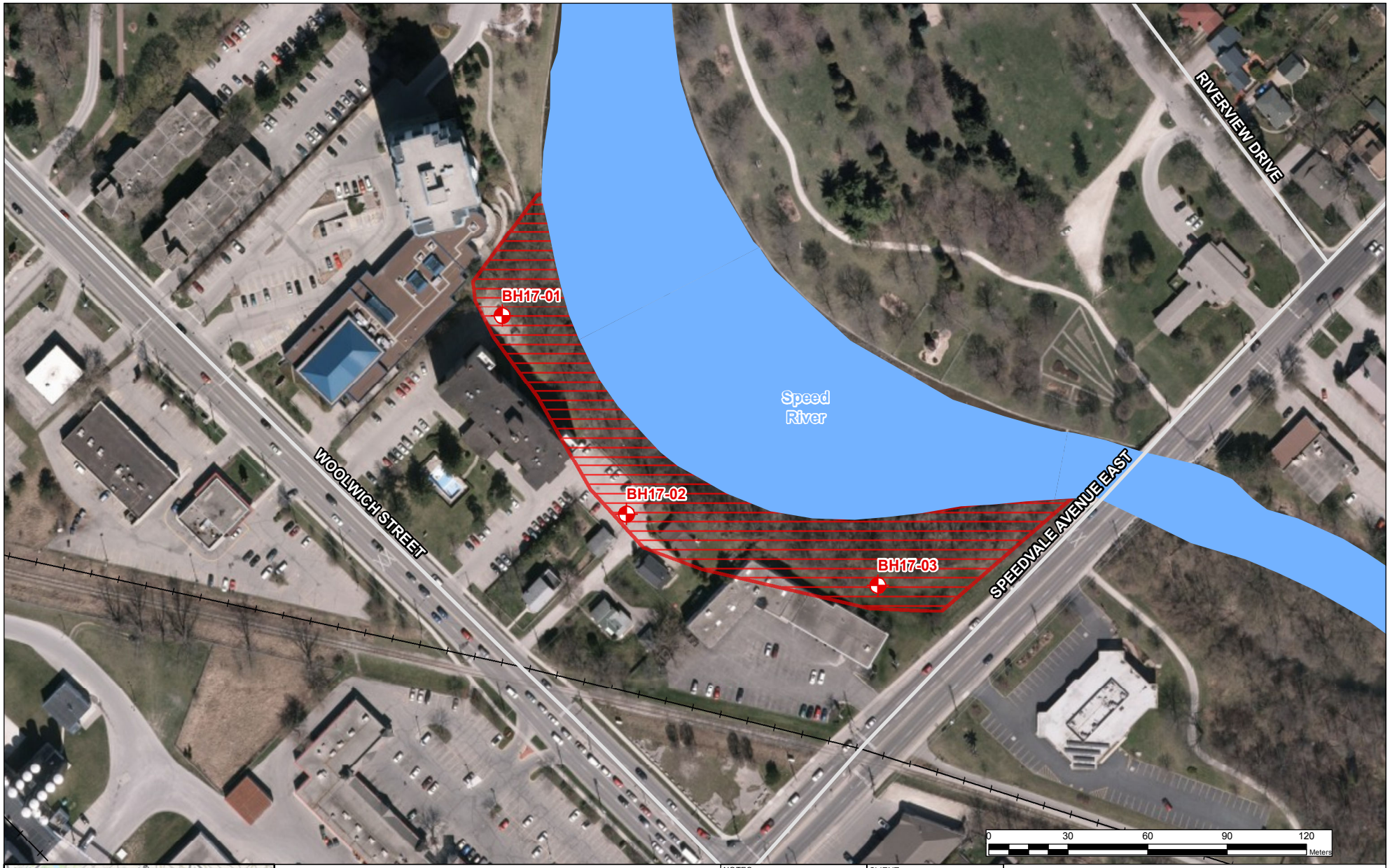

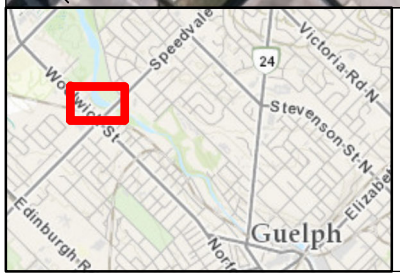

LEGEND

- Borehole Location
- Waterbody
- Site Location
- Railway

NOTES:

LOCATION OF FEATURES ARE APPROXIMATE

This drawing should be read in conjunction with the Amec Foster Wheeler Environment & Infrastructure Report No. SWC167252.

Conditions encountered in the field may be different from the interpreted information presented on this figure.

SOURCE: Google Earth, 2015.

CLIENT: City of Guelph

Drawn By: LJM	Checked By: TR
Revision: A	Projection: UTM Zone 17N
SCALE: 1:2,000	

N W E S

Slope Stability Assessment Proposed Speedvale Bridge Underpass and Multi-Use Trail Linkage
Guelph, ON

Borehole Location

PROJECT N°: TB173002

DATE: April, 2017

FIGURE: 2

Amec Foster Wheeler Environment & Infrastructure
3450 Harvester Rd Unit 100., Burlingotn, Ontario, L7N 3W5
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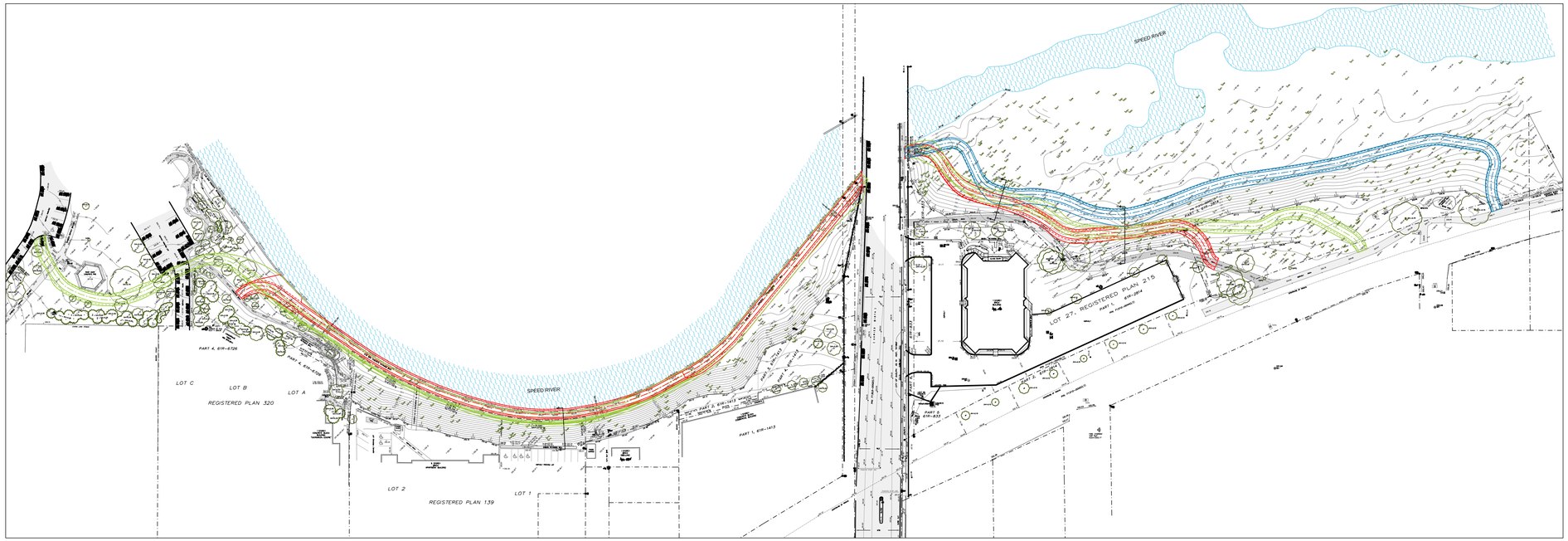
APPENDIX A


SPEED RIVER
LOT C
LOT B
LOT A
REGISTERED PLAN 320
PART 4, 61R-5726
SPEED RIVER
LOT 2
LOT 1
REGISTERED PLAN 139
PART 1, 61R-1413
LOT 27, REGISTERED PLAN 215
PART 1, 61R-2814
PART 2, 61R-2814
PART 3, 61R-2814
PART 5, 61R-2814
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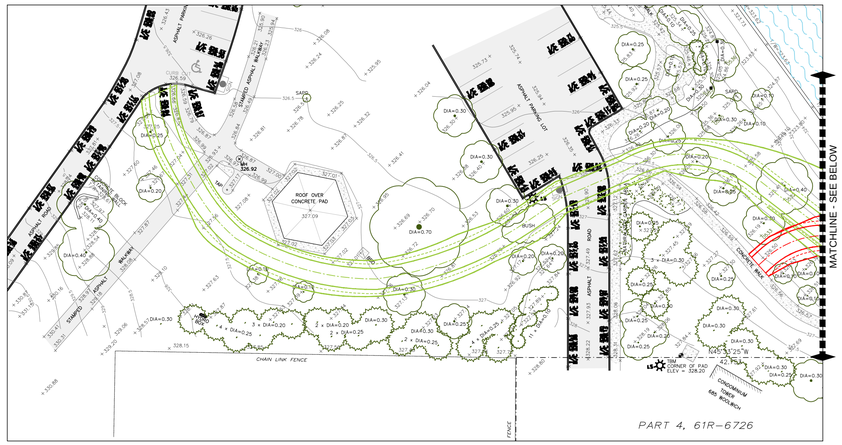

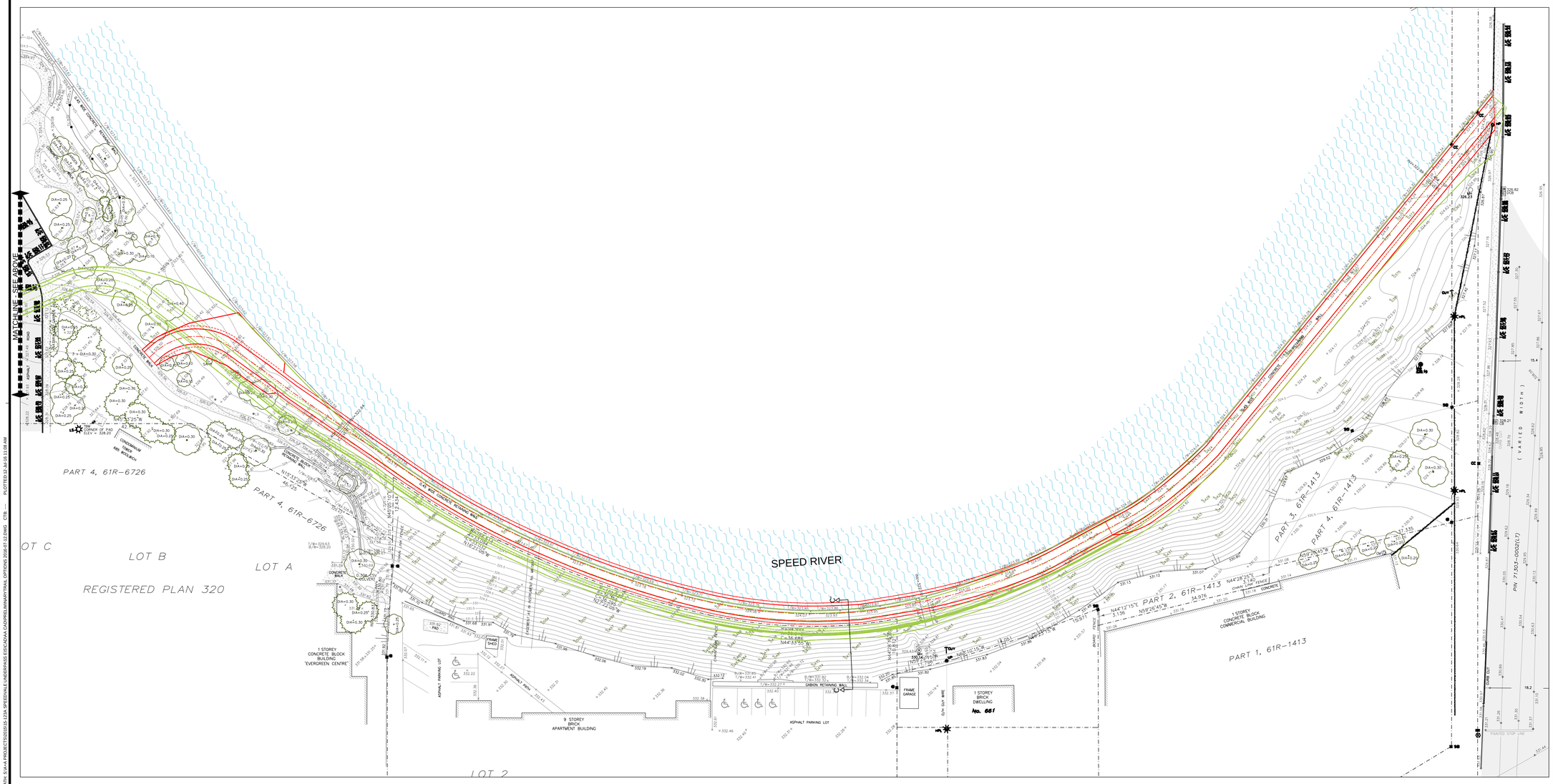

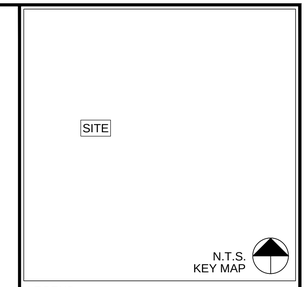

LEGEND:

- TRAIL CENTRE LINE
- EDGE OF TRAIL
- EDGE OF CLEAR ZONE
- APPROXIMATE LIMIT OF GRADING

INFORMATION SOURCES

1. Topographic Survey dated December 9, 2015 obtained from Van Harten Surveying Inc.

No.	Description	By	Date
0	PRELIMINARY FOR PARKS REVIEW	EE	12 JUL-16

REVISIONS: All previous issues of this drawing are superceded

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T:519.822.6839 , F:519.822.4052 , info@aboudtng.com , www.aboudtng.com

Title:

TRAIL ALIGNMENT OPTIONS NORTH SIDE

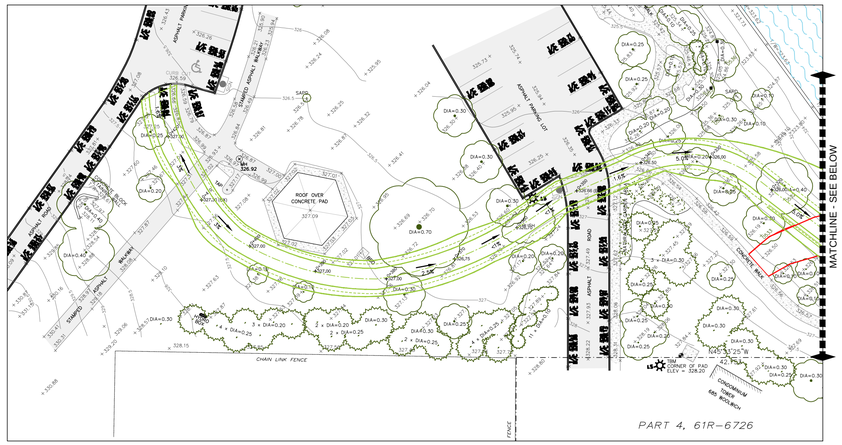
Project:

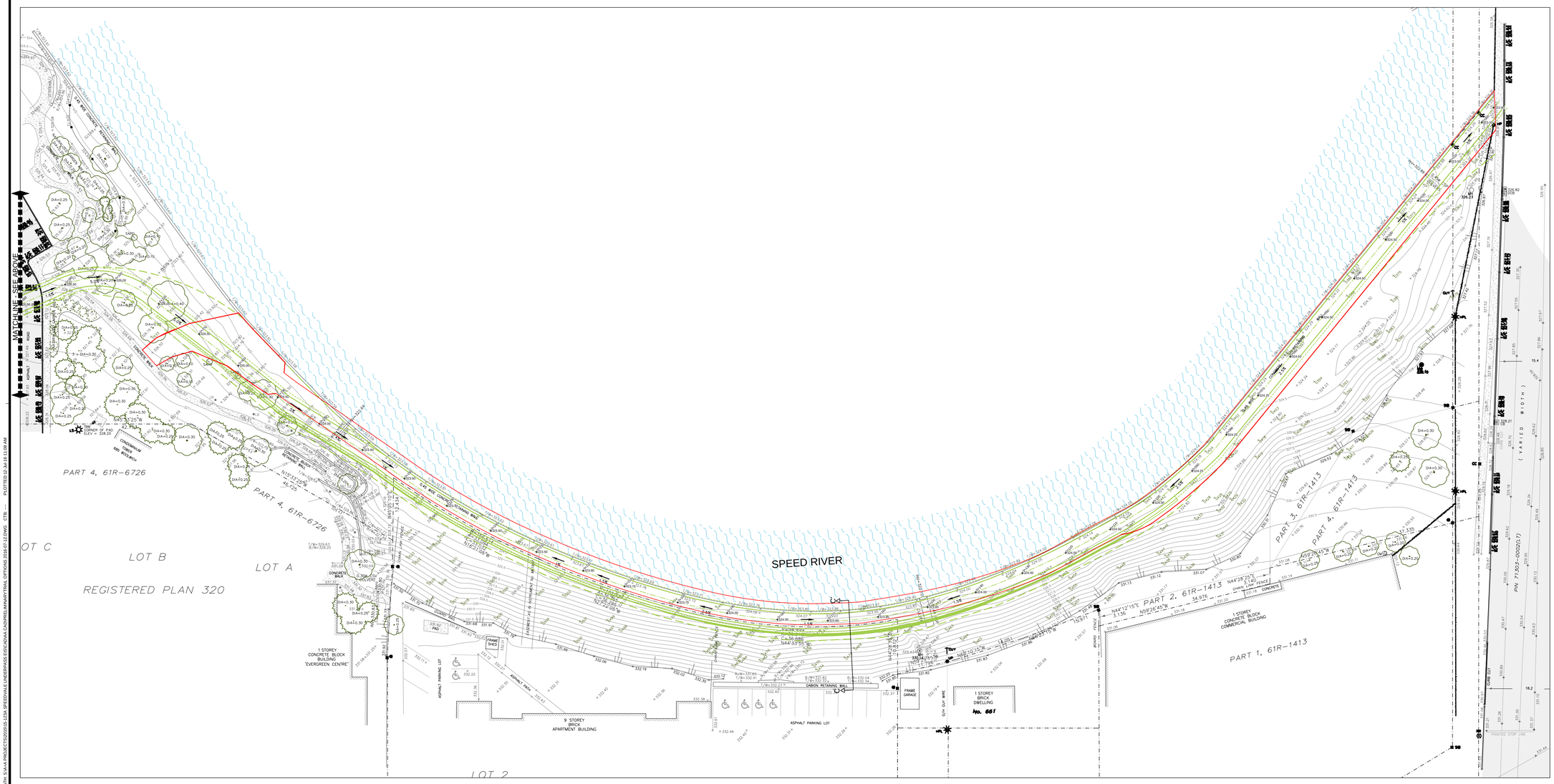
SPEEDVALE BRIDGE UNDERPASS & MULTI-USE TRAIL LINKAGE PROJECT
CITY OF GUELPH

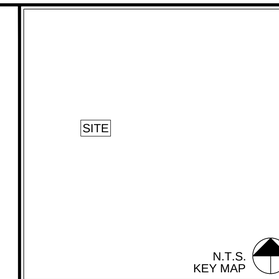
Date: APRIL 2016	Designer: MN
Project: AA15-123A	Drawn: EE
Scale: 1:400	Checked: MN

Drawing No:

LP2







LEGEND:

- TRAIL CENTRE LINE
- EDGE OF TRAIL
- EDGE OF CLEAR ZONE
- APPROXIMATE LIMIT OF GRADING

INFORMATION SOURCES

1. Topographic Survey dated December 9, 2015 obtained from Van Harten Surveying Inc.

No.	Description	By	Date
0	PRELIMINARY FOR PARKS REVIEW	EE	12 JUL-16

REVISIONS: All previous issues of this drawing are superceded

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Title:

TRAIL ALIGNMENT OPTIONS NORTH SIDE - OPTION 1

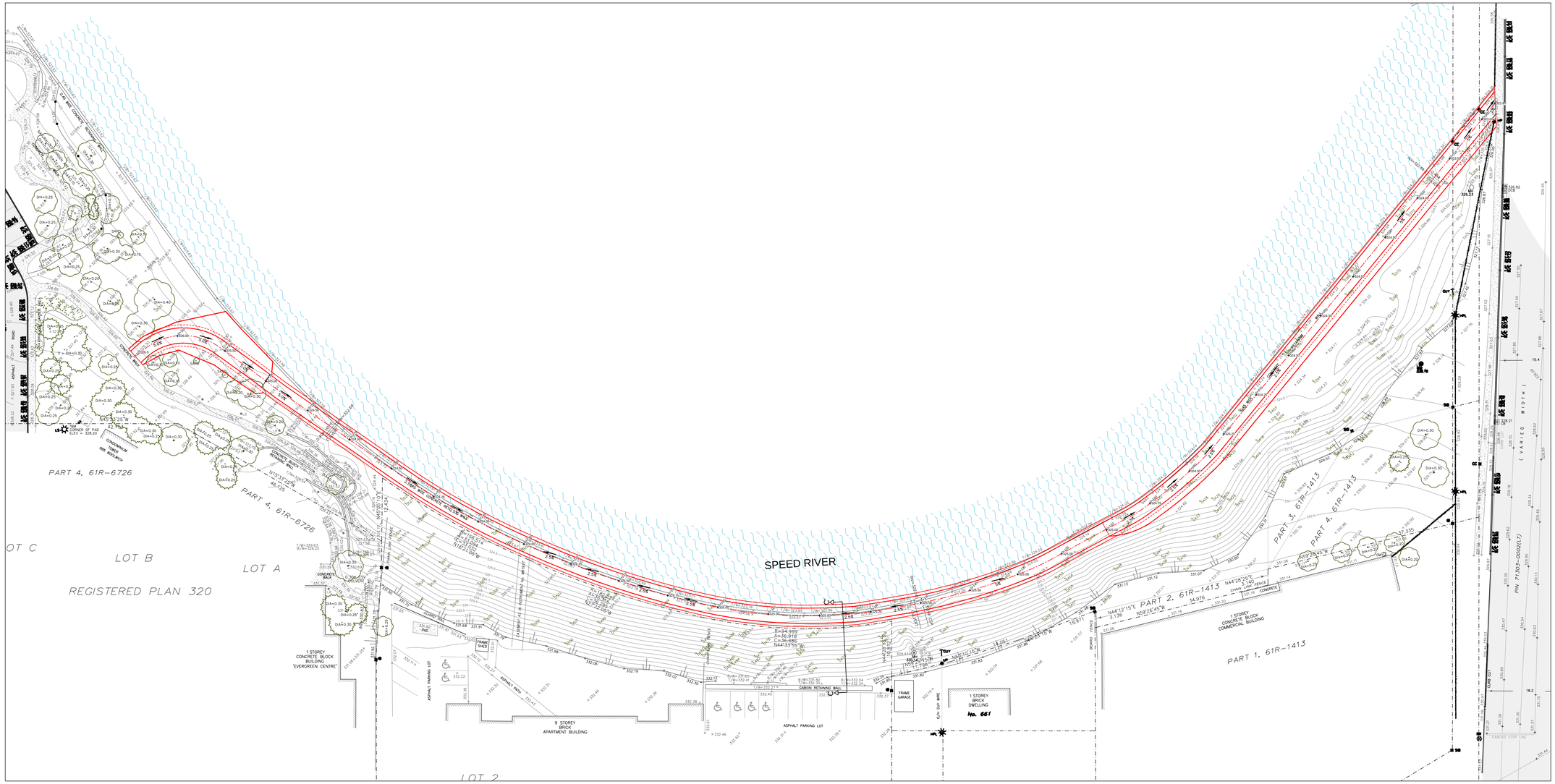
SPEEDVALE BRIDGE UNDERPASS & MULTI-USE TRAIL LINKAGE PROJECT

CITY OF GUELPH

Date: APRIL 2016	Designer: MN
Project: AA15-123A	Drawn: EE
Scale: 1:400	Checked: MN

Drawing No:

LP3



SITE

N.T.S.
KEY MAP

LEGEND:

- TRAIL CENTRE LINE
- EDGE OF TRAIL
- EDGE OF CLEAR ZONE
- APPROXIMATE LIMIT OF GRADING

INFORMATION SOURCES

1. Topographic Survey dated December 9, 2015 obtained from Van Harten Surveying Inc.

No.	Description	By	Date
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Title:

TRAIL ALIGNMENT OPTIONS NORTH SIDE - OPTION 2

SPEEDVALE BRIDGE UNDERPASS & MULTI-USE TRAIL LINKAGE PROJECT

CITY OF GUELPH

Date: APRIL 2016	Designer: MN
Project: AA15-123A	Drawn: EE
Scale: 1:400	Checked: MN

Drawing No:

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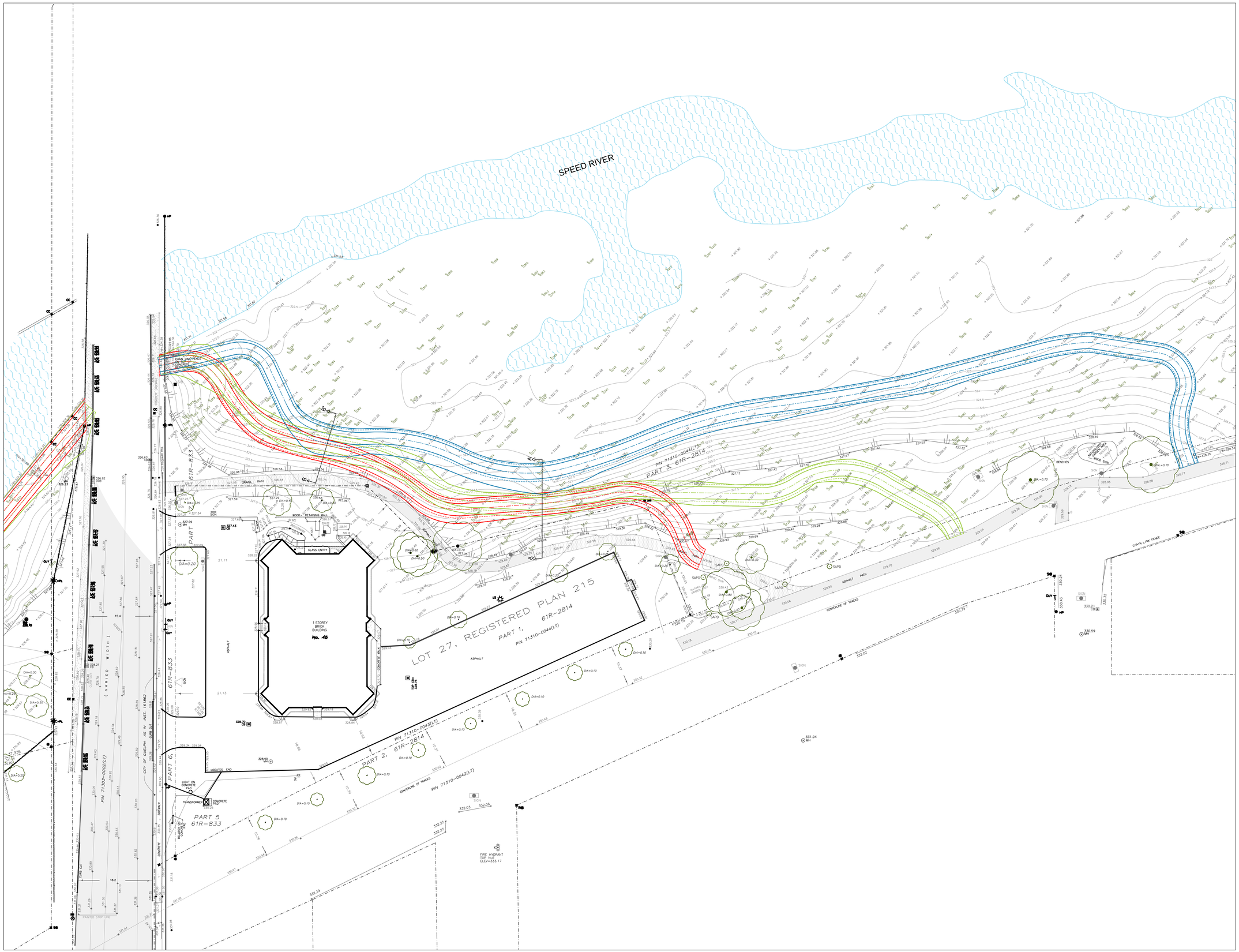

SITE

N.T.S.
KEY MAP

LEGEND:

- TRAIL CENTRE LINE
- EDGE OF TRAIL
- EDGE OF CLEAR ZONE
- APPROXIMATE LIMIT OF GRADING

INFORMATION SOURCES

1. Topographic Survey dated December 9, 2015 obtained from Van Harten Surveying Inc.

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REVISIONS: All previous issues of this drawing are superceded

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Title:

TRAIL ALIGNMENT OPTIONS SOUTH SIDE - OPTIONS

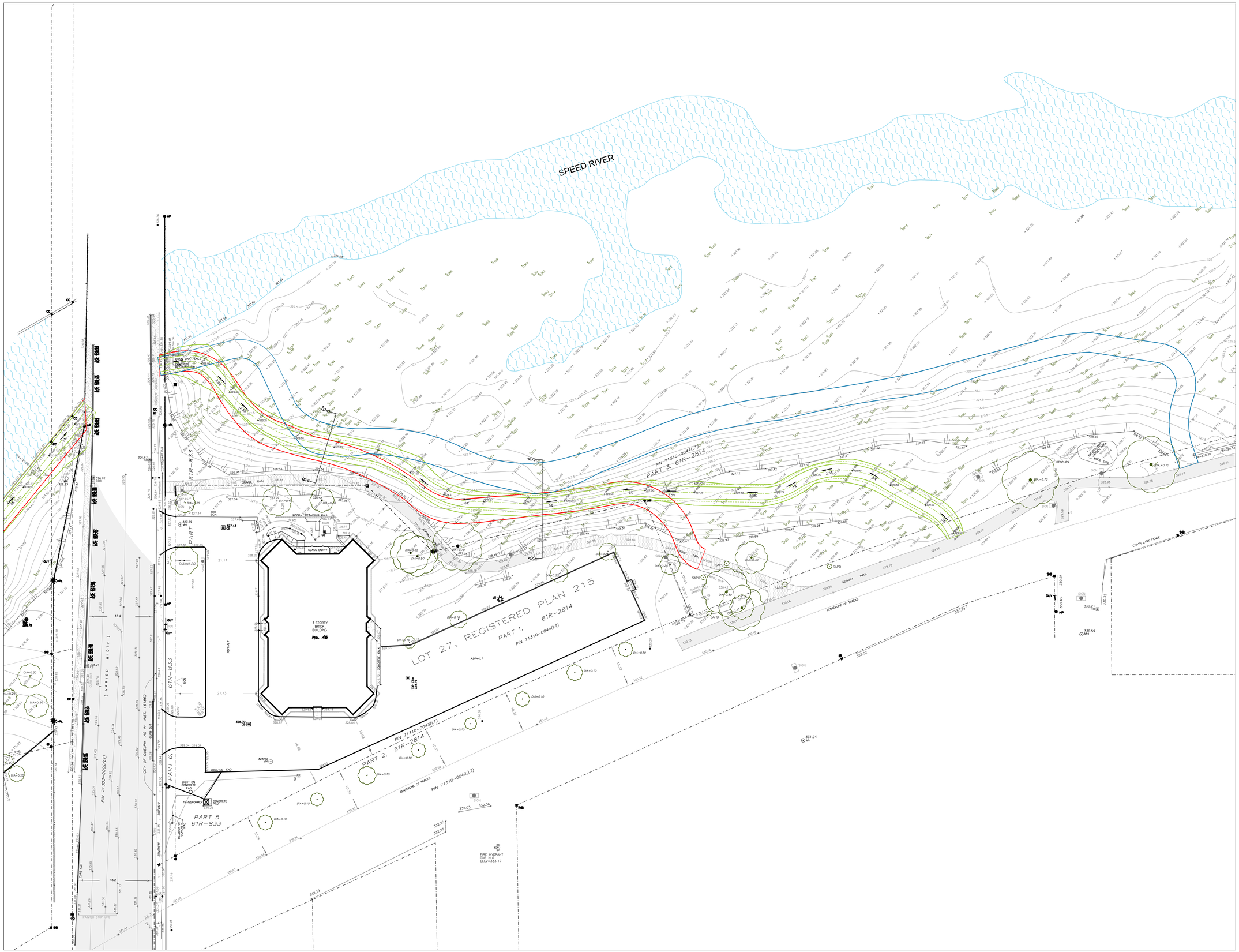
SPEEDVALE BRIDGE UNDERPASS & MULTI-USE TRAIL LINKAGE PROJECT

CITY OF GUELPH

Date: APRIL 2016	Designer: MN
Project: AA15-123A	Drawn: EE
Scale: 1:400	Checked: MN

Drawing No:

LP5



SITE

N.T.S.
KEY MAP

LEGEND:

- TRAIL CENTRE LINE
- EDGE OF TRAIL
- EDGE OF CLEAR ZONE
- APPROXIMATE LIMIT OF GRADING

INFORMATION SOURCES

1. Topographic Survey dated December 9, 2015 obtained from Van Harten Surveying Inc.

No.	Description	By	Date
0	PRELIMINARY FOR PARKS REVIEW	EE	12 JUL-16

REVISIONS: All previous issues of this drawing are superceded

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Title:

TRAIL ALIGNMENT OPTIONS SOUTH SIDE - OPTION 1

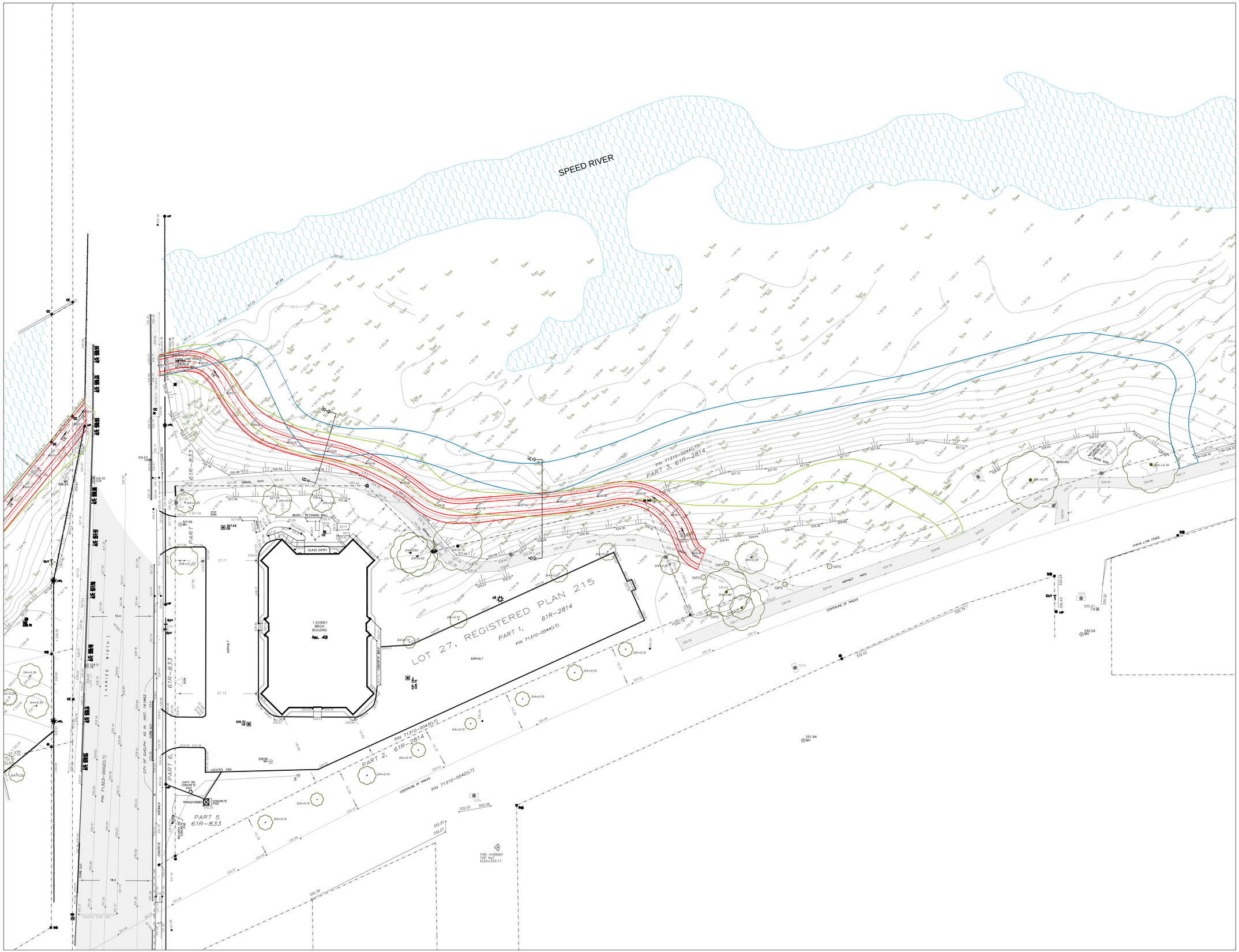
SPEEDVALE BRIDGE UNDERPASS & MULTI-USE TRAIL LINKAGE PROJECT

CITY OF GUELPH

Date: APRIL 2016	Designer: MN
Project: AA15-123A	Drawn: EE
Scale: 1:400	Checked: MN

Drawing No:

LP6



SITE

N.T.S.
KEY MAP

LEGEND:

- TRAIL CENTRE LINE
- EDGE OF TRAIL
- EDGE OF CLEAR ZONE
- APPROXIMATE LIMIT OF GRADING

INFORMATION SOURCES

1. Topographic Survey dated December 9, 2015 obtained from Van Harten Surveying Inc.

No.	Description	By	Date
0	PRELIMINARY FOR PARKS REVIEW	EE	12 JUL-16

REVISIONS: All previous issues of this drawing are superceded

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Title:

TRAIL ALIGNMENT OPTIONS SOUTH SIDE - OPTION 2

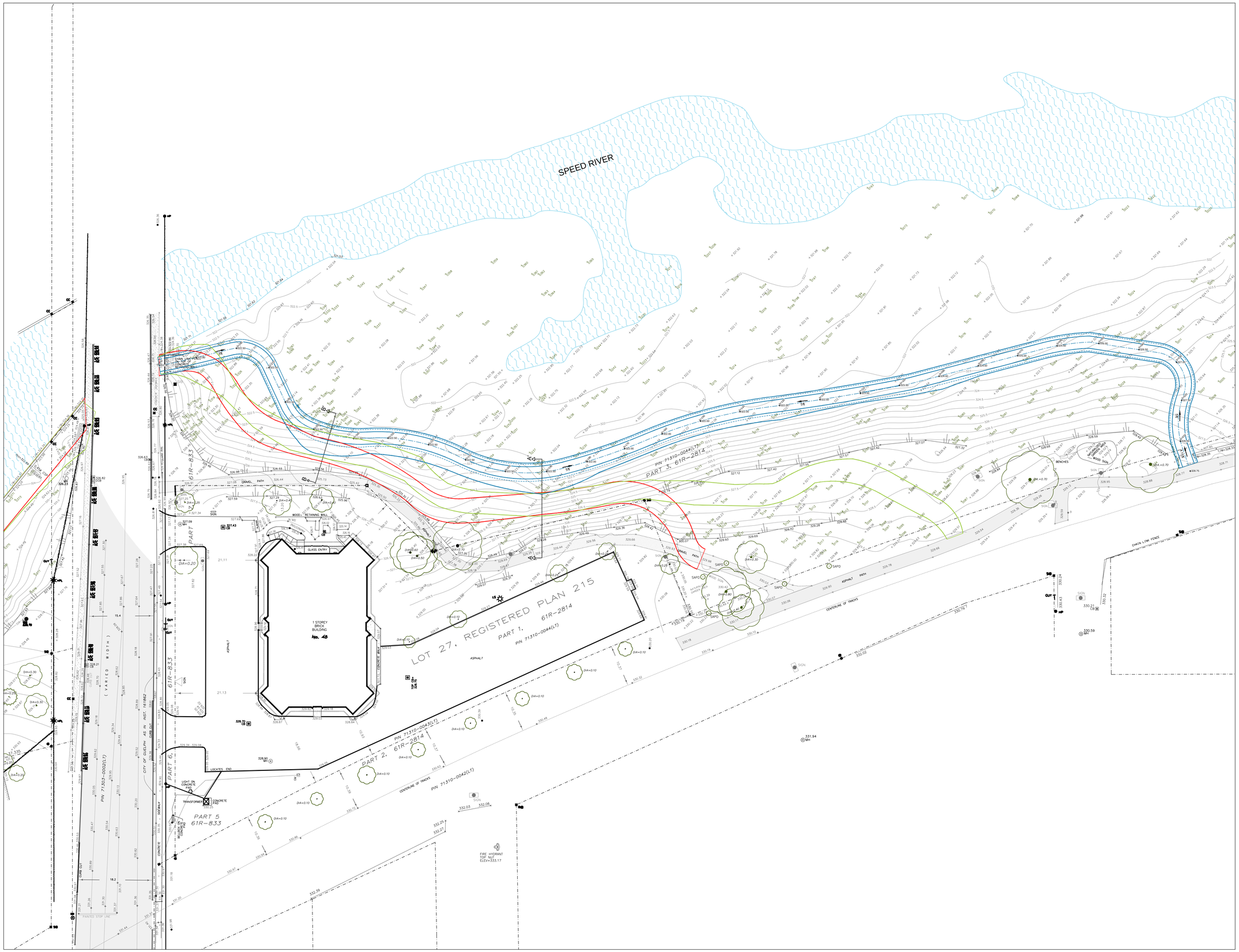
SPEEDVALE BRIDGE UNDERPASS & MULTI-USE TRAIL LINKAGE PROJECT

CITY OF GUELPH

Date: APRIL 2016	Designer: MN
Project: AA15-123A	Drawn: EE
Scale: 1:400	Checked: MN

Drawing No:

LP7



SITE

N.T.S.
KEY MAP

LEGEND:

- TRAIL CENTRE LINE
- EDGE OF TRAIL
- EDGE OF CLEAR ZONE
- APPROXIMATE LIMIT OF GRADING

INFORMATION SOURCES

1. Topographic Survey dated December 9, 2015 obtained from Van Harten Surveying Inc.

No.	Description	By	Date
0	PRELIMINARY FOR PARKS REVIEW	EE	12 JUL-16

REVISIONS: All previous issues of this drawing are superceded

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Title:

TRAIL ALIGNMENT OPTIONS SOUTH SIDE - OPTION 3

SPEEDVALE BRIDGE UNDERPASS & MULTI-USE TRAIL LINKAGE PROJECT

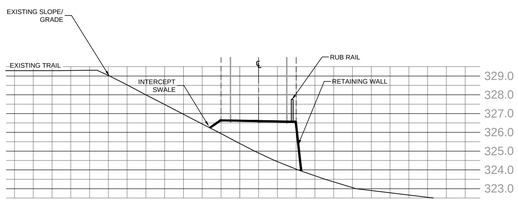
CITY OF GUELPH

Date: APRIL 2016	Designer: MN
Project: AA15-123A	Drawn: EE
Scale: 1:400	Checked: MN

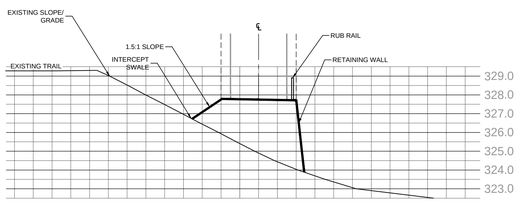
Drawing No:

LP8

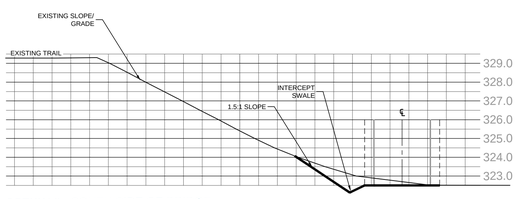
CROSS SECTION A-A'



OPTION 1 - SOUTH SIDE OF BRIDGE

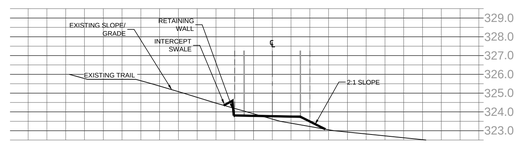


OPTION 2 - SOUTH SIDE OF BRIDGE

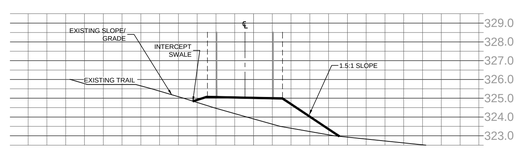


OPTION 3 - SOUTH SIDE OF BRIDGE

CROSS SECTION B-B'



OPTION 1 - SOUTH SIDE OF BRIDGE



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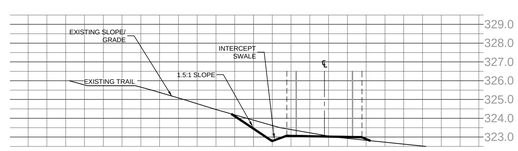
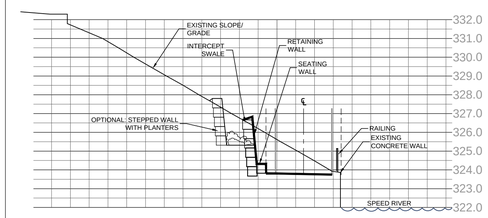
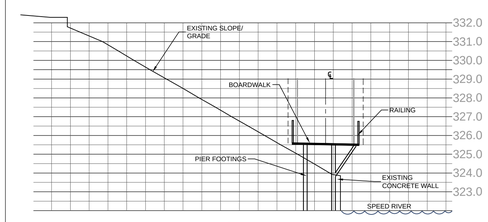


OPTION 3 - SOUTH SIDE OF BRIDGE

CROSS SECTION C-C'



OPTION A - NORTH SIDE OF BRIDGE



OPTION B - NORTH SIDE OF BRIDGE

SITE

N.T.S.
KEY MAP

LEGEND:

- TRAIL CENTRE LINE
- EDGE OF TRAIL
- EDGE OF CLEAR ZONE
- APPROXIMATE LIMIT OF GRADING

INFORMATION SOURCES

1. Topographic Survey dated December 9, 2015 obtained from Van Harten Surveying Inc.

No.	Description	By	Date
0	PRELIMINARY FOR PARKS REVIEW	EE	12 JUL-16

REVISIONS: All previous issues of this drawing are superceded

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Title:

TRAIL ALIGNMENT OPTIONS CROSS SECTIONS

SPEEDVALE BRIDGE UNDERPASS & MULTI-USE TRAIL LINKAGE PROJECT

CITY OF GUELPH

Date: APRIL 2016	Designer: MN
Project: AA15-123A	Drawn: EE
Scale: 1:150	Checked: MN

Drawing No:

LP9

G:\DATA\ S\A-A PROJECTS\2015\15-123A SPEEDVALE UNDERPASS EIS\CADD\LANDPLAN\TRAIL OPTIONS 2016-07-12.DWG CTB: - PLOTTED:12-Jul-16 11:09 AM

APPENDIX B

EXPLANATION OF BOREHOLE LOG

This form describes some of the information provided on the borehole logs, which is based primarily on examination of the recovered samples, and the results of the field and laboratory tests. Additional description of the soil/rock encountered is given in the accompanying geotechnical report.

GENERAL INFORMATION

Project details, borehole number, location coordinates and type of drilling equipment used are given at the top of the borehole log.

SOIL LITHOLOGY

Elevation and Depth

This column gives the elevation and depth of inferred geologic layers. The elevation is referred to the datum shown in the Description column.

Lithology Plot

This column presents a graphic depiction of the soil and rock stratigraphy encountered within the borehole.

Description

This column gives a description of the soil stratums, based on visual and tactile examination of the samples augmented with field and laboratory test results. Each stratum is described according to the *Modified Unified Soil Classification System*.

The compactness condition of cohesionless soils (SPT) and the consistency of cohesive soils (undrained shear strength) are defined as follows *(Ref. Canadian Foundation Engineering Manual)*:

Compactness of Cohesionless Soils	SPT N-Value
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

Consistency of Cohesive Soils	Undrained Shear Strength kPa	Undrained Shear Strength psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1000
Stiff	50 to 100	1000 to 2000
Very stiff	100 to 200	2000 to 4000
Hard	Over 200	Over 4000

Soil Sampling

Sample types are abbreviated as follows:

SS	Split Spoon	TW	Thin Wall Open (Pushed)	RC	Rock Core
AS	Auger Sample	TP	Thin Wall Piston (Pushed)	WS	Washed Sample

Additional information provided in this section includes sample numbering, sample recovery and numerical testing results.

Field and Laboratory Testing

Results of field testing (e.g., SPT, pocket penetrometer, and vane testing) and laboratory testing (e.g., natural moisture content, and limits) executed on the recovered samples are plotted in this section.

Instrumentation Installation

Instrumentation installations (monitoring wells, piezometers, inclinometers, etc.) are plotted in this section. Water levels, if measured during fieldwork, are also plotted. These water levels may or may not be representative of the static groundwater level depending on the nature of soil stratum where the piezometer tips are located, the time elapsed from installation to reading and other applicable factors.

Comments

This column is used to describe non-standard situations or notes of interest.

Amec Foster Wheeler Environment & Infrastructure
3300 Merrittville Hwy, Unit 5
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Tel: (905) 687-6616 Fax: (905) 687-6620
www.amecfw.com

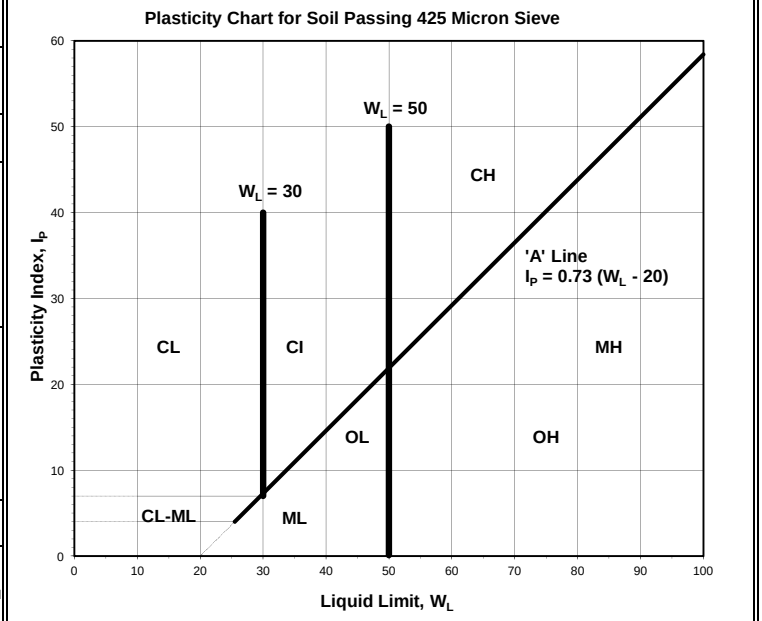
MODIFIED * UNIFIED CLASSIFICATION SYSTEM FOR SOILS

*The soil of each stratum is described using the 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.) modified slightly so that an inorganic clay of "medium plasticity" is recognized.

MAJOR DIVISION			GROUP SYMBOL	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	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 4$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3
			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS
		DIRTY GRAVELS (WITH SOME OR MORE FINES)	GM	SILTY GRAVELS, GRAVEL-SAND- SILT MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR P.I MORE THAN 4
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR P.I MORE THAN 7
	SANDS MORE THAN HALF THE COARSE FRACTION SMALLER THAN 4.75mm	CLEAN SANDS (TRACE OR NO FINES)	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 6$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3
			SP	POORLY GRADED GRAVELS, GRAVEL- SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS
		DIRTY SANDS (WITH SOME OR MORE FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR P.I MORE THAN 4
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR 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	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	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS	
	CLAYS ABOVE "A" LINE NEGLIGIBLE ORGANIC CONTENT	$W_L < 30\%$	CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY OR SILTY CLAYS, LEAN CLAYS	
		$30\% < W_L < 50\%$	CI	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS	
		$W_L > 50\%$	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
	ORGANIC SLITS & CLAYS BELOW "A" LINE	$W_L < 50\%$	OL	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	ORGANIC CLAYS OF HIGH PLASTICITY	
HIGH ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOUR, AND OFTEN FIBROUS TEXTURE

SOIL COMPONENTS

FRACTION	U.S STANDARD SIEVE SIZE		DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS		
		PASSING	RETAINED	PERCENT	DESCRIPTOR
GRAVEL	COARSE	76 mm	19 mm	35-50	AND
				20-35	Y/EY
	FINE	19 mm	4.75 mm	10-20	SOME
				1-10	TRACE
SAND	COARSE	4.75 mm	2.00 mm		
	MEDIUM	2.00 mm	425 µm		
	FINE	425 µm	75 µm		
FINES (SILT OR CLAY BASED ON PLASTICITY)		75 µm			
OVERSIZED MATERIAL					
ROUNDED OR SUBROUNDED: COBBLES 76 mm TO 200 mm BOULDERS > 200 mm				NOT ROUNDED: ROCK FRAGMENTS > 76 mm ROCKS > 0.76 CUBIC METRE IN VOLUME	



Amec Foster Wheeler
Environment & Infrastructure
3300 Merrittville Hwy Unit 5
Thorold, ON L2V 4Y6
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Fax: (905) 687.6620

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Note 1: Soils are classified and described according to their engineering properties and behaviour.

Note 2: 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.

RECORD OF BOREHOLE No. 17-01

Project Number:	TB173002	Drilling Method:	200 mm Hollow Stem Augering/Rock Coring		
Project Client:	City of Guelph	Drilling Machine:	Track Mounted Drill		
Project Name:	Slope Stability Assessment	Date Started:	30 Mar 17	Date Completed:	30 Mar 17
Project Location:	Speedvale Bridge Underpass and Multi-Use Trail Linkage	Logged by:	HP	Compiled by:	TH
Drilling Location:	4823301N; 559011E	Reviewed by:	TR	Revision No.:	0, 8/5/17

amec foster wheeler

LITHOLOGY PROFILE

Geodetic Ground Surface Elevation: 332.0 m

Description	Elevation (m)	Depth (m)
PAVEMENT STRUCTURE 125 mm **Asphalt** 200 mm **Granular Base**	331.9 0.1 331.7	
Dark Brown Sandy Silt **FILL** trace clay, rootlets soft to firm moist	331.3 0.4	
Brown **Sand and Gravel** trace silt, occasional cobble compact to very dense moist	329.9 2.1	
Brown **Sand** some gravel compact moist	329.1 2.9	
trace gravel	328.4 3.7	
Occasional cobble	326.1 5.9	
some silt very dense	325.0	

SOIL SAMPLING

Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
SS	1	50	8
SS	2	44	27
SS	3	47	70/28
SS	4	67	20
SS	5	67	23
SS	6	33	23
SS	7	6	26
SS	8	56	27
SS	9	44	50/8

FIELD TESTING

Penetration Testing: ○ SPT ● DCPT

MTO Vane*: △ Intact ▲ Remould

Nilcon Vane*: ◇ Intact ◆ Remould

* Undrained Shear Strength (kPa) 20 40 60 80

LAB TESTING

△ Combustible Organic Vapour (ppm)
▲ Combustible Organic Vapour (%LEL)
★ Total Organic Vapour (ppm) 100 200 300 400

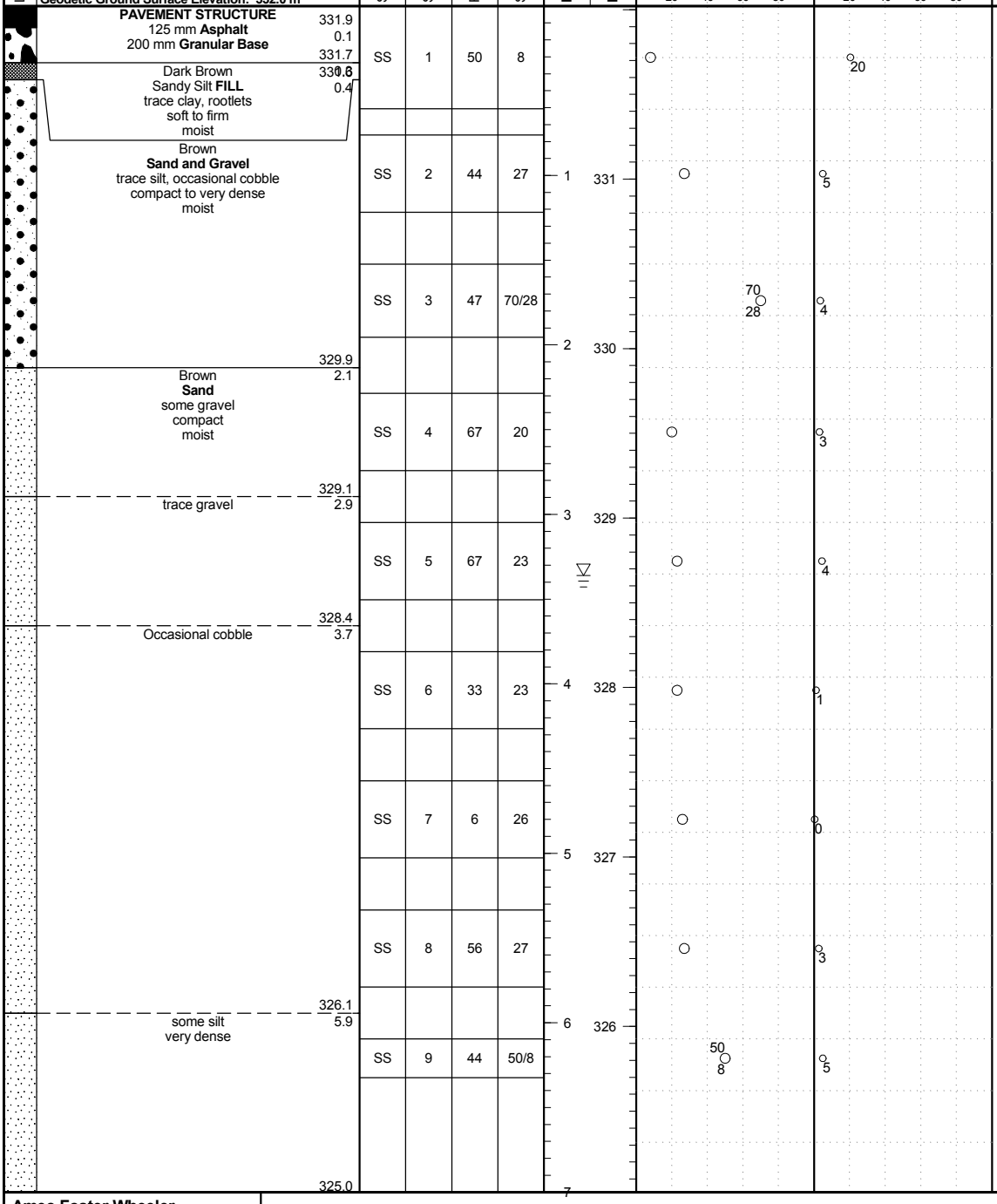
Atterberg Limits: W_P W W_L; Plastic – Liquid

○ Water Content (%) 20 40 60 80

INSTRUMENTATION INSTALLATION

COMMENTS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL



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Groundwater depth encountered on completion of drilling: 3.4 m.

Cave in depth after removal of augers: 7.3 m.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

Scale: 1 : 39

Continued on Next Page

RECORD OF BOREHOLE No. 17-01

Project Number:	TB173002	Drilling Method:	200 mm Hollow Stem Augering/Rock Coring		
Project Client:	City of Guelph	Drilling Machine:	Track Mounted Drill		
Project Name:	Slope Stability Assessment	Date Started:	30 Mar 17	Date Completed:	30 Mar 17
Project Location:	Speedvale Bridge Underpass and Multi-Use Trail Linkage	Logged by:	HP	Compiled by:	TH
Drilling Location:	4823301N; 559011E	Reviewed by:	TR	Revision No.:	0, 8/5/17

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LITHOLOGY PROFILE		SOIL SAMPLING						FIELD TESTING	LAB TESTING	INSTRUMENTATION INSTALLATION	COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	PenetrationTesting ○ SPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	△ Combustible Organic Vapour (ppm) ▲ Combustible Organic Vapour (%LEL) ★ Total Organic Vapour (ppm) 100 200 300 400; Atterberg Limits W_P W W_L Plastic Liquid; ○ Water Content (%) 20 40 60 80		GR	SA	SI	CL
	Brown 7.0 **Silty Sandy Gravel** dense to very dense moist													
		SS	10	67	43	8	324	○	○ 5		53	24		(23)
						9	323							
		SS	11	100	88/28			88 ○ 28	○ 9					
						10	322							
		SS	12	57	50/3			50 ○ 3	○ 9					
						11	321							
									✳ 23					
	320.0													
	Beige 12.0 **Dolostone**	CORE	1	100		12	320				RQD=100%			
		CORE	2	100		13	319				RQD=92%			
	318.2													
	BOREHOLE TERMINATED 13.9													

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

Scale: 1 : 39

RECORD OF BOREHOLE No. 17-02

Project Number:	TB173002	Drilling Method:	200 mm Hollow Stem Augering/Rock Coring		
Project Client:	City of Guelph	Drilling Machine:	Track Mounted Drill		
Project Name:	Slope Stability Assessment	Date Started:	31 Mar 17	Date Completed:	31 Mar 17
Project Location:	Speedvale Bridge Underpass and Multi-Use Trail Linkage	Logged by:	HP	Compiled by:	TH
Drilling Location:	4823225N; 559056E	Reviewed by:	TR	Revision No.:	0, 8/5/17

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LITHOLOGY PROFILE

Geodetic Ground Surface Elevation: 332.3 m

DESCRIPTION	Elevation	Depth
PAVEMENT STRUCTURE	332.2	0.1
100 mm **Asphalt**		
460mm **Granular Base**		
75mm **Buried Asphalt**	331.7	0.6
Dark Brown Sandy Silt **FILL** trace gravel and rootlets compact moist	331.4	0.9
Light Brown **Sandy Gravel** trace silt dense to compact moist		
Brown **Silty Sand** some gravel, occasional cobble dense moist	326.3	5.9

SOIL SAMPLING

Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
SS	1	67	13
SS	2	67	34
SS	3	33	32
SS	4	44	31
SS	5	56	40
SS	6	67	43
SS	7	67	19
SS	8	22	19
SS	9	67	38

DEPTH (m): 1, 2, 3, 4, 5, 6, 7

ELEVATION (m): 332, 331, 330, 329, 328, 327, 326

FIELD TESTING

Penetration Testing: ○ SPT ● DCPT

MTO Vane*: △ Intact ▲ Remould

Nilcon Vane*: ◇ Intact ◆ Remould

* Undrained Shear Strength (kPa) 20 40 60 80

LAB TESTING

△ Combustible Organic Vapour (ppm)
▲ Combustible Organic Vapour (%LEL)
★ Total Organic Vapour (ppm) 100 200 300 400

Atterberg Limits: W_P W W_L; Plastic Liquid

○ Water Content (%) 20 40 60 80

Sample Number	Water Content (%)
1	20
2	3
3	4
4	4
5	4
6	3
7	4
8	3
9	12
	6

INSTRUMENTATION INSTALLATION

COMMENTS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
59	35		(6)

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Groundwater depth encountered on completion of drilling: 7.6 m.

Cave in depth after removal of augers: 2.7 m.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

Scale: 1 : 39

Continued on Next Page

RECORD OF BOREHOLE No. 17-02

Project Number:	TB173002	Drilling Method:	200 mm Hollow Stem Augering/Rock Coring		
Project Client:	City of Guelph	Drilling Machine:	Track Mounted Drill		
Project Name:	Slope Stability Assessment	Date Started:	31 Mar 17	Date Completed:	31 Mar 17
Project Location:	Speedvale Bridge Underpass and Multi-Use Trail Linkage	Logged by:	HP	Compiled by:	TH
Drilling Location:	4823225N; 559056E	Reviewed by:	TR	Revision No.:	0, 8/5/17

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LITHOLOGY PROFILE			SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)
Lithology Plot	DESCRIPTION		Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	PenetrationTesting ○ SPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	△ Combustible Organic Vapour (ppm) ▲ Combustible Organic Vapour (%LEL) ★ Total Organic Vapour (ppm) 100 200 300 400; Atterberg Limits W_P W W_L Plastic Liquid; ○ Water Content (%) 20 40 60 80	INSTRUMENTATION INSTALLATION	GR SA SI CL
		325.2										
	Grey **Sandy Silt** trace clay dense moist	7.1						325				
			SS	10	100	48	8		○	○ 13		
		323.8						324				
	Brown **Fine Sand** trace silt and gravel very dense wet	8.5					9					
			SS	11	100	81		323	○	○ 32		
		322.1					10					
	Beige **Dolostone**	10.2	CORE	1	100			322				RQD=86%
			CORE	2	100		11	321				RQD=97%
							12					
			CORE	3	100		13	320				RQD=94%
		318.9						319				
	BOREHOLE TERMINATED	13.4										

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

Scale: 1 : 39

RECORD OF BOREHOLE No. 17-03

Project Number:	TB173002	Drilling Method:	200 mm Hollow Stem Augering		
Project Client:	City of Guelph	Drilling Machine:	Track Mounted Drill		
Project Name:	Slope Stability Assessment	Date Started:	29 Mar 17	Date Completed:	29 Mar 17
Project Location:	Speedvale Bridge Underpass and Multi-Use Trail Linkage	Logged by:	HP	Compiled by:	TH
Drilling Location:	4823197N; 559157E	Reviewed by:	TR	Revision No.:	0, 8/5/17

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LITHOLOGY PROFILE / SOIL SAMPLING

Geodetic Ground Surface Elevation: 330.5 m

Description	Elevation (m)	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
200mm TOPSOIL	330.3				
Dark Brown Sand **FILL** trace gravel medium grain DTPL	329.5	SS	1	83	17
Dark Brown Silty Sand **FILL** trace gravel, organics, and rootlets very loose to loose moist	327.3	SS	2	50	2
		SS	3	67	4
		SS	4	67	5
Brown **Sand** some silt and gravel loose moist	326.8	SS	5	78	8
Brown **Sand and Gravel** some silt dense to very dense moist	325.3	SS	6	67	48
		SS	7	67	51
Brown **Gravely Sand and Silt** dense moist	324.5	SS	8	89	40
Brown **Sand** some gravel and silt, occasional cobble very dense moist		SS	9	78	51

FIELD TESTING

Penetration Testing: ○ SPT ● DCPT

MTO Vane*: △ Intact ▲ Remould

Nilcon Vane*: ◇ Intact ◆ Remould

* Undrained Shear Strength (kPa) 20 40 60 80

LAB TESTING

△ Combustible Organic Vapour (ppm)
▲ Combustible Organic Vapour (%LEL)
★ Total Organic Vapour (ppm) 100 200 300 400

Atterberg Limits: W_P W W_L; Plastic Liquid

○ Water Content (%) 20 40 60 80

INSTRUMENTATION INSTALLATION

COMMENTS & GRAIN SIZE DISTRIBUTION (%)

Sample Number	GR	SA	SI	CL
1				
2				
3				
4				
5				
6				
7				
8	22	43	(36)	
9				

Groundwater depth encountered on completion of drilling: 8.5 m.

Groundwater depth observed on 26/04/2017 at a depth of: 2.2 m.

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

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Scale: 1 : 39

Continued on Next Page

RECORD OF BOREHOLE No. 17-03

Project Number:	TB173002	Drilling Method:	200 mm Hollow Stem Augering		
Project Client:	City of Guelph	Drilling Machine:	Track Mounted Drill		
Project Name:	Slope Stability Assessment	Date Started:	29 Mar 17	Date Completed:	29 Mar 17
Project Location:	Speedvale Bridge Underpass and Multi-Use Trail Linkage	Logged by:	HP	Compiled by:	TH
Drilling Location:	4823197N; 559157E	Reviewed by:	TR	Revision No.:	0, 8/5/17

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LITHOLOGY PROFILE		SOIL SAMPLING						FIELD TESTING	LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	PenetrationTesting ○ SPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; * Undrained Shear Strength (kPa) 20 40 60 80	△ Combustible Organic Vapour (ppm) ▲ Combustible Organic Vapour (%LEL) ★ Total Organic Vapour (ppm) 100 200 300 400; Atterberg Limits W_P W W_L Plastic Liquid; ○ Water Content (%) 20 40 60 80	INSTRUMENTATION INSTALLATION	GR SA SI CL
	Brown **Sand** some gravel and silt, occasional cobble very dense moist						323				
		SS	10	67	50/8			50 8	3		
						8					
							322				
						9			36		
	321.3	SS	11	100	50/5			50 5	11		
	BOREHOLE TERMINATED 9.2 On Infered Bedrock										

Borehole details as presented, do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying'Explanation of Borehole Log'.

Scale: 1 : 39

APPENDIX C

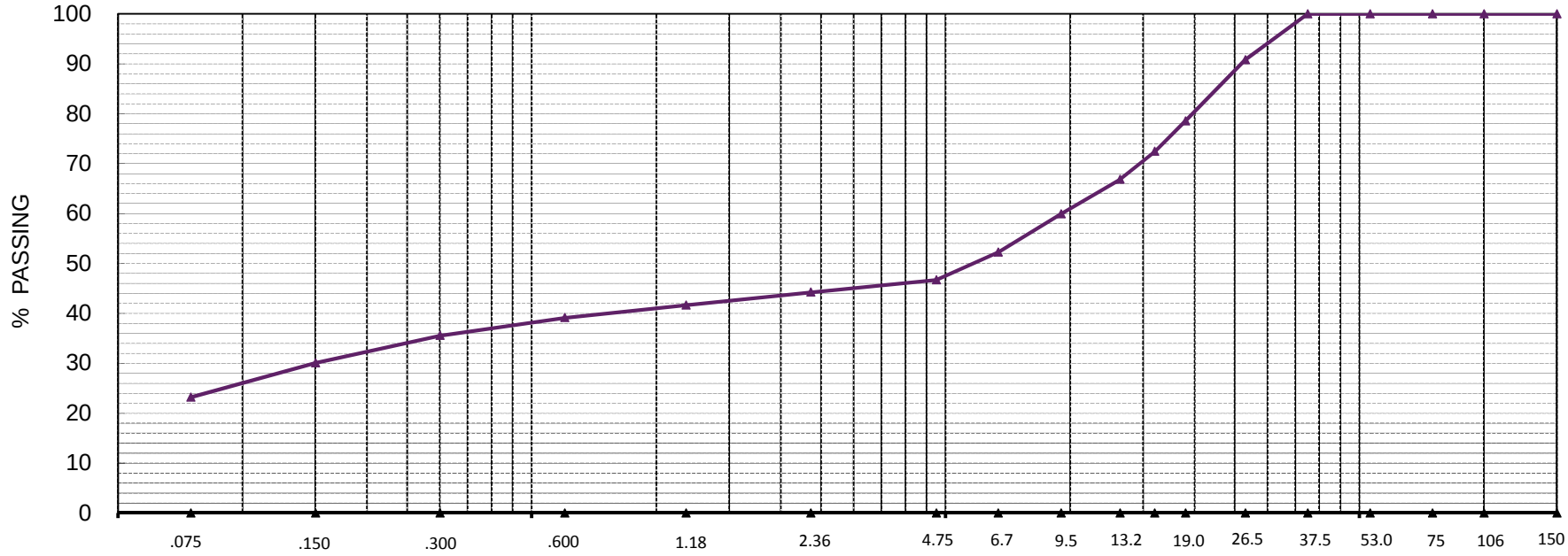
MATERIAL FINER THAN 75µm BY WASHING AND SIEVE ANALYSIS OF AGGREGATES
MTO LS-601 & LS-602

Project No.:	TB173002.1000		
Client:	City of Guelph	**Lab No:**	17120
Project:	Speedvale Slope	**Date Sampled:**	30 March 2017
Sample Source:	BH 17-01 SS10	**Sampled by:**	Herman P
Sample Type:	Silty Sandy Gravel	**Date Received:**	30 March 2017
Specification:	0	**Date Tested:**	13 April 2017
	0		

Crushed Particles: **Asphalt Coated Particles:** **Remarks:**

Specification: **Specification:**

SIEVE SIZES (mm)	150	106	75.0	53.0	37.5	26.5	19.0	16.0	13.2	9.5	6.7	4.75	2.36	1.18	0.600	0.300	0.150	0.075
SPECIFICATIONS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% PASSING	100.0	100.0	100.0	100.0	100.0	90.8	78.5	72.4	66.8	59.9	52.3	46.7	44.2	41.6	39.1	35.5	30.1	23.2



Sample Gradation
Lower Specification Limit
Upper Specification Limit
sieve designations

Enclosure: 1

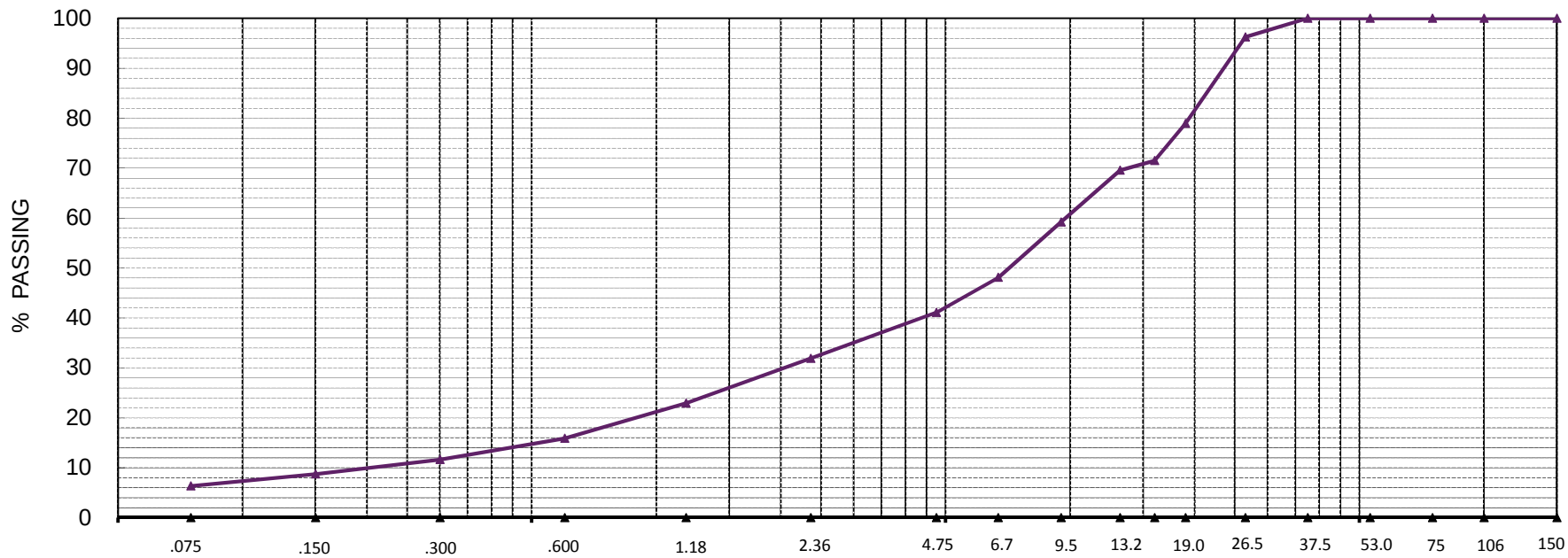
MATERIAL FINER THAN 75µm BY WASHING AND SIEVE ANALYSIS OF AGGREGATES
MTO LS-601 & LS-602

Project No.:	TB173002.1000		
Client:	City of Guelph	**Lab No:**	17121
Project:	Speedvale Slope	**Date Sampled:**	30 March 2017
Sample Source:	BH 17-02 SS5	**Sampled by:**	Herman P
Sample Type:	Sandy Gravel trace Silt	**Date Received:**	30 March 2017
Specification:	0	**Date Tested:**	13 April 2017
	0		

Crushed Particles: **Asphalt Coated Particles:** **Remarks:**

Specification: **Specification:**

SIEVE SIZES (mm)	150	106	75.0	53.0	37.5	26.5	19.0	16.0	13.2	9.5	6.7	4.75	2.36	1.18	0.600	0.300	0.150	0.075
SPECIFICATIONS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% PASSING	100.0	100.0	100.0	100.0	100.0	96.2	78.9	71.5	69.5	59.2	48.1	41.1	31.9	22.9	15.9	11.6	8.7	6.3



Sample Gradation
Lower Specification Limit
Upper Specification Limit
sieve designations

Enclosure: 1

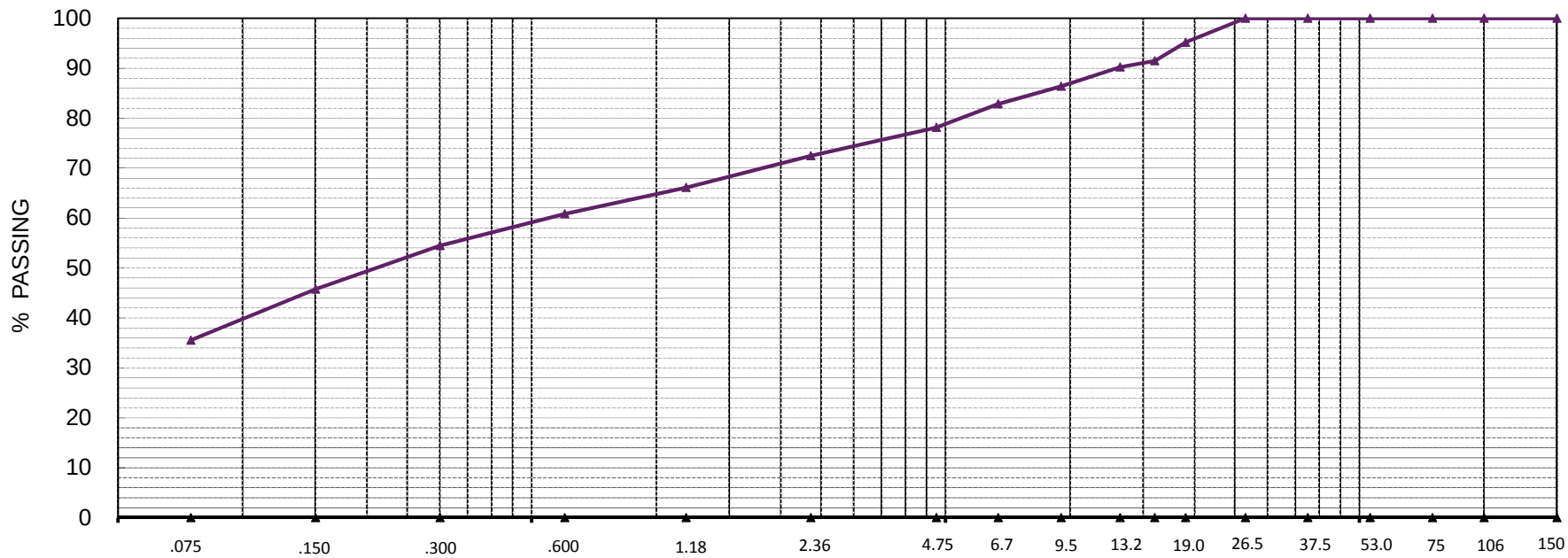
MATERIAL FINER THAN 75µm BY WASHING AND SIEVE ANALYSIS OF AGGREGATES
MTO LS-601 & LS-602

Project No.:	TB173002.1000		
Client:	City of Guelph	**Lab No:**	17122
Project:	Speedvale Slope	**Date Sampled:**	30 March 2017
Sample Source:	BH 17-03 SS8	**Sampled by:**	Herman P
Sample Type:	Gravely Sand and Silt	**Date Received:**	30 March 2017
Specification:	0	**Date Tested:**	13 April 2017
	0		

Crushed Particles: **Asphalt Coated Particles:** **Remarks:**

Specification: **Specification:**

SIEVE SIZES (mm)	150	106	75.0	53.0	37.5	26.5	19.0	16.0	13.2	9.5	6.7	4.75	2.36	1.18	0.600	0.300	0.150	0.075
SPECIFICATIONS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% PASSING	100.0	100.0	100.0	100.0	100.0	100.0	95.2	91.5	90.2	86.4	82.9	78.1	72.5	66.1	60.8	54.5	45.7	35.5



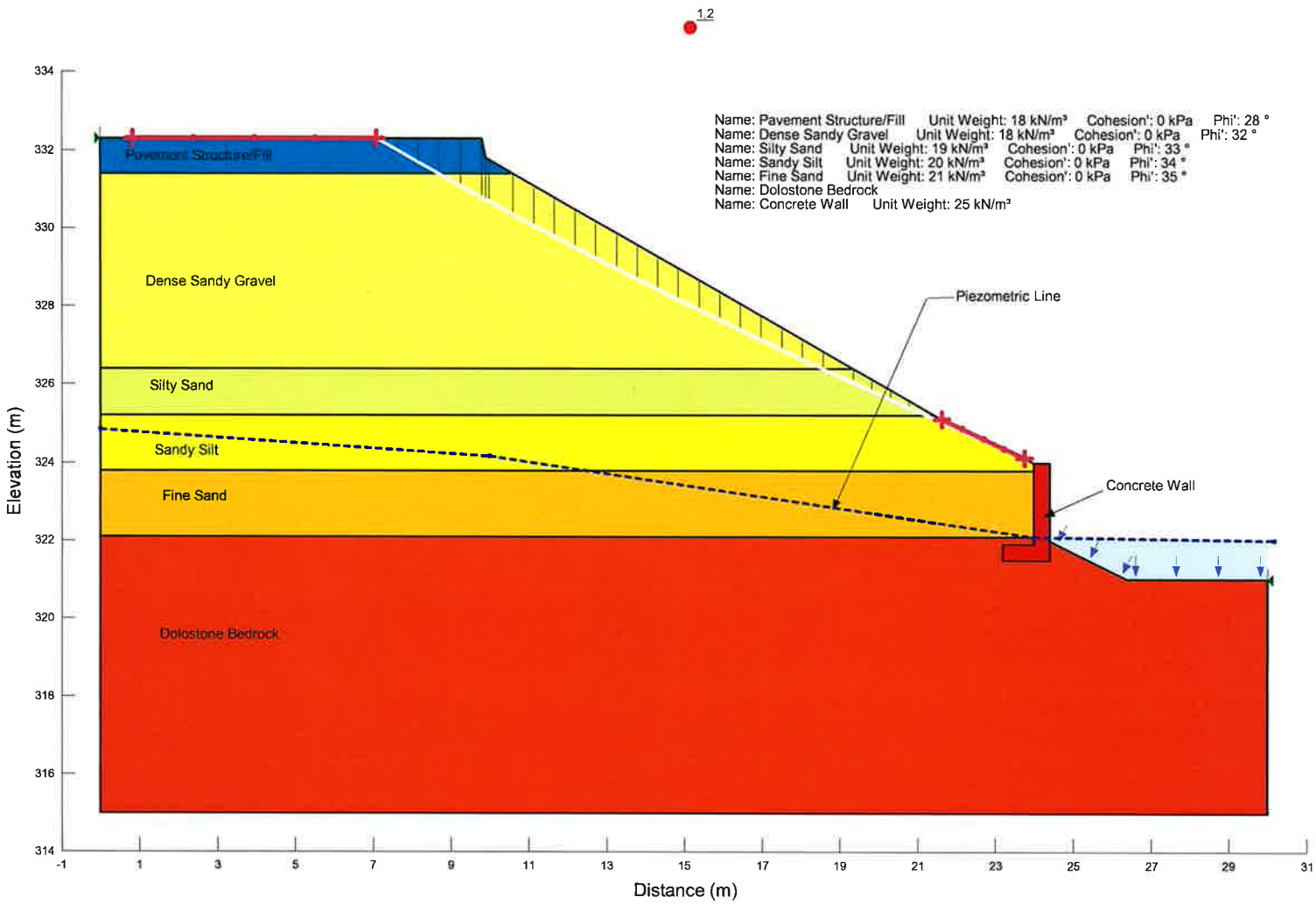
Sample Gradation
Lower Specification Limit
Upper Specification Limit
sieve designations

Enclosure: 1

APPENDIX D

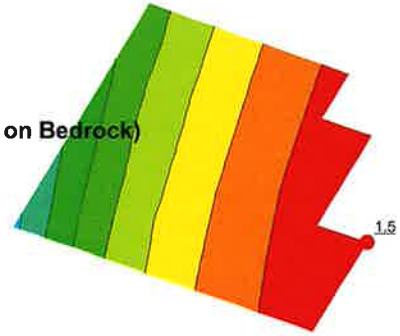
TB173002 - SPEEDVALE TRAIL SLOPE STABILITY
GUELPH, ONTARIO
SECTION C-C' - EXISTING PROFILE
(Morgenstern-Price Method)
(Shallow Slip Surface)

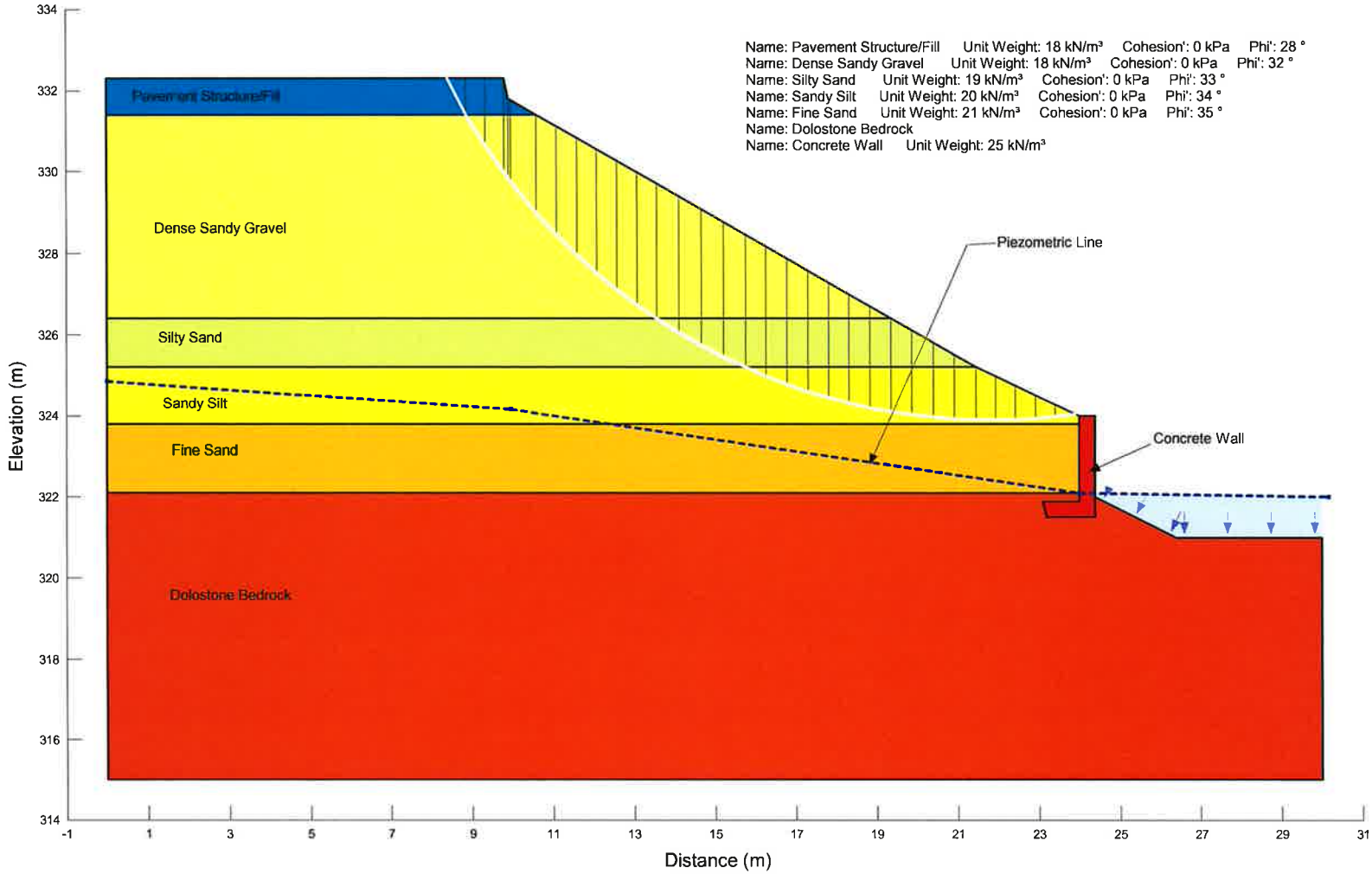
FIGURE - 3



TB173002 - SPEEDVALE TRAIL SLOPE STABILITY
GUELPH, ONTARIO
SECTION C-C' - EXISTING PROFILE
(Morgenstern-Price Method)
(Deep-seated Slip Surface Assuming Existing Wall is founded on Bedrock)

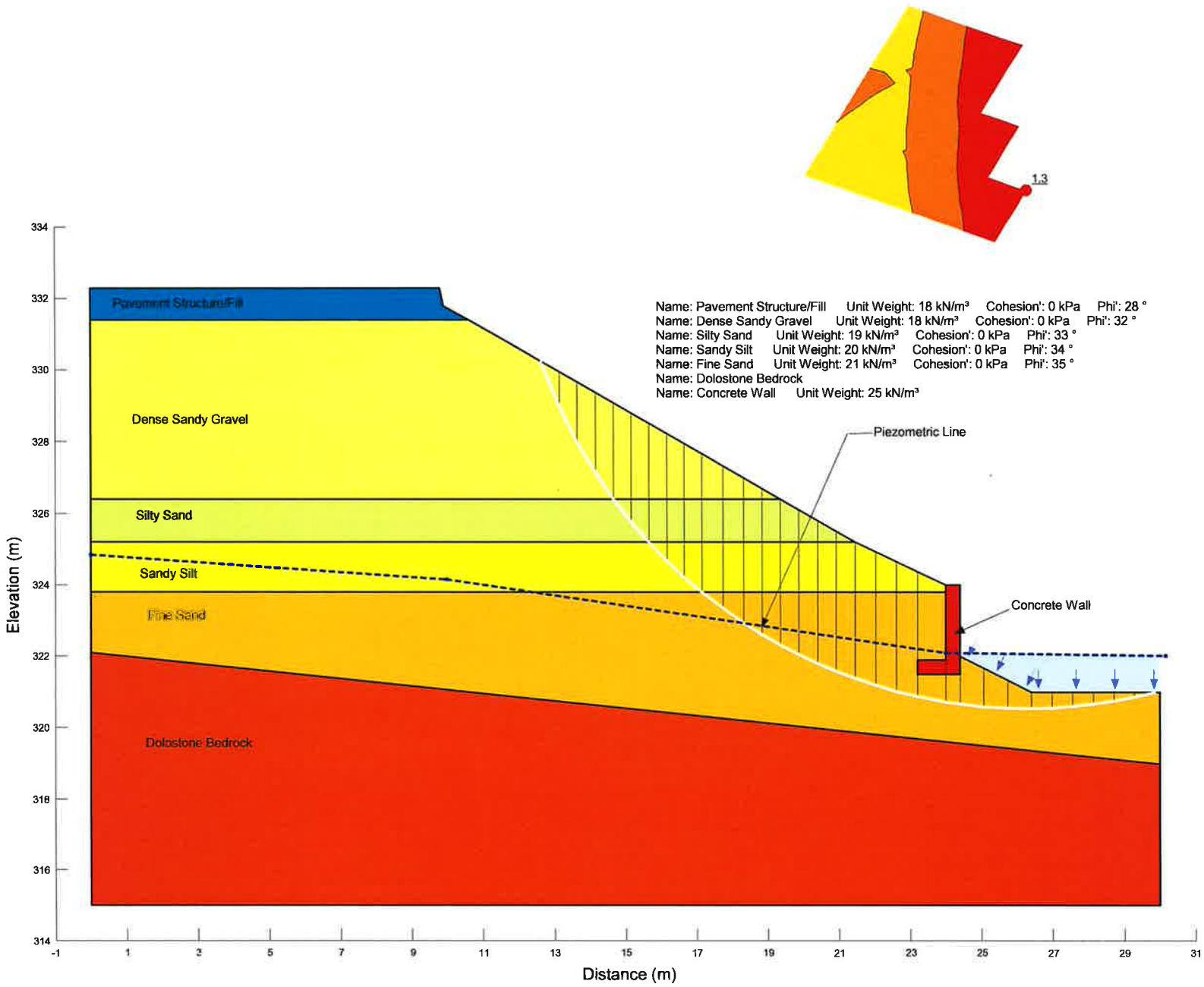
FIGURE - 4





TB173002 - SPEEDVALE TRAIL SLOPE STABILITY
GUELPH, ONTARIO
SECTION C-C' - EXISTING PROFILE
(Morgenstern-Price Method)
(Deep-Seated Failure Surface Assuming Existing Wall is founded on Soil)

FIGURE - 5



TB173002 - SPEEDVALE TRAIL SLOPE STABILITY
GUELPH, ONTARIO
SECTION C-C' - PROPOSED PROFILE
(Morgenstern-Price Method)
(Stability for Temporary Cut to Build Upper Retaining Wall)
(Assuming Existing Wall is Founded on Bedrock)

FIGURE - 6

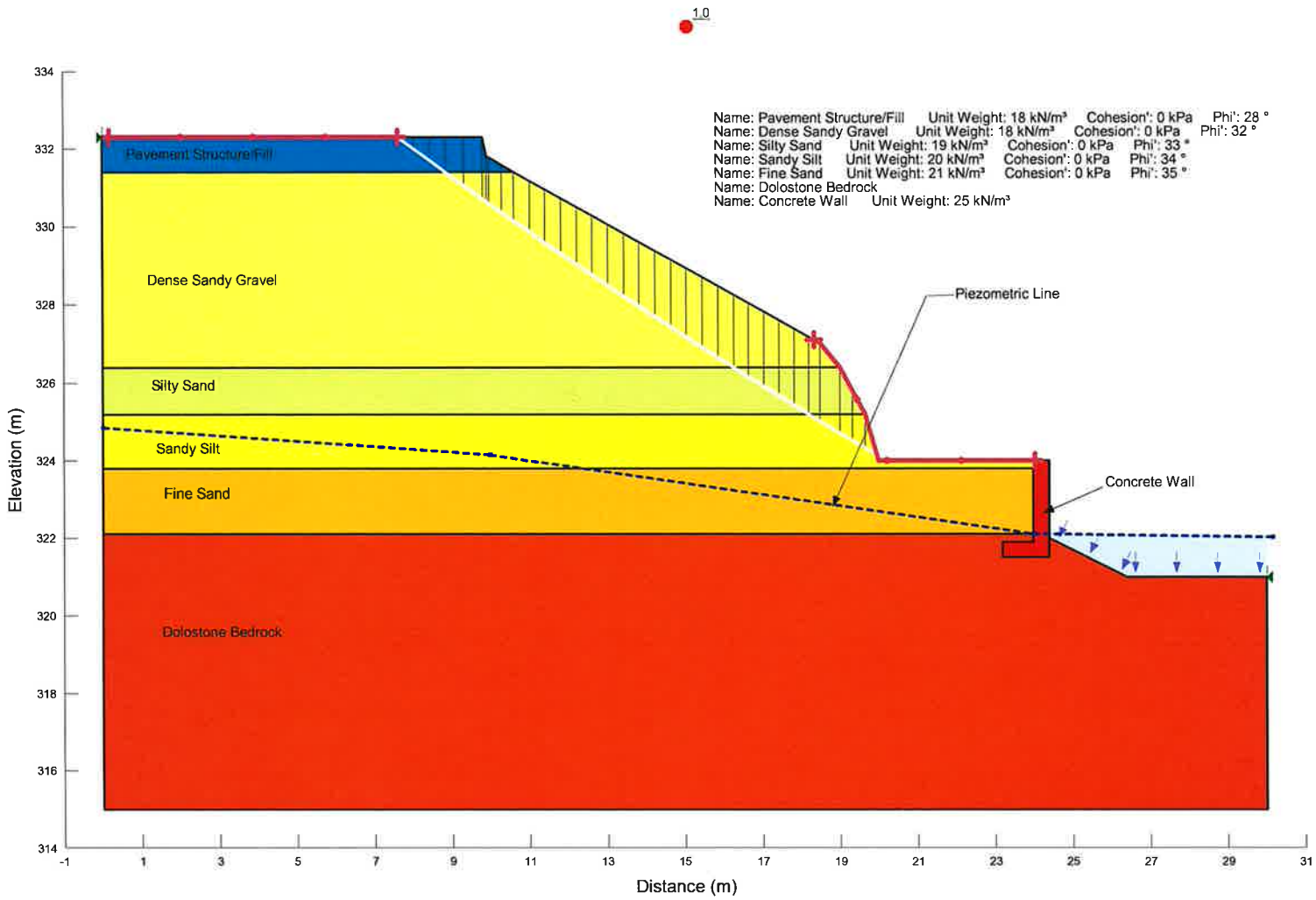


TABLE 4.1 - Slope Inspection Record

1. FILE NAME / NO. TB173002 Speedvale Slope Stability

INSPECTION DATE (DDMMYY): 26/04/17

WEATHER (circle):

• sunny • partly cloudy • cloudy
• calm • breeze • windy
• clear • fog • rain • snow
• cold • cool • warm • hot

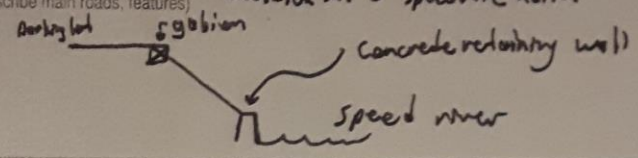
estimated air temperature: 19°C

INSPECTED BY (name): Tyler Reaume / Mike Patterson

2. SITE LOCATION (describe main roads, features) Woolwich St. & Speedvale Rd. N.

Slope approx. 1.75:1

SKETCH



3. WATERSHED Speed River

4. PROPERTY OWNERSHIP (name, address, phone): City of Guelph

LEGAL DESCRIPTION
Lot
Concession
Township
County

CURRENT LAND USE (circle and describe)

• vacant -field, bush, woods, forest, wilderness, tundra,

• passive -recreational parks, golf courses, non-habitable structures, buried utilities, swimming pools,

• active -habitable structures, residential, commercial, industrial, warehousing and storage,

• infra-structure or public use - stadiums, hospitals, schools, bridges, high voltage power lines, waste management sites,

5. SLOPE DATA

HEIGHT • 3 - 6 m • 6 - 10 m • 10 - 15 m • 15 - 20 m
• 20 - 25 m • 25 - 30 m • > 30 m

estimated height (m):

INCLINATION AND SHAPE

• 4:1 or flatter 25 % 14°	• up to 3:1 33 % 18°	• up to 2:1 50 % 26°
• up to 1:1 100 % 45°	• up to :1 200 % 63°	• steeper than :1 > 63°

6. SLOPE DRAINAGE (describe)

TOP

FACE

BOTTOM

7. SLOPE SOIL STRATIGRAPHY (describe, positions, thicknesses, types) see BH Logs sand & gravel

TOP

FACE

BOTTOM

8. WATER COURSE FEATURES (circle and describe)

SWALE, CHANNEL

GULLY

STREAM, CREEK, (RIVER) speed river @ ~~base~~ toe of slope, river bank is concrete retaining wall

POND, BAY, LAKE

SPRINGS

MARSHY GROUND

9. VEGETATION COVER(grasses, weeds, shrubs, saplings, trees)

TOP manicured grass & asphalt

FACE Mature trees

BOTTOM - River

10. STRUCTURES(buildings, walls, fences, sewers, roads, stairs, decks, towers,)

TOP garage single car, parking lot, apartment building

FACE None

BOTTOM retaining wall, poured concrete

11. EROSION FEATURES(scour, undercutting, bare areas, piping, rills, gully)

TOP none

FACE none

BOTTOM none

12. SLOPE SLIDE FEATURES(tension cracks, scarps, slumps, bulges, grabens, ridges, bent trees)

TOP none

FACE none

BOTTOM none

13. PLAN SKETCH OF SLOPE

14. PROFILE SKETCH OF SLOPE

TABLE 4.2 - SLOPE STABILITY RATING CHART

Site Location: Woolwich St./Speedvale
Property Owner: City of Guelph
Inspected By: TR/MP

File No. TB17J002
Inspection Date: 26/04/2017
Weather: Overcast 19°C

1. SLOPE INCLINATION		
degrees	**horiz. : vert.**	
a) 18 or less	3 : 1 or flatter	0
b) 18 - 26	2 : 1 to more than 3 : 1	6
c) more than 26	steeper than 2 : 1	16
2. SOIL STRATIGRAPHY		
a) Shale, Limestone, Granite (Bedrock)		0
b) Sand, Gravel		6
c) Glacial Till		9
d) Clay, Silt		12
e) Fill		16
f) Leda Clay		24
3. SEEPAGE FROM SLOPE FACE		
a) None or Near bottom only		0
b) Near mid-slope only		6
c) Near crest only or. From several levels		12
4. SLOPE HEIGHT		
a) 2 m or less		0
b) 2.1 to 5 m		2
c) 5.1 to 10 m		4
d) more than 10 m		8
5. VEGETATION COVER ON SLOPE FACE		
a) Well vegetated; heavy shrubs or forested with mature trees		0
b) Light vegetation; Mostly grass, weeds, occasional trees, shrubs		4
c) No vegetation, bare		8
6. TABLE LAND DRAINAGE		
a) Table land flat, no apparent drainage over slope		0
b) Minor drainage over slope, no active erosion		2
c) Drainage over slope, active erosion, gullies		4
7. PROXIMITY OF WATERCOURSE TO SLOPE TOE		
a) 15 metres or more from slope toe		0
b) Less than 15 metres from slope toe		6
8. PREVIOUS LANDSLIDE ACTIVITY		
a) No		0
b) Yes		6
SLOPE INSTABILITY RATING VALUES INVESTIGATION RATING SUMMARY		**TOTAL** 38

APPENDIX E

REPORT LIMITATIONS

REPORT LIMITATIONS

The conclusions and recommendations given in this report are based on information determined at the test hole locations. The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Geotechnical Engineer be retained during the construction to confirm that the subsurface conditions across the site do not deviate materially from those encountered in the test holes.

The design recommendations given in this report are applicable only to the project described in the text, and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, Amec Foster Wheeler Environment & Infrastructure recommends that we be retained during the final design stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

The comments made in this report relating to potential construction problems and possible methods of construction are intended only for the guidance of the designer. The number of test holes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

The benchmark and elevations mentioned in this report were obtained strictly for use by this office in the geotechnical design of the project. They should not be used by any other party for any other purpose.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Amec Foster Wheeler Environment & Infrastructure accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.