350 St. Andrew Street West

Functional Servicing & Stormwater Management Report

Project Location:
350 St. Andrew Street West, Fergus, ON

Prepared for:
Van Grootheest Holdings Inc.
645 St. David St. N., Fergus ON

Prepared by:
MTE Consultants Inc.
520 Bingemans Centre Drive
Kitchener, ON N2B 3X9

June 18, 2021
Revised: November 24, 2021

MTE File No.: 48790-100

Engineers, Scientists, Surveyors.

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1.0 Introduction

MTE Consultants Inc. was retained by Van Grootheest Holdings Inc. to complete a Functional Servicing and Stormwater Management Report for a new mixed-use development to be constructed at 350 St. Andrew Street West (herein referred to as ‘the Site’) in the Township of Centre Wellington in support of the Zoning By-Law Amendment and Site Plan Approval Applications. The current zoning of the site is C1. The proposed zoning will remain C1. However, since five stories is not permitted under the current zoning, a Zoning By-Law Amendment Application is required.

The property is bounded to the north by the existing Melville United Church, to the west by St. Andrew Street West, to the south by an existing commercial development, and to the east by the Grand River. The existing driveway access is shared with the church and is located within an easement on the church’s property. The Site is located within a Grand River Conservation Authority regulated area and is partially within the floodplain limit. For the exact location of the Site, refer to the key plan on the enclosed engineering MTE Drawings C1.1, C2.1 and C2.3.

The proposed development for the Site is the demolition of the existing building and construction of a five storey commercial and residential building complete with underground and surface parking at the basement level. The existing driveway access will remain.

The purpose of this study is to support the Zoning By-Law Amendment and Site Plan Approval Applications. This will be accomplished by reviewing the opportunities and constraints for the subject property with respect to servicing, grading, and stormwater management; reviewing the requirements of the reviewing agencies; describing the development concept; and demonstrating the functional serviceability of the property. The Zoning By-Law Amendment Application and Site Plan Approval Application will be submitted concurrently. Detailed design of the Site has commenced.

2.0 Existing Conditions

2.1 Existing Topography

The Site encompasses an area of 0.115 ha and currently comprises of an existing building with asphalt and gravel parking lot. In the existing condition, surface runoff from the Site drains from west to east. There is an elevation difference of approximately 4.0 metres between the west property line to the top of the embankment at the Grand River at the east end of the property. There are existing retaining walls along the north and south sides of the property. There is an existing embankment inside the east property line draining towards the Grand River. The Site is approximately 51% impervious in the existing condition.

2.2 Existing Servicing

2.2.1 Water

There is an existing 200 mm diameter municipal watermain along St. Andrew Street West. The closest municipal fire hydrant is located approximately 60 m south of the Site. All existing water services will be decommissioned and capped at the municipal watermain as part of the redevelopment of the Site.

2.2.2 Sanitary

There is an existing 525 mm diameter sanitary sewer along St. Andrew Street West which drains toward the north. The closest manhole is located approximately 65 m south of the Site and is approximately 3 metres deep. All existing sanitary connections will be capped at the property line as part of the redevelopment of the Site.

2.2.3 Storm

There is an existing 450 mm diameter storm sewer along St. Andrew Street West that drains towards the south. The closest existing manhole is located in front of the Site and is approximately 2.2 metres deep. Surface runoff from a majority of the Site is conveyed overland to the east of the Site where it enters the Grand River.

2.3 Existing Soils Information

Six boreholes were advanced by CMT Engineering Inc. as part of the Geotechnical Investigation and Slope Stability Assessment, dated April 2021, in order to determine the underlying soil conditions on the Site. Refer to Appendix A for the report. The subsurface stratigraphy is generally comprised of topsoil overlying a layer of gravelly fill with trace to some silt and sand, some organics and clay. Presumed bedrock was encountered at depths ranging from approximately 0.79 m to 2.37 m.

Accumulated groundwater, seepage or saturated soils were not observed in any of the boreholes.

2.4 Reviewing Agencies

Grading, servicing and stormwater management designs as well as this Functional Servicing and Stormwater Management Report will be required for submission to the Township of Centre Wellington in support of the Zoning By-Law Amendment and the Site Plan Application. The Township will also be responsible for the review and approval of site plans, lighting and landscape design and ultimately issuing building permits.

As the Site falls within the Grand River Conservation Authority (GRCA) Regulation limit, the site engineering design will also be submitted to the GRCA for their review and approval. A ‘Fill Permit’ will be required.

3.0 Proposed Grading and Servicing Strategy

Grading and servicing plans for the proposed development have been developed based on the topographic survey, plan and profile information, and Site Plan prepared by Fryett Turner Architects, dated June 2021. Refer to the separately appended MTE Drawings C2.1 and C2.2 for details.

3.1 Proposed Grading

The proposed development will have a mixed use building with underground and surface parking at the basement level, complete with shared driveway access from an easement on the adjacent property to the north. The proposed grading strategy will respect the existing grades along the west, south and east property lines. Part of the shared driveway to the north of the Site and the portion between the north property line and the church's existing retaining wall will require regrading. A ramp is required at the proposed building fronting St. Andrew Street West to ensure that the basement finished floor elevation is higher than the overland flow route to the Grand River. Based on GRCA aerial mapping, the regulatory floodline falls just inside of the eastern property line. The elevation of the regulatory floodline has yet to be confirmed by the GRCA. The basement finished floor elevation has been set roughly 0.8 m above the assumed floodplain elevation based on aerial mapping.

3.2 Proposed Servicing

3.2.1 Water

A new connection to the existing 200 mm diameter municipal watermain along St. Andrew Street West will be required in order to service the proposed building. The required private water service size will be determined in detailed design of the building, but will likely be 150 mm diameter. The water service will run approximately 3 metres from the south property line. The proposed building will be sprinklered with the fire department connection located at the front of the building. It is anticipated that a new municipal hydrant will be required to service the proposed building. The new municipal hydrant is proposed to be located across the street, similar to the existing municipal hydrants.

Detailed water demand calculations were completed for the proposed building and are included in Appendix B. The maximum day domestic demand for the Site was determined to be 0.94 L/s.

The pressures and flows must also be sufficient for firefighting conditions as established by the Ontario Building Code (2012). The minimum residual pressure permitted under fire fighting conditions is 140.0 kPa (20.3 psi) per OBC 2012 A-3.2.5.7 3(b).

The building was analyzed for fire water supply requirements using the OBC 2012 and FUS. It was determined the required minimum water supply flow rate for the proposed building is 9,000 litres/min and 8,000 litres/min based on OBC and FUS requirements, respectively. If required, a fire flow analysis can be completed to ensure that adequate flow and pressure will be available at the proposed municipal hydrant.

As mentioned, the proposed building with have a sprinkler system. Section A-3.2.5.7.2 of the OBC relates to water supply for firefighting in sprinklered buildings.

For sprinklered buildings, water supply additional to that required by the sprinkler systems should be provided for firefighting using fire hoses in accordance with the hose stream demands and water supply durations for different hazard classifications as specified in National Fire Protection Association’s (NFPA) NFPA 13, “Standard for the Installation of Sprinkler Systems”.

The Site specific system demand for the proposed sprinkler system is not known at this time; however, it is expected that the sprinkler system demand will be significantly less than the OBC demand of 9,000 L/min. Therefore, the proposed hydrant will likely be able to provide the required demand. The actual sprinkler system demand will be provided by a qualified fire suppression contractor during detailed design.

3.2.2 Sanitary

A sanitary flow design sheet has been prepared to determine the flows anticipated to be generated by the proposed development. The sanitary flow generation rate for a commercial property is 1.16 L/s/ha. Based on the site area, the peak commercial flow rate for the Site is 0.33 L/s. The residential sanitary flow generation rate is 0.004 L/s/person. With the proposed building having 36 units, the resulting cumulative peak flow is expected to be 1.50 L/s from the Site, including infiltration.

It is proposed that the Site will serviced by a new 150 mm diameter sanitary sewer connected to the existing 525 mm municipal sanitary sewer on St. Andrew Street West with an obvert to obvert connection and no manhole. The 150 mm diameter sanitary sewer will enter the Site approximately 4 metres from the south property line. The private sanitary sewer is to be installed at a slope of 2.0% with a capacity of 21.5 L/s. Therefore, the proposed sanitary service connection has adequate capacity to convey the flow from the proposed development. Refer to the sanitary sewer design sheet in Appendix C for details.

3.2.3 Storm

A private storm sewer system will be installed on-site to collect rooftop runoff from the building and runoff from the driveway and parking area. The runoff collected in the storm sewers will be directed to the OGS unit located in the surface parking lot and on to a headwall that outlets to the Grand River. Runoff from the frontage of the property will flow towards the St. Andrew Street West right-of-way. No connection to the municipal storm network along St. Andrew Street West is proposed for the Site.

The private storm sewer system will be partially installed within the weathered bedrock and possible bedrock. Refer to the Geotechnical Investigation and Slope Stability Assessment prepared by CMT Engineering dated April 2021 for recommendations.

The private storm sewer system will be serviced by a new 300 mm diameter storm sewer at 2.6% slope with a capacity of 155.9 L/s, which will outlet to the Grand River. During the 5 year storm event and 100 year storm event, the pipe discharging to the Grand River will convey a stormwater flow rate of 35 L/s and 66 L/s, respectively. The proposed storm service connection has adequate capacity to convey the 100 year flow from the proposed development, assuming the outlet is not submerged. Refer to the storm sewer design sheets in Appendix D for details.

4.0 Stormwater Management Design

4.1 SWM Criteria

The stormwater management design criteria for the subject site, as established by the Township of Centre Wellington and the Grand River Conservation Authority (GRCA), are as follows:

i) Attenuation of the post-development peak flows are not required given the proximity and direct outlet to the Grand River;

ii) Quantification of pre- and post-development peak flows towards the Grand River;

iii) Mitigation of erosion and slope stability concerns from discharging directly to the Grand River; and,

iv) Implementation of water quality controls.

4.2 Water Quantity Control

In order to successfully quantify pre- and post-development flow rates towards the Grand River for this Site, the following specific tasks were undertaken:

i) Calculated the pre-development runoff rates using MIDUSS NET;

ii) Determined the percent impervious of the site and catchment parameters for inclusion in MIDUSS modelling; and,

iii) Calculated post-development runoff hydrographs using MIDUSS NET.

In order to mitigate the erosion and slope stability concerns from directly discharging to the Grand River, the private storm sewer system will be sized to convey the 100-year storm flows.

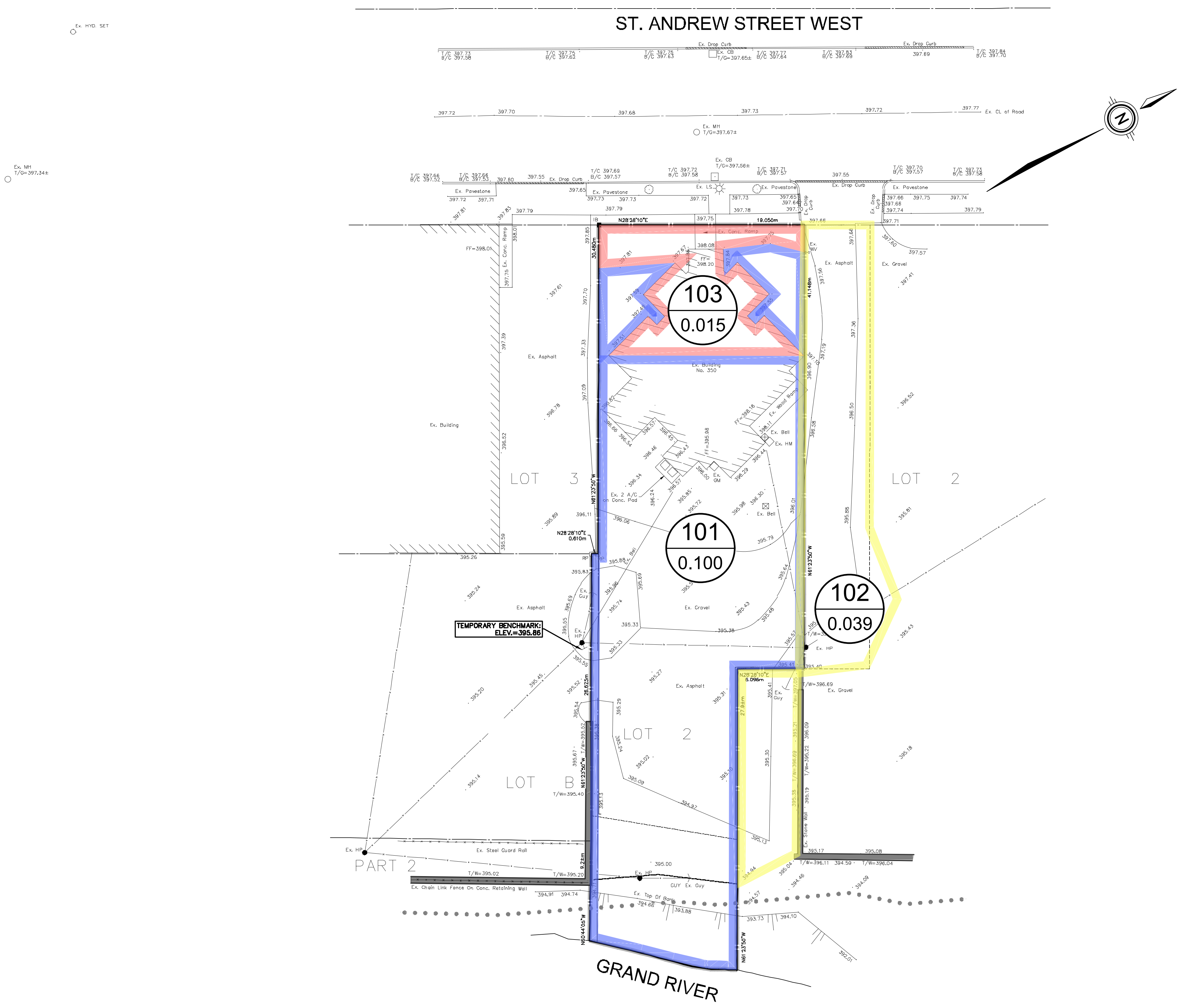
The following table summarizes the catchments used in the modelling of the Site. The pre-development condition was separated into three catchment areas: Site to the Grand River, external area to the Grand River, and Site to right-of-way. The post-development condition was separated into three catchment areas: captured area to OGS then to the Grand River, the uncontrolled area to the Grand River, and the uncontrolled area to the right-of-way. Figure 1.0 illustrates the limits of the pre-development catchment areas. Figure 2.0 illustrates the limits of the post-development catchment areas.

Table 4.1 - Catchment Parameters

#	Catchment	Area (ha)	% Impervious	Pervious CN	Impervious CN	Slope (%)	Flow Length (m)
Pre-Development Catchment Areas							
101	Site to Grand River	0.100	49.0	75	98	5.0	57.0
102	External area to Grand River	0.039	86.0	75	98	5.0	60.0
103	Site to ROW	0.015	68.0	75	98	2.0	12.0
Post-Development Catchment Areas							
201	To OGS to Grand River	0.136	86.0	75	98	5.0	55.0
202	To Grand River Uncontrolled	0.010	0.0	75	98	30.0	8.0
203	Uncontrolled to ROW	0.008	100.0	75	98	2.0	4.0

As mentioned, a geotechnical investigation was undertaken by CMT Engineering Inc. dated April, 2021. A complete copy of their report is included in Appendix A for the Township of Centre Wellington's records. The investigation revealed topsoil overlying a layer of gravelly fill with trace to some silt and sand, some organics and clay. Presumed bedrock was encountered at depths ranging from approximately 0.79 m to 2.37 m. Therefore, a pervious CN of 75 for grass areas is appropriate.

Accumulated groundwater, seepage or saturated soils were not observed in any of the boreholes.



LEGEND

▬ SITE BOUNDARY

+ 397.73 EXISTING ELEVATIONS

▬ EXISTING RETAINING WALL

(TOP) EXISTING EMBANKMENT

▨ EXISTING BUILDING

🟦 CATCHMENT 101

🟨 CATCHMENT 102

🟥 CATCHMENT 103

101 — SUB-CATCHMENT NUMBER

0.100 — AREA (ha.)

Figure 1.0

Date: JUNE.17/21
Scale: 1:400

PRE-DEVELOPMENT CATCHMENT AREAS

MTE
Engineers, Scientists, Surveyors

Project No.: 48790-100

June 3, 2021 — 5:18 p.m. — plotted by: sdicesare

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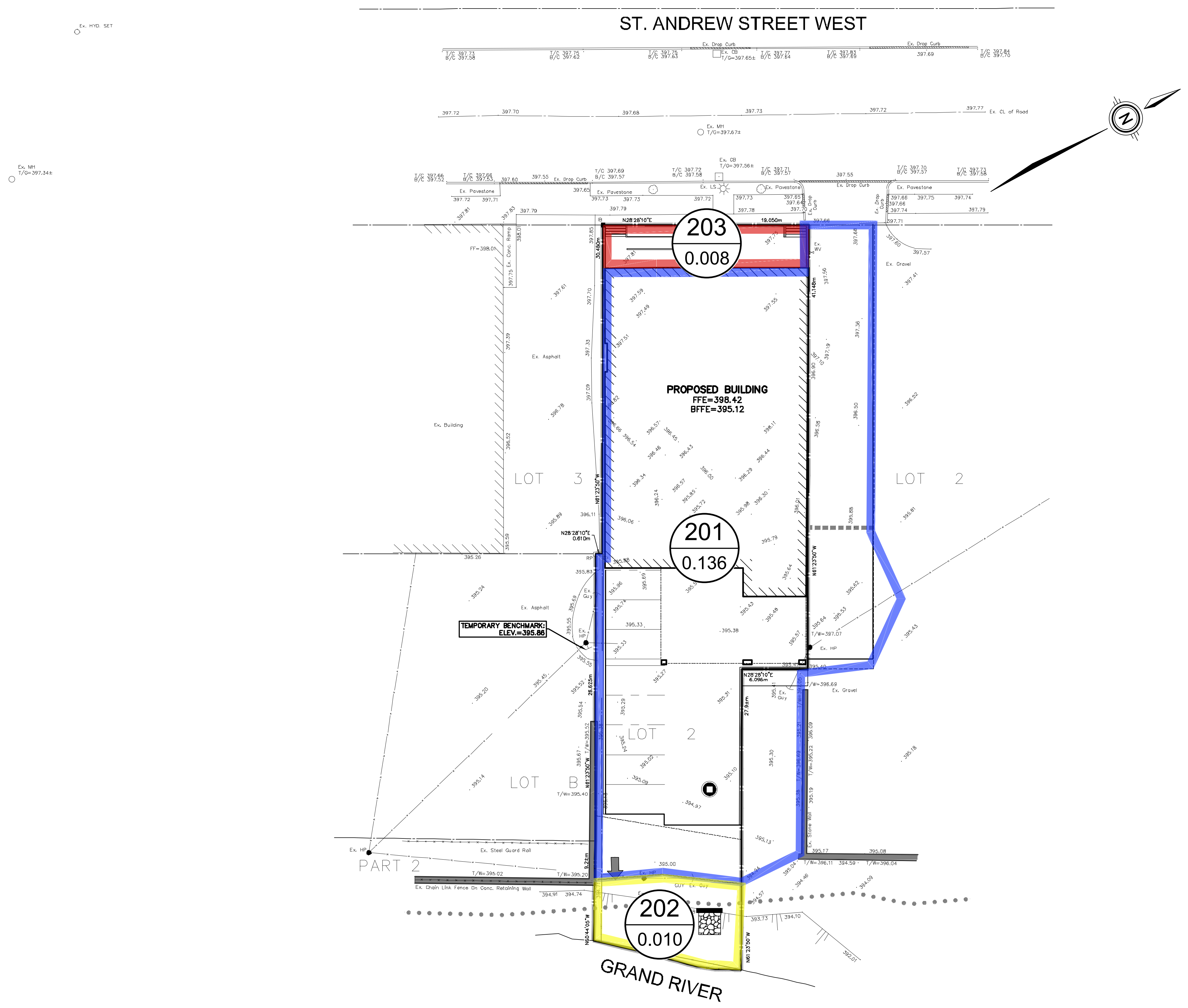

LEGEND

SITE BOUNDARY

EXISTING ELEVATIONS

EXISTING RETAINING WALL

(TOP)

EXISTING EMBANKMENT

PROPOSED BUILDING

OVERLAND FLOW ROUTE (MAJOR STORM)

🟦 CATCHMENT 201

🟨 CATCHMENT 202

🟥 CATCHMENT 203

201 — SUB-CATCHMENT NUMBER

0.136 — AREA (ha.)

Figure 2.0

Date: JUNE.17/21

Scale: 1:400

POST-DEVELOPMENT CATCHMENT AREAS

MTE

Engineers, Scientists, Surveyors

Project No.: 48790-100

June 3, 2021 — 5:24 p.m. — plotted by: sdicesare

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Stormwater management quantity controls are not required for this Site due to proximity of the Site to the Grand River. Therefore, no controls are proposed. However, in order to mitigate erosion and slope stability concerns from discharging directly to the Grand River, it is proposed to size the storm sewer system for the 100 year storm event. The proposed storm sewer system will capture the runoff from the building roofs, driveway and surface parking, then convey it to an oil-grit-separator and then to the Grand River through a headwall. The proposed 300 mm diameter pipes will be sloped at 2.6% with a capacity of 155.9 L/s. The captured 100 year flow rate will be 66 L/s. Therefore, the pipes have been sized to capture the 100 year storm flow. The overland flow route will be directed to the Grand River.

Refer to Appendix E for the MIDUSS NET output.

The following table summarizes the flows generated by the whole Site.

Table 4.2 - Summary of Flows

Modelling Condition	2 year Storm Event (m^3/s)	5 year Storm Event (m^3/s)	10 year Storm Event (m^3/s)	25 year Storm Event (m^3/s)	50 year Storm Event (m^3/s)	100 year Storm Event (m^3/s)
Pre-development to River (Catchment 101 & 102)	0.017	0.025	0.031	0.037	0.042	0.048
Pre-development to ROW (Catchment 103)	0.002	0.003	0.004	0.005	0.006	0.006
Pre-development Total	**0.020**	**0.028**	**0.035**	**0.041**	**0.048**	**0.054**
Post-Development to River (Catchments 201 & 202)	0.025	0.035	0.044	0.052	0.060	0.068
Post-Development to ROW (Catchment 203)	0.002	0.003	0.003	0.004	0.004	0.004
Post-Development Total (Catchments 201, 202, & 203)	**0.027**	**0.038**	**0.048**	**0.056**	**0.064**	**0.073**

The post-development flows have increased to the Grand River in comparison to the pre-development flows. The post-development flows to the right-of-way have remained the same or decreased in comparison to the pre-development flows. The overall post-development flows have increased.

4.3 Water Quality Control

A Stormceptor Model EFO4 will be installed on the storm sewer system to provide water quality control. The chosen unit is expected to provide Level 1 (Enhanced) water quality control. Refer to Appendix F for the sizing output from the Stormceptor Expert program. The Stormceptor will require regular annual maintenance to ensure it is operating properly. The owner will enter into a maintenance agreement with a suitable contractor to complete this work. In addition, all the storm structures will have a 600 mm sump. Other forms of quality control are not feasible on this Site due to the limited space.

4.4 Erosion & Sediment Control

In order to minimize the effects of erosion during the grading of the site, sediment control fencing will be installed: as shown on the enclosed engineering drawing, around any stockpiles and around the catchbasins during construction. Any sediment that is tracked onto the road way during the course of construction will be cleaned by the contractor.

5.0 Conclusions

Based on the foregoing analysis, it is concluded that:

- The proposed grading design will respect the natural topography of the site to achieve a reasonable cut/fill balance where possible;
- Existing municipal infrastructure for water and sanitary is available along St. Andrew Street West;
- The storm sewer service will outlet to the Grand River and has been sized to convey the 100 year flow; and,
- The SWM criteria can be satisfied with the implementation of on-site controls for water quality.

All of which is respectfully submitted,

MTE CONSULTANTS INC.

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LICENSED PROFESSIONAL ENGINEER
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Appendix A

Geotechnical Investigation and Slope Stability Assessment

GEOTECHNICAL INVESTIGATION AND SLOPE STABILITY ASSESSMENT

PROPOSED 5-STOREY BUILDING
350 ST. ANDREW STREET WEST
FERGUS, ONTARIO

CMT Project 16-708(b).R01

Prepared for:

Van Grootheest Holdings Inc.

April 23, 2021

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April 23, 2021 16-708(b).R01

Van Grootheest Holdings Inc.
645 St. David Street North
Fergus, Ontario
N1M 2K6

Attention: Eric Van Grootheest

Dear Eric:

Re: Geotechnical Investigation and Slope Stability Assessment
Proposed 5-Storey Building
350 St. Andrew Street West
Fergus, Ontario

As requested, CMT Engineering Inc. conducted a geotechnical investigation at the above-referenced site, and we are pleased to present the enclosed report.

We trust that this information meets your present requirements, and we thank you for allowing us to undertake this project. Should you have any questions, please do not hesitate to contact our office.

Yours very truly,

Shawn Wheatley

Shawn Wheatley, M.Eng.

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TABLE OF CONTENTS

1.0 INTRODUCTION

The services of CMT Engineering Inc. (CMT Inc.) were retained by Van Grootheest Holdings Inc. to conduct a geotechnical investigation and slope stability analysis for the proposed 5-storey building to be constructed at 350 St. Andrew Street West in Fergus, Ontario. The location of the site is shown on Drawing 1.

It is understood that the developer is proposing to construct a five (5) storey building with one (1) storey of underground parking, as well as associated asphalt surface driveways and an above-ground parking lot.

The purpose of the geotechnical investigation was to assess the existing soil and groundwater conditions encountered in the boreholes. Included in the assessment are the soil classification and groundwater observations, as well as comments and recommendations regarding geotechnical resistance (bearing capacity); serviceability limit states (anticipated settlement); dewatering considerations; site classification for seismic site response; recommendations for site grading, site servicing, excavations and backfilling, building demolition; recommendations for slab-on-grade construction; pavement design/drainage; soil/bedrock design properties; slope stability assessment; and a summary of the laboratory test results.

The recommendations in this report are solely based on the soil conditions encountered in the boreholes advanced on the subject site.

2.0 EXISTING SITE CONDITIONS

The site currently comprises an existing single-storey building, as well as gravel/asphalt surface driveways and parking areas. A limestone block wall exists to the northeast of the property. It would be expected that the limestone block may be part of a former structure that existed on the subject site and/or the adjacent property. There is a slightly depressed area evident in the existing paved parking lot that is oriented towards the river. There is the potential that the depressed area may be related to existing or former underground piping that may have been located in this area. The site is bounded by St. Andrew Street West to the west, the Grand River to the east, Melville United Church to the north, and an existing commercial building to the south. The topography of the property generally slopes down towards the east, with almost 3.0 m of variance in elevation, prior to a steep drop-off of approximately 10.0 m to the Grand River at the east boundary of the property.

3.0 FIELD AND LABORATORY PROCEDURES

CMT Inc. has carried out a previous geotechnical investigation on the subject property and is relying on that information to complete this geotechnical report and slope stability assessment.

The drilling field investigation was conducted on January 30, 2017 and comprised the advancement of six (6) boreholes (referenced as Boreholes 1 to 6), utilizing a Geoprobe 7822DT drillrig operated by employees of CMT Drilling Inc. The boreholes were advanced from depths of 0.79 m (approximately 2.5 ft) to 2.37 m (approximately 7.8 ft) below the existing ground surface elevations. Boreholes 1 to 4 were advanced in the area of the proposed building; and Boreholes 5 and 6 were advanced to generally cover the proposed paved area.

Standard penetration testing and sampling was carried out in the majority of the boreholes using 38 mm inside diameter split spoon sampling equipment and an automatic hammer, in accordance with ASTM D 1586 "Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils". Standard Penetration Testing (SPT) was generally conducted at 0.76 m (2.5 ft) intervals and Macro Core (MC5) direct push sampling was conducted between the SPT samples, as well as where the SPT sampler could not be advanced due to the very dense nature of the soil/rock encountered in Boreholes 1 to 6. Technical staff from CMT Inc. observed the drilling operation and collected and logged the recovered soil samples. A small portion of each sample was placed in a sealed, marked jar for moisture content determinations. A representative sample from the following borehole and depth was submitted to our laboratory for grain size analysis:

- Borehole 5 – approximate depth 0.8 m to 1.4 m (2.5 ft to 4.5 ft)

The borehole logs are provided in Appendix A and the grain size analysis is provided in Appendix B.

CMT Inc. surveyed the ground surface elevations at the borehole locations on January 30, 2017. The existing catch basin located on the west side of St. Andrew Street West was utilized as a temporary benchmark with a reported elevation of 397.56 m. The ground surface elevations at the borehole locations ranged from approximately 395.06 m to 397.83 m. The locations of the boreholes are shown on Drawing 2.

4.0 __SUBSOIL CONDITIONS__

The soils encountered in the boreholes are described briefly below and a more detailed stratigraphic description is provided on the borehole logs in Appendix A. The following paragraphs have been simplified into terms of major soil strata. The soil boundaries indicated have been inferred from non-continuous samples and observations of sampling and drilling resistance and typically represent transitions from one soil type to another rather than exact planes of geological change. Further, the subsurface conditions are anticipated to vary between and beyond the borehole locations.

*4.1. **Asphalt***

Black, cracked asphaltic concrete (asphalt) was encountered at the surface of Boreholes 5 and 6. The asphalt ranged in thickness from approximately 25 mm to 30 mm (average 27 mm) at the borehole locations. Due to the frozen conditions during the investigation, some variation in the asphalt thickness and composition should be expected.

*4.2. **Topsoil***

Dark brown, silty topsoil in a wet state was encountered at the surface of Boreholes 1 to 4. The topsoil thickness was observed to range from approximately 0.10 m to 0.50 m (average 0.25 m), however the topsoil thickness is anticipated to vary throughout the site. Materials designated as topsoil in this report were classified based solely on visual and textural evidence. Testing of organic content or for other nutrients was not carried out.

*4.3. **Fill***

Brown, gravelly fill with trace to some silt and sand, some organics and clay was encountered underlying the topsoil in Boreholes 1 to 4. The fill was considered to be moist, with moisture contents ranging from about 3.2% to 16.9% (average 8.5%). Due to the low recovery in Boreholes 1 to 2, some variation in fill composition should be expected in those areas. The fill was considered to be very loose to very dense, with SPT N-values ranging from 3 to 100 blows per 0.3 m (average 23 blows per 0.3 m). The fill ranged in thickness from approximately 0.56 m to 2.09 m (average 1.02 m) at the borehole locations. Due to the variation in fill thickness at the borehole locations, it should be expected that the fill thickness will also vary throughout the site. It is therefore recommended that provisions for the stripping of additional fill be included as part of the tender documents.

*4.4. **Granular Base***

Grey sandy gravel granular base with trace silt and clay was encountered underlying the asphalt in Boreholes 5 and 6. The granular base was considered to be moist to wet, with moisture contents ranging from about 3.9% to 16.9% (average 10.4%). The granular base was considered to be loose to compact, with SPT N-values ranging from 6 to 15 blows per 0.3 m (average 10 blows per 0.3 m). The granular base ranged in thickness from approximately 0.58 m to 0.77 m (average 0.68 m) at the borehole locations. Due to the variation in granular base thickness at the borehole locations, it should be expected that the granular base thickness will also vary throughout the site. It is therefore recommended that provisions for the stripping of additional granular base be included as part of the tender documents.

4.5. Presumed Bedrock/Weathered Bedrock

Presumed/possible limestone bedrock was encountered at the termination of Boreholes 1 to 6. Refusal was encountered at depths ranging from approximately 0.79 m to 2.37 m below the ground surface in the boreholes. Presumed/possible weathered limestone bedrock with fractured gravel size material and silt infill was encountered in the lower zone of boreholes. Some roots and rootlets were also observed within the presumed weathered bedrock layer. It should be noted that the presence of bedrock was not proven by rock coring, however; Ontario geological maps as well as previous experience in the area indicate the presence of relatively shallow limestone bedrock. Limestone bedrock is typically undulating in nature and therefore the surface elevation can vary significantly across the site. The degree of weathering and/or fracturing of the bedrock should also be expected to vary considerably across the site.

4.6. Groundwater

Accumulated groundwater, seepage or saturated soils were not observed in any of the boreholes. However, the presumed/possible bedrock and very dense native soils have the potential to create perched water conditions in the relatively loose overlying soils. Groundwater conditions (especially perched groundwater) are generally dependent on the amount of precipitation, control of surface water, as well as the time of year, and can fluctuate significantly in elevation and volume.

Recommendations with respect to dewatering conditions are provided in Section 5.8 of this report.

5.0 DISCUSSION AND RECOMMENDATIONS

This section of the report provides CMT Inc.'s interpretation of the factual geotechnical data obtained during the investigation and is intended for the guidance of the owner and design engineer. Where comments are made on construction, they are provided only to highlight those aspects which could affect the design of the project. Contractors bidding on or undertaking the work should make their own independent interpretation of the factual subsurface information provided as it affects their proposed construction means and methods, equipment selection, scheduling, pricing, and the like.

Utilizing the information gathered during the geotechnical investigation and assuming that the borehole information is representative of the subsoil conditions throughout the site, the following comments and recommendations are provided.

5.1. Serviceability and Ultimate Limit Pressure

Based on the information obtained from the boreholes, the following table provides a summary of the estimated geotechnical reaction at the Serviceability Limit States (SLS) and Ultimate Limit States (ULS) pressures at the various elevations, including soil/presumed bedrock types:

Borehole No.	Ground Surface Elevation (m)	SLS kPa (psf)	ULS kPa (psf)	Estimated Highest Founding Elevation (m)	Soil Type
1	397.83	N/A	375 (7,500)	395.54 to 395.46 (termination)	Presumed Weathered/Fractured Limestone Bedrock
2	397.80	N/A	375 (7,500)	396.84 to 396.43 (termination)	Presumed Weathered/Fractured Limestone Bedrock
3	396.43	N/A	375 (7,500)	395.37 to 395.34 (termination)	Presumed Weathered/Fractured Limestone Bedrock
4	395.92	N/A	375 (7,500)	395.16 to 395.13 (termination)	Presumed Weathered/Fractured Limestone Bedrock

Since the anticipated settlement for foundations placed on bedrock is considered to be nil, there is no corresponding geotechnical reaction at the Serviceability Limit State (SLS). It should be noted that foundations constructed on bedrock will typically not experience the same settlement as foundations constructed on native soils or structural fill. In order to reduce the potential for differential settlement, should the bedrock elevation vary to the point where any foundation may be partially founded on bedrock and partially founded on native soils or structural fill, further excavation and placement of concrete will be required in order to provide a homogeneous bearing stratum.

Bedrock is typically undulating in nature and therefore the surface elevation can vary significantly. All exterior footings founded on soil/fractured rock must be provided with a minimum of 1.2 m of soil cover or equivalent thermal insulation in order to provide protection against frost action. Exterior footings founded on sound bedrock may be founded at elevations that do not achieve the minimum 1.2 m of soil cover, provided the bedrock is thoroughly inspected prior to footing construction to ensure that the bedrock is free of cracks and fractures. Pinning of the footings to the bedrock, in accordance with the structural design would be required in these situations.

The proposed founding elevations were not available at the time of preparation of this report. If the new structure is designed to bear on the good to excellent quality bedrock, then site-specific rock coring may be required prior to construction.

Presumed/possible bedrock capable of supporting foundations designed with a bearing capacity of 375 kPa (7,500 psf) at SLS were encountered at elevations ranging from approximately 326.84 m to 395.16 m at the top of the bearing surface at the location of Boreholes 1 to 4.

Should footings be designed to be constructed at elevations higher than the elevations indicated in the table above, then structural fill will be required in order to achieve the design grades for the proposed foundations. The serviceability limit pressure for good quality granular structural fill (OPSS 1010 Granular 'A' or Type II, III Granular 'B') placed and compacted in accordance with Section 5.4.6 of this report is estimated to be at least 250 kPa (5,000 psf). Alternatively, footings could be stepped down to bear on approved undisturbed founding soils/rock.

It should be expected that disturbed soils/limestone rock will be encountered at the locations of any buried foundation walls as well as any existing/former site services. Therefore, excavations for foundations constructed in the area of any existing or previously existing foundation walls and/or services must extend down to at least the founding elevation of the foundation walls/underside of the pipe bedding and/or approved founding stratum based on the structural design. The presence or founding elevation of any existing foundation walls or the depth of any existing services and service structures was not determined as part of this geotechnical investigation. It would be recommended to expose and assess the condition and quality of the existing founding strata prior to construction.

Due to the presence of fill and the undulation of the bedrock, it is imperative that the founding strata be assessed at the time of construction by qualified geotechnical personnel in order to confirm their founding suitability.

Footings founded on soil may be placed at a higher elevation relative to another footing provided that the slope between the outside face of the footings is separated by a minimum slope of 10 horizontal to 7 vertical (10H:7V) with an imaginary line projected from the underside of the footings. It is recommended that footings founded on bedrock that are constructed at a lower elevation relative to an adjacent foundation be backfilled around the constructed foundation with lean concrete in order to maintain the structural integrity of the generally fractured bedrock.

It is recommended that structural foundation drawings be cross-referenced with site servicing drawings to ensure that service pipes do not conflict with building foundations (including the zone of influence down and away from the footings).

CMT Inc. would be pleased to review design drawings when they become available and provide further recommendations with respect to bearing and foundation elevations.

5.2. Seismic Site Classification

The site classification for seismic response in Table 4.1.8.4 of the 2012 Ontario Building Code relates to the average properties of the upper 30.0 m of strata. The information obtained in the geotechnical field investigation was gathered from the upper 2.37 m of strata. Based on the information gathered in the geotechnical field investigation, the site classification for seismic site response would be considered Site Class C (very dense soil/soft rock) for structures founded on the native soils at the recommended founding elevations provided in Section 5.1 of this report. For foundations constructed on structural fill, placed in accordance with Section 5.4.6 of this report, the site classification for seismic site response would also be considered Site Class C (very dense soil/soft rock). The structural engineer responsible for the design of the structure should review the earthquake loads and effects.

5.3. Soil Design Parameters

The following table provides the soil design parameters for imported granular fill, as well as the existing fill and the native soils encountered on-site. It should be noted that earth pressure coefficients (Ka, Kp, Ko) provided are for flat ground surface conditions and will differ for areas with slopes or embankments. The estimated soil design parameters can be utilized for the design of perimeter shoring, foundations and retaining walls, lateral earth pressure calculations, as required. The estimated soil design parameters can be utilized for design of foundations and retaining walls, as required:

Soil Type	Soil Density (kg/m^3)	Friction Angle (Degree)	Coefficient of Active Pressure (K_a)	Coefficient of Passive Pressure (K_p)	Coefficient of At-Rest Pressure (K_o)	Coefficient of Friction (μ)	Cohesion (Undrained) (kPa)
Imported Granular 'A'/ Granular 'B' (OPSS 1010)	2,000	34	0.28	3.54	0.44	0.45	0
Fill	1,600 to 1,850	18 to 28	0.53 to 0.36	1.89 to 2.77	0.69 to 0.53	0.22 to 0.35	0

5.4. Site Preparation

The site preparation for the proposed development is anticipated to include: the demolition and removal of the existing building, foundations, and pavement; removal or relocation of any existing services; stripping of topsoil; removal of tree root structures and associated loose, organic soil; excavation of all fill and native soil/rock deemed not capable of supporting the design bearing capacity; followed by the placement of structural fill (if required) and site grading to achieve proposed grades. Excavation of bedrock would be required to provide underground parking depending on the proposed elevations. Excavation of bedrock can create significant noise and vibration, depending on the excavation technique and quality of the bedrock. A qualified contractor should be contacted to provide the proper method of construction considering the urban location of the site, nearby roadway (and possible underground services), as well as adjacent buildings including the old/historic church located to the north of the property.

5.4.1. Building Demolition

It is understood that the existing structure will be demolished. All existing foundation walls, footings, slab-on-grade and other construction materials must be removed from the areas of the demolished building. The excavation must be inspected and then backfilled according to the procedures outlined in Section 5.4.6 of this report. It is recommended that imported sand and gravel (OPSS 1010 Granular 'A' or Granular 'B' Type I, II, III or an approved alternative) be placed as structural fill to backfill the building demolition area.

Given the presence of the partial limestone block wall on the adjacent property, this site may have also comprised old structures. All old structures on-site have been demolished above grade; however, there is no confirmation that any old building foundations (if present) have been removed below grade. If encountered during excavating, all existing foundation walls, footings, slab-on-grades and other construction materials (if present) as well as all relatively loose backfill material must be removed from within the proposed building envelopes, driveways and surface parking lot areas. The excavation must be inspected and then backfilled as required according to the procedures outlined in Section 5.4.6 of this report. It is recommended that good quality imported sand and gravel (OPSS 1010 Granular 'A' or Granular 'B' Type I, II, III or an approved alternative) be placed as structural fill as required. Provided any concrete/rock from the existing and/or former building foundations (if encountered) and slab-on-grades, as well as any other concrete/rock on-site (if encountered) is reduced to a maximum size of 100 mm, and all reinforcing steel and any deleterious materials are removed, the reduced concrete material may be combined with imported granular fill to be utilized as fill on-site. The reuse of this material will be subject to approval from qualified geotechnical personnel.

5.4.2. Asphalt/Concrete Stripping

All existing asphalt, concrete, and granular fill must be removed from the building envelope, driveway, and parking lot areas. All removed asphalt/concrete must be properly disposed of off-site. The granular fill may be reused if it is free of organic material and deleterious fill and considered to be acceptable by qualified geotechnical personnel.

5.4.3. Shoring

At this time, it is uncertain if a shoring system will be required during construction. If required, the shoring system is to be designed be a qualified structural engineer, and must account for appropriate factors of safety, and any possible surcharge loading (such as but not limited to vehicle traffic on nearby roads and parking lots). The support system must comply with the current Occupational Health and Safety Act and Regulations for Construction Projects (O.Reg. 213/91). The estimated soil parameters in Section 5.3 can be utilized in the shoring design.

5.4.4. Removal/Relocation of Existing Services

Any existing services (if present) that may be located within proposed building envelope must be removed/relocated as part of the demolition. If left in place, the location of existing services must be reviewed to ensure that they do not conflict with the proposed foundation location. Any terminated piping that is left in place must be completely sealed with watertight mechanical covers, concrete or grout at termination points to prevent the migration of soils into pipe voids which can result in potential settlement. All existing trench backfill material must be subexcavated and the subsequent excavation should be backfilled with approved soils placed in accordance with Section 5.4.6 of this report.

5.4.5. Fill Removal

All existing topsoil and fill (including any existing trench backfill and any buried foundations and/or concrete slabs), as well as any native soils that are deemed unsuitable to support foundations or slab-on-grades, must be subexcavated from within the proposed building envelope, driveways and parking lot envelopes to expose approved competent native subgrade soils/rock. It is prudent to remove all fill below the driveways and parking lots, however, this may not be cost-effective. At a minimum, thorough inspection will be required at the time of construction to assess the existing fill to ensure there is no buried topsoil or other deleterious materials within the prepared subgrade. Remedial action will also be required to further consolidate the existing fill if it is decided to leave it in place. If the existing fill is left in place, provisions for the alterations to the design of the pavement structure should be included in the tender documents. Review of the subgrade and potential changes to the design of the pavement structure, as required, will be addressed at the time of construction. The fill containing organics could be used in landscaped areas where some settlement can be tolerated; otherwise it should be disposed of properly off-site.

5.4.6. ***Site Grading***

Following removal of the topsoil, as well as the subexcavation of unsuitable fill and native soils/rock deemed unsuitable of supporting the design bearing capacity, the exposed subgrade (if comprised of soil) must be proof-rolled and any soft or unstable areas must be subexcavated and replaced with approved fill materials.

Any fill materials required to achieve the design site grades should be placed according to the following procedures:

- Prior to placement of any structural fill, the subgrade for the proposed building must be prepared large enough to accommodate a 1:1 slope commencing a distance of 1.0 m beyond the outside edge of the proposed foundation (where feasible) down to the approved competent native founding soils/rock;

- Soils approved for use as structural fill must be placed in loose lifts not exceeding 0.3 m (12") in depth for granular soils (recommended fill material) and 0.2 m (8") in depth for silts and clays, or the capacity of the compactor (whichever is less);

- Imported granular fill materials (OPSS 1010 Type I, II or III Granular 'B' recommended for this application) can be compacted utilizing adequate heavy vibratory smooth drum compaction equipment.

- Fine-grained silt and clay soils must be compacted utilizing adequate heavy padfoot vibratory compaction equipment (not recommended for structural fill);

- Approved fill materials must be at suitable moisture contents to achieve the specified compaction. Soil moisture will be dependent on weather conditions and time of year that construction takes place, therefore, the contractor must be prepared to add water as required in order to achieve the specified compaction;

- Approved structural fill materials that will support structures (including foundations, interior slab on grades, sidewalks, stairs and large expansive slabs) must be compacted to 100% standard Proctor maximum dry density (SPMDD);

- Approved bulk fill (foundation wall backfill, bulk fill under slab-on-grades that will not support footings or heavy point loading, bulk fill for driveways and parking lots) must be compacted to a minimum 95% SPMDD;

- Granular 'B' subbase and Granular 'A' base materials for the driveways and paved parking areas must be compacted to 100% SPMDD.

Based on the subsurface conditions observed in the boreholes, it is not expected that wet to saturated soils will be encountered. However, due to the presence of less permeable native soils/rock, perched water conditions may develop, increasing the moisture content within the existing soils. In general, for soils excavated from the zone of saturation, significant air-drying along with working of the soils may be required in order to achieve the specified compaction of 100% SPMDD in building envelopes (including 1:1 as required) and 95% SPMDD for bulk fill for the parking lot and driveways.

5.5. __Foundation Subgrade Preparation__

Structural fill (if required) may be sensitive to change in moisture content and can become loose/soft if the soils are subjected to additional water or precipitation, as well as severe drying conditions. The prepared subgrade soils could also be easily disturbed if traveled on during construction. Once they become disturbed, they are no longer considered adequate for the support of shallow foundations. To ensure and protect the integrity of the founding soils/rock during construction operations, the following is recommended:

- During construction, the subgrade should be sloped/ditched to a sump (as required) located outside the building footprint (if feasible) in the excavation to promote surface drainage of rainwater or seepage and the collected water should be pumped out of the excavation. It is critical that all water be controlled (not allowed to pond) and that the subgrade and foundation preparation commence in dry conditions;

- Construction equipment travel and foot traffic on the founding soils should be minimized;

- If construction is to be undertaken during subzero weather conditions, the founding soils must be maintained above freezing;

- Prior to pouring concrete for the footings, the footing area must be cleaned of all disturbed or caved materials;

- The foundation formwork and concrete should be installed as soon as practical following the excavation, inspection and approval of the founding soils/rock. The longer that the excavated soils/weathered bedrock remain open to weather conditions and groundwater seepage, the greater the potential for construction problems to occur;

- If it is expected that the founding soils will be left open to exposure for an extended period of time, it is recommended that a 75 mm concrete mud slab be poured in order to protect the structural integrity of the founding soils.

5.6. Slab-on-Grade/Modulus of Subgrade Reaction

Prior to the placement of the granular base for the slab-on-grade construction, the subgrade (if comprised of soil) should be proof-rolled and consolidated. Any soft or weak zones, as well as the unsuitable fill and loose native soil in the subgrade, should be subexcavated and backfilled with approved fill materials (see Sections 5.1 and 5.4.6 of this report).

The following table provides the estimated modulus of subgrade reaction (k) for imported granular fill, as well as the fill and native soils/rock encountered on-site:

Soil Type	**Modulus of Subgrade Reaction (k)**
Imported Sand and Gravel (OPSS 1010)	81,000 kN/m^3 (300 lb/in^3)
Existing Fill	6,800 kN/m^3 (25 lb/in^3)
Bedrock	150,000 kN/m^3 (550 lb/in^3)

In dry conditions, slabs should be founded on a minimum thickness of 150 mm (6") Granular 'A' (OPSS 1010) and compacted to 100% SPMDD. Alternatively, (particularly in wet conditions), 150 mm (6") of 19 mm clear crushed stone (OPSS 1004) could be used instead of Granular 'A'. Utilizing clear crushed stone for the slab-on-grade base can assist in providing a moisture barrier by reducing the potential for capillary rise of moisture from the subgrade soils. Compactive effort is required to consolidate the clear stone. The 19 mm clear crushed stone should meet the physical property requirements and gradation requirements of OPSS 1004.

It is recommended that areas of extensive exterior slab-on-grade (sidewalks, accessibility ramps and exterior stairs) be constructed with a Granular 'B' subbase (450 mm) and a Granular 'A' base (150 mm), as well as incorporating subdrains, to promote rapid drainage and reduce the effects of frost heaving; this is particularly critical at barrier-free access points. Alternatively, a structural frost slab could be designed and constructed at door entrances and areas of barrier-free access.

5.7. Excavations

All excavations must be carried out in accordance with Ontario Regulation 213/91 (Reg 213/91) of the Occupational Health and Safety Act and Regulations for Construction Projects.

Type 3 Soils - In general, the existing fill material and granular base material, as well as highly weathered bedrock (with separate gravel size particles) encountered in the boreholes, in a drained state (not wet or saturated), would be classified as Type 3 soils under Reg 213/91. The Type 3 soils must be sloped from the bottom of the excavation at a minimum gradient of 1 horizontal to 1 vertical. All saturated soils encountered must be treated as Type 4 soils, as described below.

Type 4 Soils - In general, any wet to saturated soils, would be classified as Type 4 soils under Reg 213/91. Type 4 soils must be sloped from the bottom of the excavation at a minimum gradient of 3 horizontal to 1 vertical.

Bedrock - With respect to Reg 213/91, temporary excavations undertaken in limestone bedrock do not necessarily require a support system provided the bedrock is sound and stable and that the walls of the excavation are not influenced by surcharge loading from adjacent structures or traffic (including construction vehicles). However, depending on the size of the excavation and quality of the bedrock in the excavation walls following excavating, shoring of the excavation may be necessary to ensure worker safety from potentially loose and/or falling rock.

If it is not practical to excavate according to the above requirements, then a trench support system (designed in accordance with the Ontario Health and Safety Act Regulations) may be utilized. When using a temporary trench support system consisting of trench boxes to reduce the lateral extent of the excavations, it should be noted that the support system is intended primarily to protect workers as opposed to controlling lateral soil movement. Any voids between the excavation walls and the support system should be immediately filled to reduce the potential for loss of ground and to provide support to existing adjacent utilities and roadways, and it is recommended that the excavation be carried out in short sections, with the support system installed immediately upon excavation completion.

The surface of the bedrock typically exhibits chemical and mechanical weathering as well as fractures, however the amount of weathering/fracturing is expected to vary throughout the construction area. The extent of weathering/fractures will determine the methodology for excavating. The quality of the bedrock and the extent of weathering/fractures could be determined by rock coring, which was not a part of scope of work for the current investigation. Generally, if the upper zone of the bedrock is weathered/fractured, it could be excavated utilizing large excavators designed for rock excavation. The less fractured rock may require line drilling to enable excavation to the design founding elevation. The structure of limestone bedrock generally results in large pieces or blocks of bedrock being excavated. Therefore, over-excavation should be anticipated and a provision for additional foundation concrete and/or lean concrete backfill (as required) should be included in the tender documents. Blasting is not recommended for this site due to the urban location, as well as the close proximity and age of the adjacent buildings. A qualified contractor must be contacted to provide proper construction method.

It should be noted that bedrock surface elevations will likely vary across the site. The bedrock elevations encountered in the boreholes may be influenced by previous excavations for the existing building and any former structures.

5.8. ***Construction Dewatering Considerations***

The groundwater water table, seepage or saturated soil conditions were not encountered in the boreholes. However, due to the presence of the less permeable presumed bedrock, a perched water condition may develop, increasing the moisture content within the existing soils. Seepage should be expected where perched groundwater is present. Should heavier seepage be encountered, sloughing/caving of the excavation walls should be expected. Groundwater conditions are generally dependent on the amount of precipitation, control of surface water as well as the time of year, and can fluctuate significantly in elevation and volume. As such, provisions for site dewatering may be part of the site development and construction process. As required, seepage should generally be adequately controlled using conventional construction dewatering techniques such as pumping from sump pits. However, if heavy seepage occurs it may be necessary to increase the number of pumps during construction.

Dewatering should be performed in accordance with OPSS 517 and the control of water must be in accordance with OPSS 518. It is the responsibility of the contractor to propose a suitable dewatering system based on the groundwater elevation at the time of construction. Collected water should discharge a sufficient distance away from the excavation to prevent re-entry. Sediment control measures must be installed at the discharge point of the dewatering system to avoid any potential adverse impacts on the environment.

5.9. ***Service Pipe Bedding***

The native soils/bedrock encountered in the geotechnical investigation are generally considered suitable for indirect support of the site service pipes. Should instability due to saturated soil conditions be encountered, it may be necessary to increase the thickness of the granular base and utilize 19 mm clear stone to create an adequate supporting base for the service pipes and/or manholes. Pipe embedment, cover and backfill for both flexible and rigid pipes should be in accordance with all current and applicable OPSD, OPSS and OBC standards and guidelines and as follows:

Flexible Pipes –The pipe bedding should be shaped to receive the bottom of the pipe. If necessary, pipe culvert frost treatment should be undertaken in accordance with OPSD-803.031. The trench excavations should be symmetrical with respect to the centreline of the pipe. The granular material placed under the haunches of the pipe must be compacted to 100% SPMDD prior to the continued placement and compaction of the embedment material. The homogeneous granular material used for embedment should be placed and compacted uniformly around the pipe. Should wet conditions be encountered at the base of the trench, then the pipe bedding should consist of 19 mm clear stone (meeting OPS Specifications) wrapped completely in a geotextile fabric such as Terrafix 270 or equivalent.

Rigid Pipes - In general, the pipe installation recommendations for rigid pipes are the same as those for flexible pipes, except that the minimum bedding depth below a rigid pipe should be 0.15*D* (where *D* is the pipe diameter). In no case should this dimension be less than 150 mm or greater than 300 mm.

Any service pipes that are not provided with sufficient frost coverage must be protected with the necessary equivalent thermal insulation. The general contractor is responsible to protect service piping from damage by heavy equipment.

5.10. Perimeter Building Drainage, Foundation Wall Backfill and Trench Backfill

In order to assist in maintaining a dry building with respect to surface water seepage, it is recommended that exterior grades around the building be sloped down and away at a 2% gradient or more, for a distance of at least 1.5 m. Any surface discharge rainwater leaders must be constructed with solid piping that discharges with positive drainage at least 1.5 m away from building foundations and/or beyond sidewalks to a drainage swale or appropriate storm drainage system.

The construction of foundations, slabs-on-grade, and deep structures such as elevator pits and sump pits within or below zones of saturation will require design of site-specific waterproofing and dewatering systems constructed in accordance with the 2012 OBC. If required, it would be recommended that a good quality sump pump be utilized and that the system be equipped with a battery backup in the event of power failure (keeping in mind that a battery backup system does not typically have a long run time).

Since the proposed building will include an underground parking level, an exterior perimeter weeping tile system comprising perforated drainage pipe with a factory installed filter sock, bedded in 19 mm clear crushed stone and wrapped in a geotextile filter fabric such as Terrafix 270R (or equivalent), must be installed at an elevation that is below the proposed basement slab-on-grade elevation and provided with positive drainage into a sump pit. The portion of the piping that connects the exterior weeping tile system into the sump pit must comprise solid piping to prevent exterior water from being introduced into the interior subslab stone. It may be prudent to install perforated drainage pipe in the interior basement as well to provide an outlet for any water that may collect in the subslab stone. It is also recommended that a capped cleanout port(s) be extended up to the ground surface elevation to provide future access (if required). The rainwater leaders must not be connected to the perimeter weeping tile system. Foundation wall and slab-on-grade dampproofing and/or waterproofing must conform to current OBC regulations.

In order to reduce the effects of surficial frost heave, it is recommended that the exterior foundation backfill in areas that will be hard surfaced consist of free-draining granular material such as imported Granular 'B' (OPSS 1010), or the native granular soils, with a maximum aggregate size not exceeding 100 mm and that it extend a minimum lateral distance of 600 mm out from the foundation walls and/or beyond perimeter sidewalks and entranceway slabs. It is critical that particles greater than 100 mm in diameter are not in contact with the foundation wall to prevent point loading and overstressing. The backfill material used against the foundation walls must be placed so that the allowable lateral capacities of the foundation walls are not exceeded. Where only one side of a foundation wall will be backfilled and the height of the wall is such that lateral support is required, or where the required concrete strength has not been achieved, the wall must be braced or laterally supported prior to backfilling. The backfill material used against the foundation walls must be placed so that the allowable lateral capacities of the foundation walls are not exceeded. In situations where both sides of the wall are backfilled, the backfill should be placed in equal lifts, not exceeding 200 mm differential on each side during backfill operations and the backfill should be compacted to a minimum of 98% SPMDD.

Approved fill materials (non-organic) are generally considered suitable for use as trench backfill and bulk fill in the parking lot and driveways; however, any wet to saturated soils (if encountered) will require significant air-drying in order to achieve the specified field compaction. Excavated bedrock is not recommended as backfill due to the large void space that will be present, which may result in subsidence/settlement of adjacent soils. Therefore, it is recommended that provisions be included in the tender documents for imported granular backfill for any excavations in the bedrock, as well as proper disposal off-site of excess excavated rock.

Backfilling operations should be carried out with the following minimum requirements:

- Adequate heavy smooth drum or padfoot vibratory compaction equipment (suited to soil type) should be used for compaction and to break down any large blocky pieces of soil;

- Loose lift thicknesses should not exceed 0.3 m (12") for granular soils or 0.2 m (8") for clay and silt soils or the capacity of the compactor (whichever is less);

- The soils must be at suitable moisture contents to achieve compaction to a minimum 95% SPMDD in non-structural bulk fill areas. Service trenches excavated within the zone of influence of footings for structures must be compacted to a minimum of 100% SPMDD;

- It is recommended that inspection and testing be carried out during construction to confirm backfill quality, thickness and to ensure that compaction requirements are achieved;

- Service trench backfill materials may consist of approved excavated soils with no particles greater than 100 mm and no topsoil or other deleterious materials;

- If construction operations are undertaken in the winter, strict consideration should be given to the condition of the backfill material to make certain that frozen material is not used.

5.11. Pavement Design/Drainage

It is understood that some asphalt surface driveway and parking lot surrounding the new building will be completed as part of this project. All existing asphalt, concrete, topsoil, vegetation, granular base, fill and highly weathered bedrock with significant organic infill and roots/rootlets must be subexcavated from within the parking lot and driveway areas; however, this may not be cost-effective. At a minimum, all existing fill or weathered bedrock with intermixed organic material should be subexcavated from the driveway and parking lot areas to prevent problems associated with frost heaving such as loss of structural integrity and frost boils. Thorough inspection will be required at the time of construction to assess the existing fill and subgrade to ensure there is no buried topsoil or other deleterious materials within the subgrade. Remedial action will most likely be required to further consolidate the existing fill if it is decided to leave it in place. If the existing fill/granular base is left in place in the parking lot, provisions for the alterations to the design of the pavement structure should be included in the tender documents. Review of the subgrade and potential changes to the design of the pavement structure as required (such as using biaxial geogrids), will have to be addressed at the time of construction.

Prior to placement of the granular base, the subgrade (if comprised of soil) must be proof-rolled to further consolidate the existing fill (if left in-place). Any soft or unstable areas should be subexcavated and replaced with suitable drier materials. The subgrade should be graded smooth (free of depressions) and properly crowned to ensure positive drainage, with a minimum grade of 3% toward catch basins (if installed) or to the road edge (provided collection and proper gravity drainage to a suitable outlet is provided). When service pipes are installed, pipe bedding and backfilling should be undertaken as indicated in Sections 5.9 and 5.10 of this report.

Rapid drainage of the pavement structure is critical to ensure long-term performance. The requirement for subdrains will be dependent on the composition of the prepared road subgrade soils. Should the subgrade comprise fine-grained, frost-susceptible soils or relatively impermeable bedrock, it is highly recommended to install subdrains (provided gravity drainage to a suitable outlet can be provided). It is recommended to install minimum 100 mm diameter perforated subdrains to collect and redirect water beneath the pavement surface. Subdrains should be designed and installed in accordance with OPSS 405 and OPSD 216.021. If Granular 'A' bedding (OPSS 1010) is utilized, the subdrains should be equipped with a factory installed filter sock. If 19 mm clear stone (OPSS 1004) is utilized as bedding for the subdrain, then the bedding must be wrapped completely with geotextile filter fabric such as Terrafix 270R (or equivalent). Installation of rigid subdrains allows for better grade control and less potential for damage during installation, however, it would be expected that there would be higher cost implications associated with the installation of rigid subdrains over flexible subdrains. Positive drainage through grade control of subdrains is critical, as improperly installed subdrains can turn drainage systems into reservoirs, which can fuel frost action. The subdrains will hasten the removal of water, thereby reducing the risk and effects of frost heaving and load transfer in saturated conditions. It is suggested that, at a minimum, subdrains be installed through all low areas in the parking lot and driveways, and ideally along each curb line as well to prevent water from entering the granular subbase. The subdrains should be installed in a 0.3 m (1.0 ft) by 0.3 m (1.0 ft) trench in the subgrade and bedded approximately 50 mm (2") above the bottom of the trench. The subgrade must be prepared with positive drainage to the subdrains and the subdrains must be installed with positive drainage into a catch basin structure or other suitable outlet. Should the subgrade soils comprise free-draining, granular soils (minimum 1.0 m thick with positive drainage at the interface with any relatively impermeable soils or rock), then the installation of subdrains may not be required.

The subgrade soils could be sensitive to change in moisture content and can become loose or soft if the soils are subject to inclement weather and seepage or severe drying. Furthermore, the subgrade soils could be easily disturbed if traveled on during construction. As such, it is recommended that the granular subbase be placed immediately upon completion of the subgrade preparation to protect the integrity of the subgrade soils.

Should wet conditions be encountered during construction or should it be decided to leave the existing fill/granular base in place, site assessments may be required to determine what options can be undertaken to construct a modified pavement base. These options may include subexcavation of wet soils and increasing the thickness of the granular base, the use of reinforcing geotextiles, or a combination of both.

It is expected that the driveway/parking lot will experience mostly light traffic (personal vehicles) and some heavy traffic (delivery trucks, as well as maintenance and emergency vehicles, etc.). Based on the anticipated loading, and the frost-susceptibility of the soils, the following pavement design is provided:

Material	**Recommended Thickness For New Pavement**
Asphaltic Concrete	HL3 - 40 mm (1.5") HL4 or HL8 - 50 mm (2.0")
Granular 'A' Base	150 mm (6.0")
Granular 'B' Subbase	450 mm (18.0")

The granular base and subbase materials must conform to the physical property and gradation requirements of OPSS 1010 and must be compacted to 100% SPMDD. Asphaltic concrete should be supplied, placed and compacted to a minimum 92.0% Marshall maximum relative density, in accordance with OPSS 1150 and OPSS 310.

Construction joints in the surface asphalt must be offset a minimum of 150 mm to 300 mm (6" to 12") from construction joints in the binder asphalt so that longitudinal joints do not coincide.

Where new asphalt is joined into existing asphalt, it is recommended that any construction joints in the existing asphalt be sawcut in a straight line prior to being milled to a depth of 40 mm and a width of 150 mm as per OPSD 509.010. It is recommended that a tackcoat in conformance with OPSS 308 be applied to the edge of all milled asphalt prior to placement of new asphalt.

The pavement should be designed to ensure that water will not pond on the pavement surface. If the surface asphalt is not placed within a reasonable time following placement of the binder asphalt, it is recommended that the catch basin lids are set at a lower elevation or apertures provided to allow surface water to drain into the catch basins and not accumulate around the catch basins. The strength of the pavement structure relies on all of the components to be in place in order to provide the design strength; therefore, it is strongly recommended that the surface asphalt be placed shortly after placement of the binder asphalt so as to avoid undue stress on the binder asphalt by not having the complete pavement structure in place.

It should be noted that, currently, asphalt mixes tend to be more flexible and, as such, there is a tendency for damage to occur from vehicles turning their steering wheels or applying excessive brake pressure. The damage can occur from both passenger vehicles as well as large vehicles. The condition is further intensified during hot weather. In high traffic/tight turning areas, it is recommended that rigid Portland cement pavement be considered.

5.12. ***Chemical Analysis/Excess Soil Management***

Generally if surplus soils are to be exported off-site, it will be necessary to perform chemical analysis of the soils. Chemical analysis was not undertaken as part of this geotechnical investigation. Should chemical analysis tests be required, the required tests vary and will generally be dependent on the disposal site utilized by general contractor.

If soils are transported to a landfill facility, additional chemical testing in accordance with Ontario Regulation 347, Schedule 4, as amended to Ontario Regulation 558/00, dated March 2001, Toxicity Characteristic Leaching Procedure (TCLP) will be required.

When transporting soils off-site, the following is recommended:

- All chemical analyses and environmental assessment reports must be fully disclosed to the receiving site owners/authorities, who must agree to receive the material;
- An environmental consultant must confirm the land use at the receiving site is compatible to receive the material;
- An environmental consultant must monitor the transportation and placement of the materials to ensure that the material is placed appropriately at the pre-approved site;
- The excess materials may not be transported to a site that has previously had a Record of Site Condition (RSC) filed, unless the material meets the criteria outlined in the RSC.

It should be noted that landfill sites will generally only accept laboratory test results that have been completed within 30 days of exporting. Therefore, it is recommended that provisions for chemical analysis be included in the tender documents. It should also be noted that the laboratory testing generally takes five (5) working days to process with a regular turnaround time.

6.0 SLOPE STABILITY ASSESSMENT

6.1. Existing Site Conditions

A representative from CMT Inc. visited the site on December 8, 2016 and April 15, 2021 to perform a visual inspection of the slope at the back of the property. The existing slope has a height of approximately 10.0 m and is comprised of limestone bedrock. The stream valley is considered to be a confined (apparent) valley since the height of the slope is greater than 3.0 m. Since the slope is essentially vertical, the slope is considered to be oversteepened. The width of the valley is approximately 29.0 m at the site location. The top of the slope is generally moderately vegetated with occasional mature trees and low-lying vegetation. CMT Inc. probed the top of the slope and determined the depth of the soil above the bedrock to be approximately 1.0 m to 1.5 m. There were no signs of slope instability such as slumps, erosion or tension cracks. No visual signs of water seepage were noted on the slope or below the slope. Based on Table 8.1 - Slope Stability Rating Chart from *Geotechnical Principles for Stable Slopes, 1997* produced by Terraprobe for the Ontario Ministry of Natural Resources (MNR) (same as Table 4.2 – Slope Rating Chart from *Technical Guide – River and Stream Systems: Erosion Hazard Limit, 2002* by the MNR), the slope was found to have a rating of 30 and therefore, the slope is considered to have slight potential of instability. The Slope Stability Rating Chart is provided in Appendix C.

6.2. <u>Slope Stability Assessment</u>

Based on the information provided above, the slope has been assessed with respect to Section 8.2 of O. Reg. 150/06. With reference to Section 8.2, the slope is considered oversteepened.

In assessing the stability of the slope, it is important to acknowledge that the slope is comprised of limestone bedrock. Classical circular slope failures, as may occur in soils slopes, generally do not occur in rock slopes unless they are extremely blocky in nature. The most common form of failure in rock masses of this nature is toppling due to the stress relief cracks. These failures are fairly rare and are generally minor in scale. The most likely causes are due to the formation of ice or tree roots in the stress relief joints causing the rock to be pushed away from the face.

The cross-section through the slope (referenced as Cross-Section A-A') runs from west to east from St Andrew Street West, through the proposed building and across the slope to the Grand River at the east of the property. Contours provided by the Grand River Conservation Authority were used in generating the change in elevation along the cross-section. The location of the cross-section is show in Drawing 3.

A Factor of Safety of 1.0 is considered to represent a potential failure condition, and a Factor of Safety of 1.5 is considered to be adequate for this site with respect to shallow and deep-seated (global) failure surfaces.

The slope stability analysis of the slope was completed utilizing the SLIDE software package by Rocscience. The results of the slope stability analysis including the safety factor achieved for the existing slope under proposed loading conditions across Cross-Section A-A' is provided in Drawing 3. For the sake of this study, the proposed 5-storey building was modelled using a universally distributed vertical load of 200 kPa. Based on the analyses completed for the slope in Cross-Section A-A' under existing conditions, an overall minimum Safety Factor of 1.835 was determined. As such, the slope is considered to be stable under the proposed conditions.

6.3. <u>Erosion</u>

Based on Table 3 from *Technical Guide – River and Stream Systems: Erosion Hazard Limit, 2002* by the MNR, since the structure of the slope is comprised of sound limestone bedrock, and the bankfull width of the valley is less than 30.0 m with no evidence of active erosion, the anticipated long-term toe erosion will be less than 1.0 m. As such, an erosion allowance of 1.0 m should be taken into account.

The analysis was repeated utilizing the SLIDE software package by Rocscience, using the same slope configuration but with the slope face cut back 1.0 m towards the proposed building to account for long-term, toe erosion. The results of the slope stability analysis including the safety factor achieved for the slope with the added erosion is provided in Drawing 4. Based on the analyses completed for the slope in Cross-Section A-A' under existing conditions including erosion, an overall Safety Factor of 1.760 was determined. As such, the slope is considered to be stable under the long-term erosion conditions.

6.4. Slope Stability Recommendations/Conclusions

The proposed parking lot would be considered Public Infrastructure and as such, would be subject to Subsection 8.2.21 of O. Reg. 150/06. With respect to the requirements of Subsection 8.2.21 as well as Subsection 7.1 (General Policies), CMT Inc. considers the proposed parking lot construction to have negligible potential adverse effects on the existing slope.

Based on the assessment, a 1.0 m erosional setback is required in the area of the proposed parking lot. O. Reg. 150/06, however, also requires a minimum setback of 6.0 m (20.0 ft) from the top of slope to any proposed structure, resulting in a total allowance of 7.0 m (23.0 ft) from the existing top of slope. CMT Inc. recommends that this setback be maintained for the proposed parking lot. Drawing 2 shows the required setback and distances relative to the proposed building. A guard and/or fence should be installed on the east end of the parking lot in order to restrict access of both vehicles and people to the top of the slope. It should be noted that the proposed building will be located approximately 35.0 m (114.8 ft) from the top of the slope and, based on the analysis performed, will have a negligible effect with respect on the stability of the slope.

7.0 SITE INSPECTION

Qualified geotechnical personnel should supervise excavation inspections as well as compaction testing for structural filling, site grading and site servicing. This will ensure that footings are founded in the proper strata and that proper material and techniques are used and the specified compaction is achieved. CMT Engineering Inc. would be pleased to review the design drawings and provide an inspection and testing program for the construction of the proposed development.

8.0 LIMITATIONS OF THE INVESTIGATION

This report is intended for the Client named herein and for their Client. The report should be read in its entirety, and no portion of this report may be used as a separate entity. 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.

The recommendations made in this report are in accordance with our present understanding of the project. We request that we be permitted to review our recommendations when the drawings and specifications are complete, or if the proposed construction should differ from that mentioned in this report.

It is important to emphasize that a soil investigation is, in fact, a random sampling of a site and the comments are based on the results obtained at the test locations only. It is therefore assumed that these results are representative of the subsoil conditions across the site. Should any conditions at the site be encountered which differ from those found at the test locations, we request that we be notified immediately in order to permit a reassessment of our recommendations.

It should be noted that this report specifically addresses geotechnical aspects of the project and does not include any investigations or assessments relating to potential subsurface contamination. As such, there should be no assumptions or conclusions derived from this report with respect to potential soil or water contamination. Soil or water contamination is generally caused by the presence of xenobiotic (human-made) chemicals or other alteration processes in the natural soil and groundwater environment. If necessary, the investigation, assessment and rehabilitation of soil and water contaminants should be undertaken by qualified environmental specialists.

The samples obtained during the geotechnical investigation will be stored for a period of three months, after which time they will be disposed of unless alternative arrangements are made.

We trust that this report meets with your present requirements. Should you have any questions, please do not hesitate to contact our office.

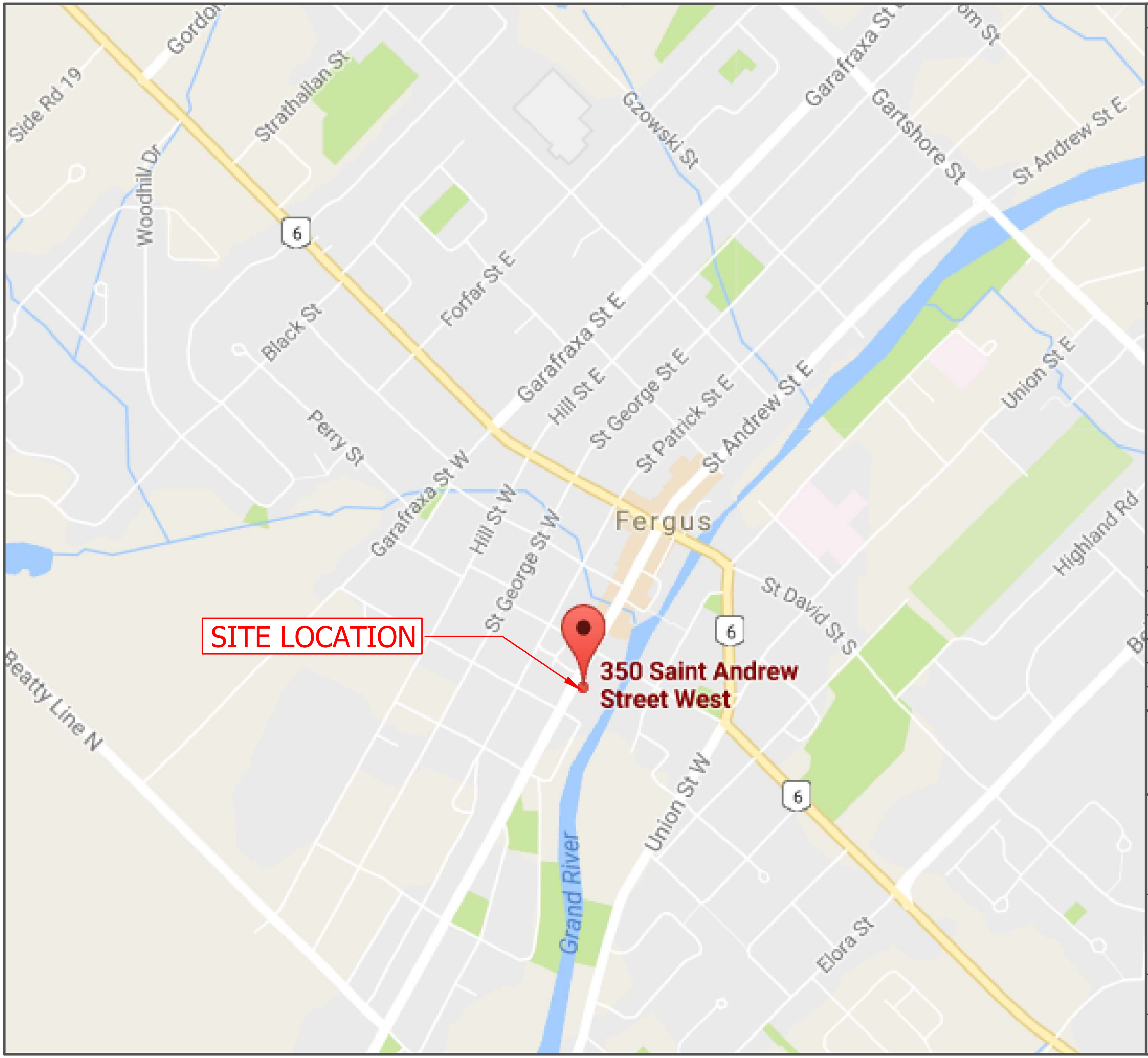
Prepared by: Reviewed by:

Shawn Wheatley

Shawn Wheatley, M.Eng. Nathan Chortos, P.Eng.

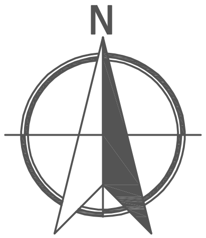
ks

LICENSED PROFESSIONAL ENGINEER
2021/04/27
N. J. CHORTOS
100210851
PROVINCE OF ONTARIO



NOTES:

Base map provided by Goo Mapsgle



NO.	DESCRIPTION	DATE

REVISIONS

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Fax: 519-699-4664
www.cmtinc.net

PROJECT:
GEOTECHNICAL INVESTIGATION &
SLOPE STABILITY ASSESSMENT
350 St. Andrew Street West
Fergus, Ontario

DRAWING TITLE:
SITE LOCATION MAP

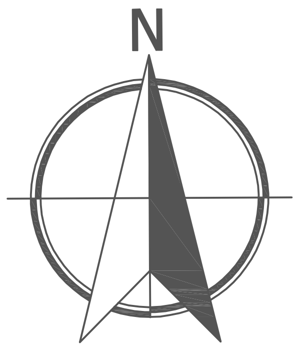
PROJECT NO.: 16-708(b)
DATE: April 23, 2021
SCALE: N.T.S.
DRAWING NO. 1

NOTES:

1. This drawing is for information purposes only. Locations and sizes of existing and proposed structures are approximate only, and should not be used for construction.
2. Base map provided by Grand River Conservation Authority, Fryett Turner Architechts.

LEGEND

⊕ CMT Borehole (2017)



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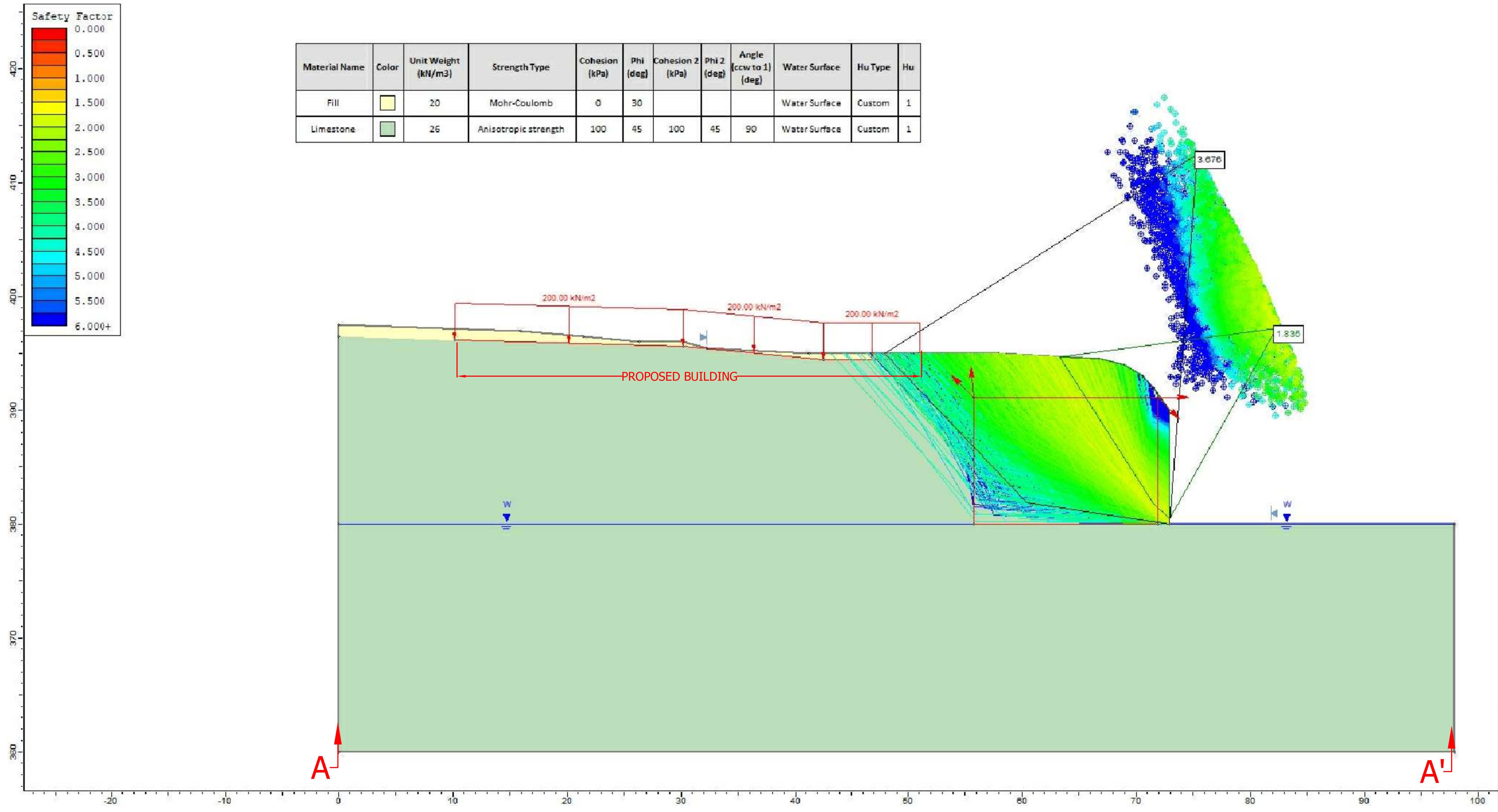
PROJECT:

GEOTECHNICAL INVESTIGATION & SLOPE STABILITY ASSESSMENT
350 St. Andrew Street West,
Fergus, Ontario

DRAWING TITLE:

SITE PLAN SHOWING BOREHOLE LOCATIONS

PROJECT NO.:	DATE:
16-708(b)	April 23, 2021
SCALE:	DRAWING NO.
N.T.S.	2



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion 2 (kPa)	Phi 2 (deg)	Angle (ccw to 1) (deg)	Water Surface	Hu Type	Hu
Fill	🟨	20	Mohr-Coulomb	0	30				Water Surface	Custom	1
Limestone	🟩	26	Anisotropic strength	100	45	100	45	90	Water Surface	Custom	1

NOTES:

1. This drawing is for information purposes only. Locations and sizes of existing and proposed structures are approximate only, and should not be used for construction.
2. Base map provided by Grand River Conservation Authority, Fryett Turner Architechts.

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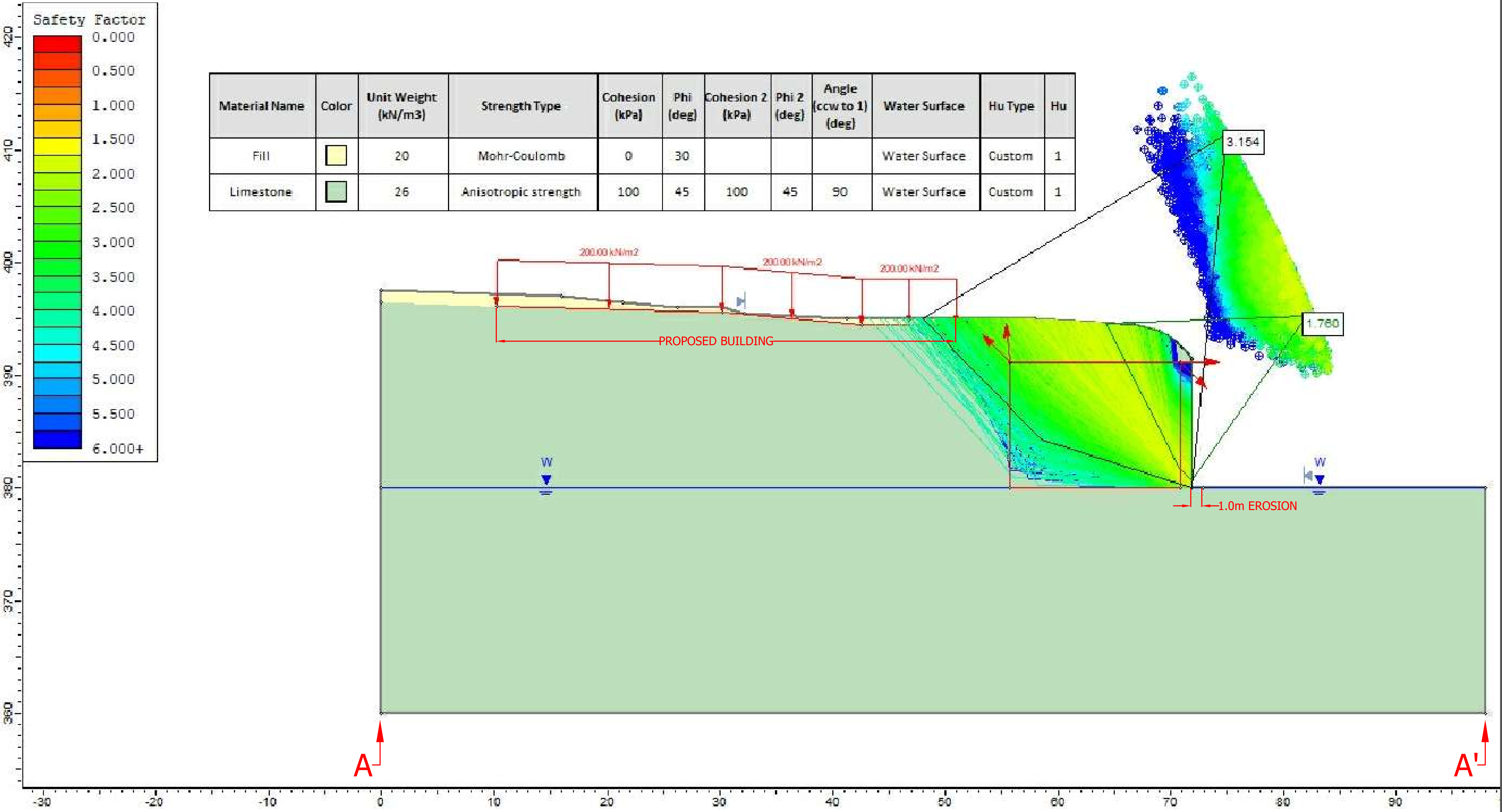
PROJECT:
GEOTECHNICAL INVESTIGATION &
SLOPE STABILITY ASSESSMENT
350 St. Andrew Street West,
Fergus, Ontario

DRAWING TITLE:
CROSS SECTION A-A'
MINIMUM FACTORS OF SAFETY
PROPOSED CONDITIONS

PROJECT NO.: 16-708(b)
DATE: April 23, 2021
SCALE: N.T.S.
DRAWING NO. 3



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion 2 (kPa)	Phi 2 (deg)	Angle (ccw to 1) (deg)	Water Surface	Hu Type	Hu
Fill	🟨	20	Mohr-Coulomb	0	30				Water Surface	Custom	1
Limestone	🟩	26	Anisotropic strength	100	45	100	45	90	Water Surface	Custom	1

NOTES:

1. This drawing is for information purposes only. Locations and sizes of existing and proposed structures are approximate only, and should not be used for construction.
2. Base map provided by Grand River Conservation Authority, Fryett Turner Architechts.

NO.	DESCRIPTION	DATE

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PROJECT:
GEOTECHNICAL INVESTIGATION &
SLOPE STABILITY ASSESSMENT
350 St. Andrew Street West,
Fergus, Ontario

DRAWING TITLE:
CROSS SECTION A-A'
MINIMUM FACTORS OF SAFETY
EROSION

PROJECT NO.: 16-708(b)
DATE: April 23, 2021
SCALE: N.T.S.
DRAWING NO. 4

APPENDIX A

BOREHOLE LOGS

BOREHOLE 1

Page 1 of 1

Date Drilled: January 30, 2017
Rig: 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT/MC5

Elevation: 397.83 m
Logged by: AG

Project No.: 16-708(b)
Project: Proposed Building
Location: 350 St. Andrew Street West
Fergus, Ontario

Depth (ft/m) | Sample Type | Recovery (%) | Sample Number | Symbols | SOIL DESCRIPTION | Well Installation | Moisture Content % ◂Wp [----X----] Wl▸ 10 20 30 40 | Pocket Penetrometer ● kPa ● 100 200 300 400 / SPT (N) ■ Blows/0.3 m ■ 20 40 60 80

Ground Surface (m) 397.83 0.00

TOPSOIL
Dark brown, wet silty topsoil [0.20m]

397.63 0.20

FILL
Loose to very loose, brown gravelly fill, trace to some silt and sand, some organics and clay, moist [2.09m]

low recovery

BH1a was advanced 0.5m away using macro coring technique to obtain samples which resulted in zero recovery

395.54 2.29

POSSIBLE BEDROCK
Thick root from nearby tree encountered
Could not drive SPT and MC5 sampler deeper possible bedrock

End of Borehole

Caved at 1.12m bgs. No accumulated groundwater upon completion.

Sample Type	Sample Number	Moisture Content %	SPT (N) Blows/0.3 m
SS	1	6.3	9
SS	2	3.2	9
SS	3	10.7	3
SS	4		70(3")

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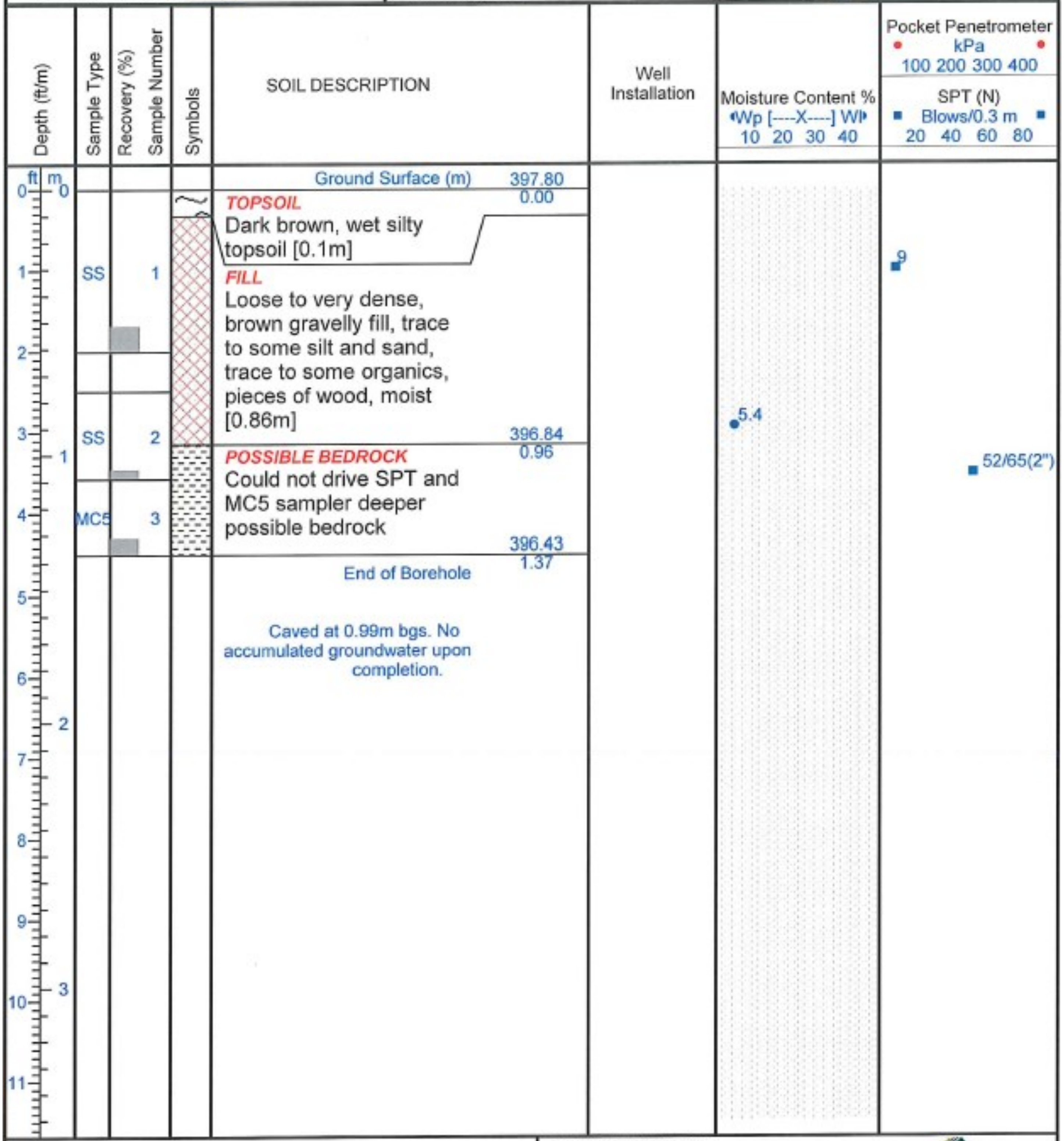
BOREHOLE 2

Page 1 of 1

Date Drilled: January 30, 2017
Rig: 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT/MC5

Elevation: 397.80 m
Logged by: AG

Project No.: 16-708(b)
Project: Proposed Building
Location: 350 St. Andrew Street West
Fergus, Ontario



Ground Surface (m) 397.80 0.00

TOPSOIL
Dark brown, wet silty topsoil [0.1m]

FILL
Loose to very dense, brown gravelly fill, trace to some silt and sand, trace to some organics, pieces of wood, moist [0.86m]

396.84 0.96

POSSIBLE BEDROCK
Could not drive SPT and MC5 sampler deeper possible bedrock

396.43 1.37

End of Borehole

Caved at 0.99m bgs. No accumulated groundwater upon completion.

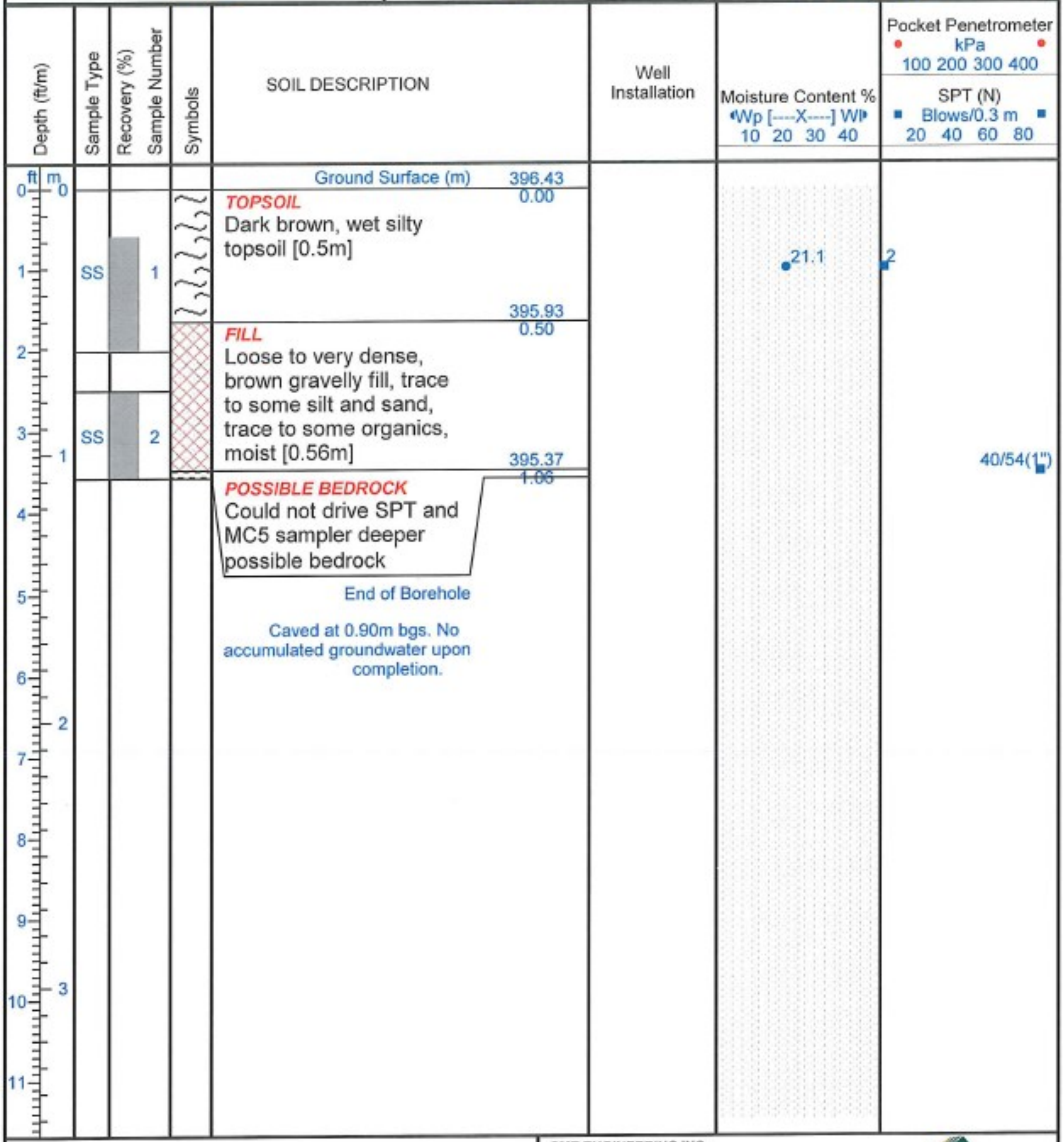
BOREHOLE 3

Page 1 of 1

Date Drilled: January 30, 2017
Rig: 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT/MC5

Elevation: 396.43 m
Logged by: AG

Project No.: 16-708(b)
Project: Proposed Building
Location: 350 St. Andrew Street West
Fergus, Ontario



Sample Type	Sample Number	SOIL DESCRIPTION	Elevation / Depth (m)	Moisture Content %	SPT (N)
		Ground Surface (m)	396.43 0.00		
SS	1	***TOPSOIL*** Dark brown, wet silty topsoil [0.5m]		21.1	2
SS	2	***FILL*** Loose to very dense, brown gravelly fill, trace to some silt and sand, trace to some organics, moist [0.56m]	395.93 0.50		40/54(1")
		POSSIBLE BEDROCK Could not drive SPT and MC5 sampler deeper possible bedrock	395.37 1.06		

End of Borehole

Caved at 0.90m bgs. No accumulated groundwater upon completion.

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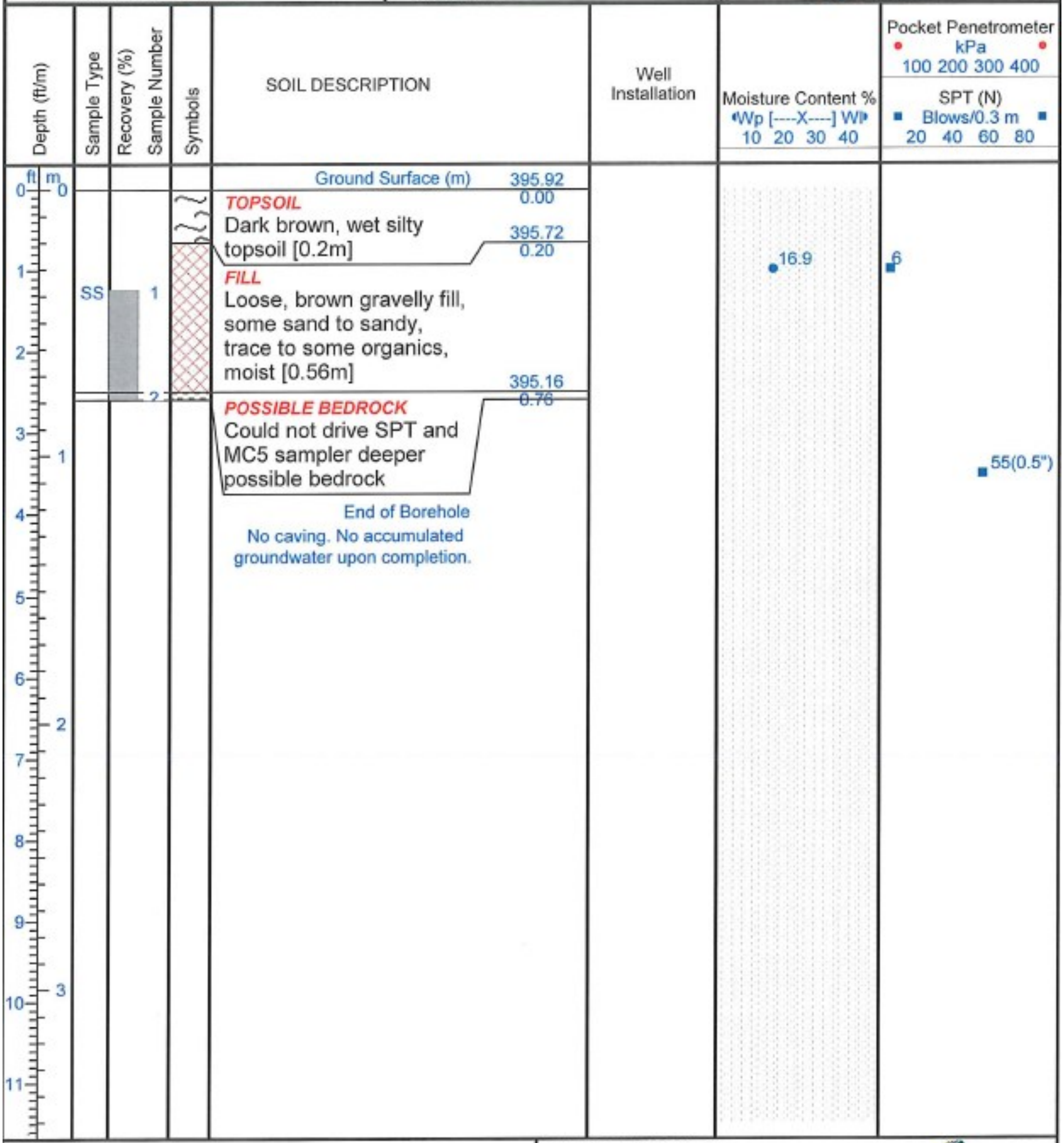
BOREHOLE 4

Page 1 of 1

Date Drilled: January 30, 2017
Rig: 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT/MC5

Elevation: 395.92 m
Logged by: AG

Project No.: 16-708(b)
Project: Proposed Building
Location: 350 St. Andrew Street West
Fergus, Ontario



Ground Surface (m) 395.92 0.00

TOPSOIL
Dark brown, wet silty topsoil [0.2m] 395.72 0.20

FILL
Loose, brown gravelly fill, some sand to sandy, trace to some organics, moist [0.56m] 395.16 0.76

POSSIBLE BEDROCK
Could not drive SPT and MC5 sampler deeper possible bedrock

End of Borehole
No caving. No accumulated groundwater upon completion.

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BOREHOLE 5

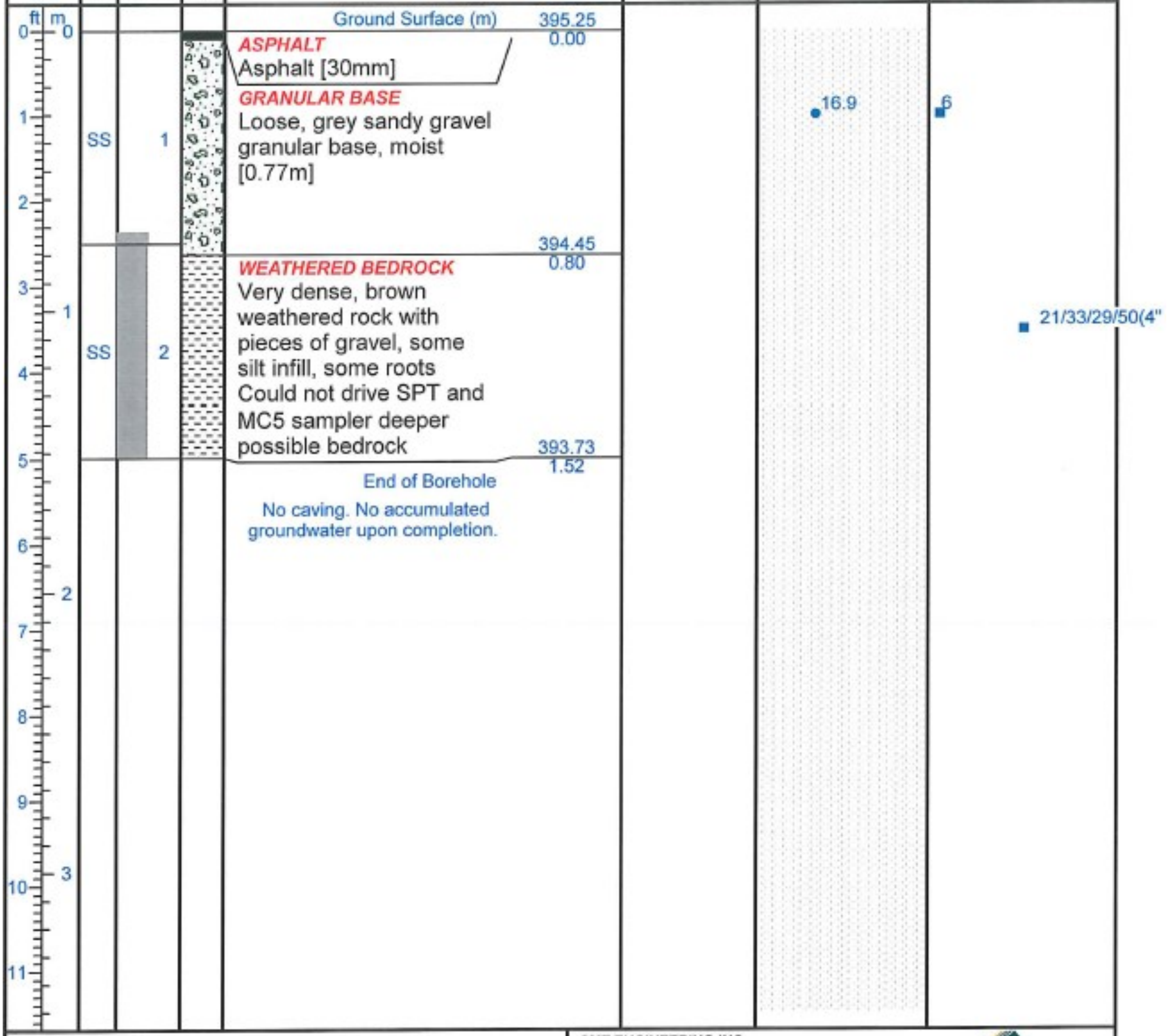
Page 1 of 1

Date Drilled: January 30, 2017
Rig: 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT/MC5

Elevation: 395.25 m
Logged by: AG

Project No.: 16-708(b)
Project: Proposed Building
Location: 350 St. Andrew Street West
Fergus, Ontario

Depth (ft/m)	Sample Type	Recovery (%)	Sample Number	Symbols	SOIL DESCRIPTION		Well Installation	Moisture Content % Wp [----X----] Wl 10 20 30 40	Pocket Penetrometer kPa 100 200 300 400 SPT (N) Blows/0.3 m 20 40 60 80
0					Ground Surface (m)	395.25 0.00			
	SS		1		***ASPHALT*** Asphalt [30mm] ***GRANULAR BASE*** Loose, grey sandy gravel granular base, moist [0.77m]			16.9	6
	SS		2		***WEATHERED BEDROCK*** Very dense, brown weathered rock with pieces of gravel, some silt infill, some roots Could not drive SPT and MC5 sampler deeper possible bedrock	394.45 0.80			21/33/29/50(4"
					End of Borehole No caving. No accumulated groundwater upon completion.	393.73 1.52			



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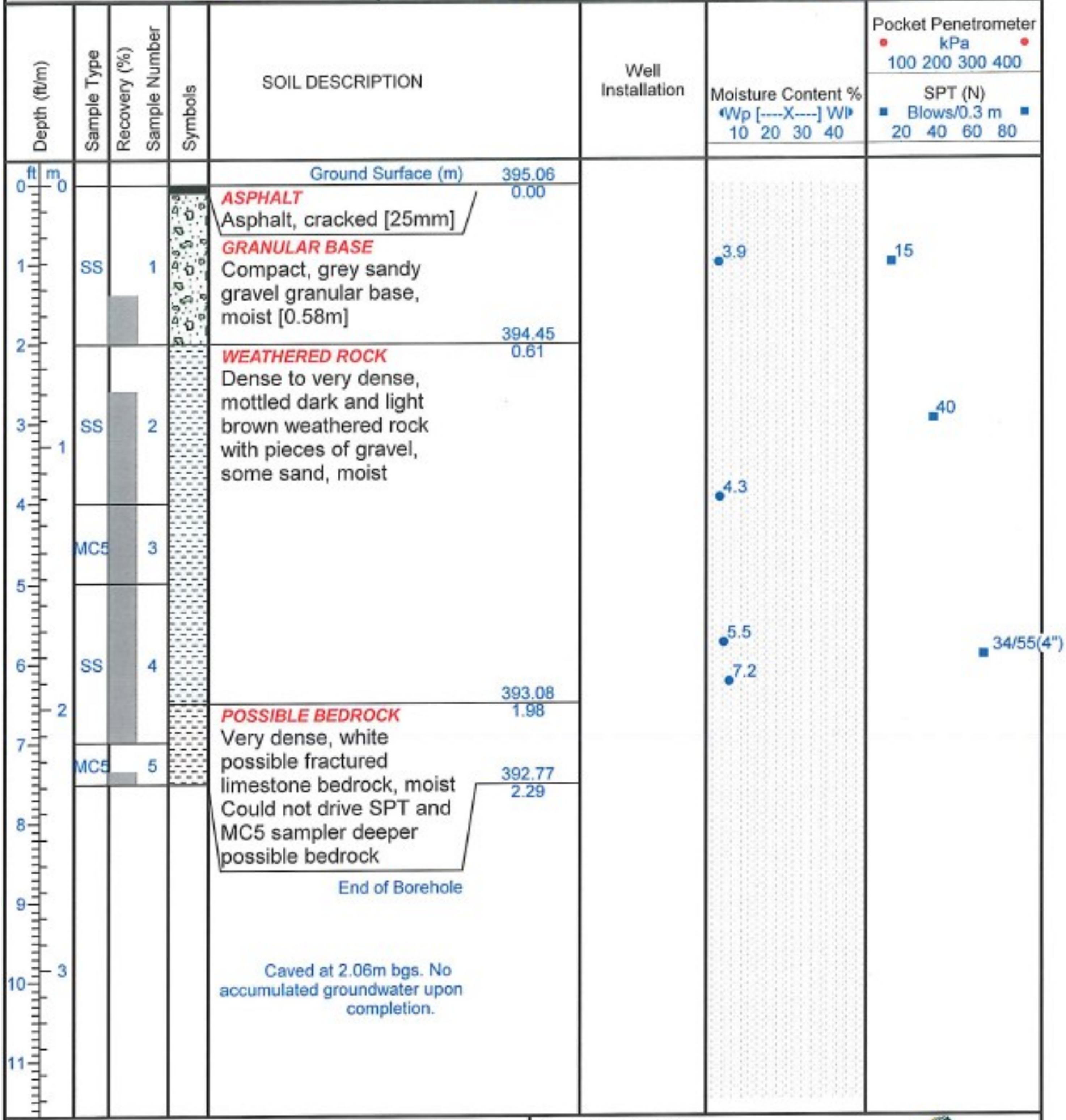
BOREHOLE 6

Page 1 of 1

Date Drilled: January 30, 2017
Rig: 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT/MC5

Elevation: 395.06 m
Logged by: AG

Project No.: 16-708(b)
Project: Proposed Building
Location: 350 St. Andrew Street West
Fergus, Ontario



Sample Type	Sample Number	SOIL DESCRIPTION	Elevation / Depth (m)	Moisture Content %	SPT (N) Blows/0.3 m
		Ground Surface (m)	395.06 0.00		
		ASPHALT Asphalt, cracked [25mm]			
SS	1	**GRANULAR BASE** Compact, grey sandy gravel granular base, moist [0.58m]		3.9	15
SS	2	**WEATHERED ROCK** Dense to very dense, mottled dark and light brown weathered rock with pieces of gravel, some sand, moist	394.45 0.61		40
MC5	3			4.3	
SS	4			5.5 7.2	34/55(4")
MC5	5	**POSSIBLE BEDROCK** Very dense, white possible fractured limestone bedrock, moist Could not drive SPT and MC5 sampler deeper possible bedrock	393.08 1.98		
		End of Borehole	392.77 2.29		

Caved at 2.06m bgs. No accumulated groundwater upon completion.

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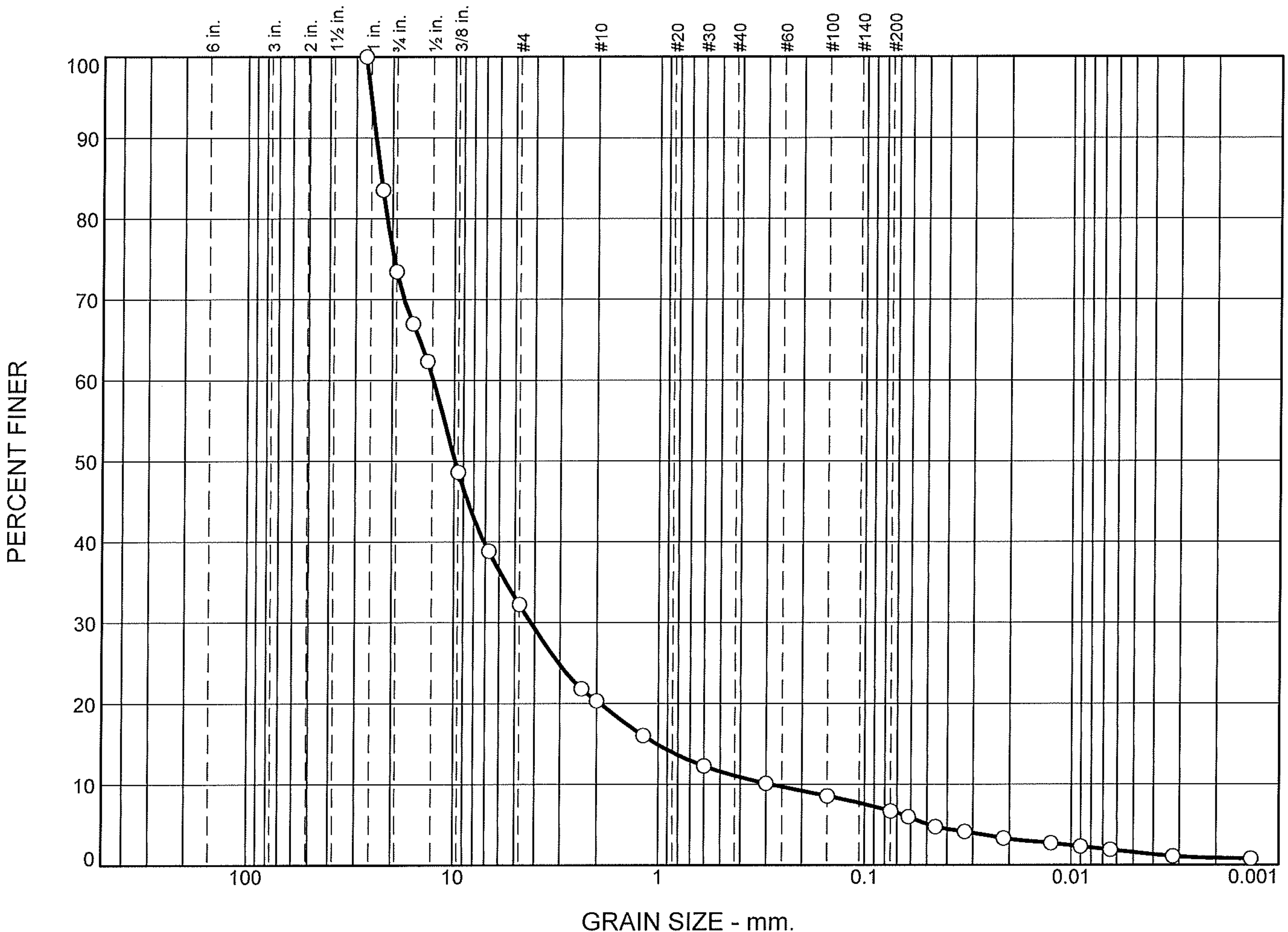
APPENDIX B

GRAIN SIZE ANALYSIS

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	26.5	41.3	11.9	9.2	4.4	5.8	0.9

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH5	Sa2	0.8-1.4m	sandy gravel, trace silt, clay	GP-GM
				Tested by JH of CMT Engineering Inc., February 7, 2017	

CMT Engineering Inc.

St. Clements, ON

Client: Van Grootheest Holdings Inc.
Project: Slope Stability - 5-Storey Building
350 St. Andrew Street West, Fergus, Ontario
Project No.: 16-708(b) **Figure** 1

APPENDIX C

SLOPE STABILITY RATING CHART

TABLE 4.2 - SLOPE STABILITY RATING CHART

Site Location: 350 St. Andrew Street West, Fergus, ON
Project No.: 16-708

Property Owner: Ms. Zainab Jafferjee
Inspection Date: December 8, 2016

Inspected By: Mark Vignault, P. Eng.
Weather: -3°c, Overcast

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) 2.0 m or less		0
b) 2.1 m to 5.0 m		2
c) 5.1 m to 10.0 m		[✓ **4**]
d) more than 10.0 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 STABILITY RATING VALUES INVESTIGATION RATING SUMMARY	**TOTAL**	**30**

SUMMARY OF RATING VALUES AND RESULTING INVESTIGATION REQUIREMENTS

1. Low potential	< 24	- site inspection only, confirmation report letter
[✓ **2. Slight potential**]	**25-35**	- site inspection and surveying, preliminary study, detailed report
3. Moderate potential	>35	- boreholes, piezometers, lab tests, surveying, detailed report

NOTES:

a) Choose only one from each category; compare total rating value with above requirements.

b) If there is a water body (stream, creek, river, pond, bay, lake) at the slope toe, the potential for toe erosion and undercutting should be evaluated in detail and protection provided if required.

Reference: Technical Guide - River and Stream Systems: Erosion Hazard Limit, Ontario Ministry of Natural Resources, 2002.

Appendix B

Water Demand Design Sheet

350 ST. ANDREW ST W
FIRE FLOW ANALYSIS
Fergus, Ontario

Project Number: 48790-100
Date: June 1, 2021
Design By: CXM

File: Q:\48790\100\Site Fire Flow Analysis.xlsx

Step 1: Determining Water Supply Coefficient

Table 1 from OBC 2012 A3.2.5.7

	Type of Construction	Classification by group or division in Accordance with Table 3.1.2.1 of the Ontario Building Code											
		A2	B1	B2	B3	C	D	A4	F3	A1	A3	E	F2	F1
1	Building is of Noncombustible construction with fire separation and fire-resistance ratings provided in accordance with Subsection 3.2.2 of the OBC, including loadbearing walls, columns and arches						10		12		14		17	23
2	Building is of Noncombustible construction or of heavy timber construction conforming to Article 3.1.4.6 of the OBC. Floor assemblies are fire separations but no fire-resistance rating. Roof assemblies, mezzanines, loadbearing walls, columns and arches do not have a fire-resistance rating.						16		19		22		27	37
3	Building is of Combustible Construction with fire separations and fire-resistance ratings provided in accordance with Subsection 3.2.2 of the OBC, including loadbearing walls, columns and arches. Noncombustible construction may be used in lieu of fire resistance rating where permitted in subsection 3.2.2 of the OBC						18		22		25		31	41
4	Building is of combustible construction. Floor assemblies are fire separations but with no fire-resistance rating. Roof assemblies, mezzanines, loadbearing walls, columns and arches do not have a fire-resistance rating.						23		28		32		39	53

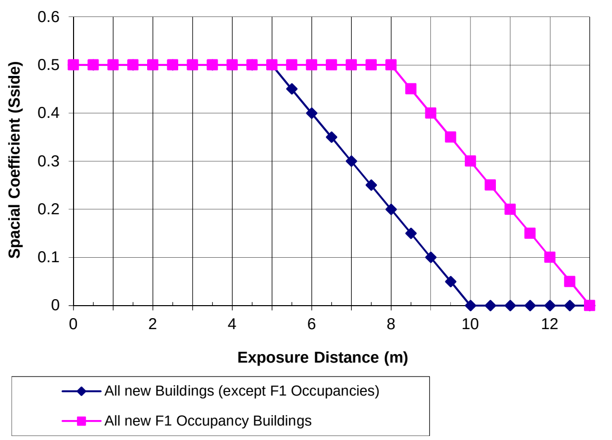
Type of Construction	Building Classification	Water Supply Coefficient (K)
3	E	**31**

Mainly Residential C, with subsidiary E

Step 2: Determine the Spacial Coefficient

		Distance	S_{side}
N	Exposure Distance 1 (m)	0.00	0.50
E	Exposure Distance 2 (m)	28.00	0.00
S	Exposure Distance 3 (m)	0.00	0.50
W	Exposure Distance 4 (m)	4.00	0.50
	Exposure Distance 5 (m)		
		S_{tot}	**2.00**

Figure 1 - Spatial Coefficient vs Exposure Distance



Step 3: Determine Volume of Building

Building Area (m2)	Average Height of Floors (m)	Volume (m3)
2837.00	3.22	9135.14

Number of Stories 6

Step 4: Calculate Minimum Water Supply

$$Q = KVS_{tot}$$

Minimum Water Supply (L) **566378.68**

Step 5: Calculate Minimum Supply Flow Rate

Table 2 from OBC 2012 A3.2.5.7

Minimum Water Supply Flow Rates

Building Code, Part 3 Buildings	Required Minimum Water Supply Flow Rate (L/min)		
One Storey Building with building area not exceeding 600 m2 (excluding F1 occupancy)	1800		
All Other Buildings	if Q> and	Q<=	
		108000	2700
	108000	135000	3600
	135000	162000	4500
	162000	190000	5400
	190000	270000	6300
	270000		9000

Minimum Water Supply Flow Rate (L/min) **9000**

Step 6: Is a private fire reservoir required? **No**

350 ST. ANDREW ST. WW.

Fergus, Ontario

Project No:	48790-100
Date:	24-Nov-21
Designer:	CXM

FIRE FLOW DEMAND REQUIREMENTS - FIRE UNDERWRITERS SURVEY (FUS GUIDELINES)

Fire flow demands for the FUS method is based on information and guidance provided in "Water Supply for Public Protection" (Fire Underwriters Survey, 1999).
An estimate of the fire flow required is given by the following formula:

$$F = 220\,C\,\sqrt{A}$$

where:

F = the required fire flow in litres per minute
C = coefficient related to the type of construction
= 1.5 for wood frame construction (structure essentially all combustible).
= 1.0 for ordinary construction (brick or other masonry walls, combustible floor and interior)
= 0.8 for non-combustible construction (unprotected metal structural components, masonry or metal walls)
= 0.6 for fire-resistive construction (fully protected frame, floors, roof)
A = Total floor area in square metres

Adjustments to the calculated fire flow can be made based on occupancy, sprinkler protection and exposure to other structures.
The table below summarizes the adjustments made to the basic fire flow demand.

			(1)		(2)		(3)		(4)		**Final Adjusted**		
	Area "A"	C	Fire Flow "F"		Occupancy		Sprinkler		Exposure		**Fire Flow**		
Building	(m^2)		(l/min)	(l/s)	%	Adjusted Fire Flow (L/min)	%	Adjustment (L/min)	%	Adjustment (L/min)	**(L/min)**	**Rounded(L/min)**	**(L/s)**
Detached Residential Building	2,837	0.8	9,000	150.0	0	9,000	-50	-4,500	35	3,150	7,650	**8,000**	133

(2) Occupancy

Non-Combustible	-25%
Limited Combustible	-15%
Combustible	No charge
Free Burning	15%
Rapid Burning	25%

(3) Sprinkler

40% credit for adequately designed system per NFPA 13. Additional 10% if water supply standard for both the system and fire department hose lines.

(4) Exposure

0 to 3m	25%
3.1 to 10m	20%
10.1 to 20m	15%
20.1 to 30m	10%
30.1 to 45m	5%

Calculate for all sides. Maximum charge shall not exceed 75%

350 ST. ANDREW ST W
WATER DEMANDS
Fergus, Ontario

Project #: 48790-100
Date: November 24, 2021
BY: CXM
Checked B LEI

								Fire Flow[2]															Domestic Flow[3,4]						
Development Information[1]								Ontario Building Code						Fire Underwriters Survey															
Node ID / Area ID / Building #	**F.F.E. (m.a.s.l.)**	**Description**	**# of Units**	**Population**	**Bldg Area** (1st Floor)	**Total Bldg Area**	**Building Volume**	**K**	**V**	**S_{tot}**	**Q**	**F**	**F**	**C**	**A**	**F**	**(2)** Occupancy Reduction	**(3)** Sprinkler Protection	**(4)** Building Exposure	**F**	**F**	**Fire Flow (Max OBC/FUS)**	**MOE Guidelines**	**Average Day**	**Max Day**	**Peak Hour**	**Minimum Hour**	**Max Day + OBC Fire Flow**	**Max Day + FUS Fire Flow**
				# of people	*m^2*	*m^2*	*m^3*		*m^3*		*L*	*L/min*	*L/s*		*m^2*	*L/min*				*L/min*	*L/s*	*L/s*	*L/s*	*L/s*	*L/s*	*L/s*	*L/s*	*L/s*	*L/s*
	398.42	Prop 5-storey bldg	36	66	595	2,837	9,135	31	9,135	2.00	566,379	9,000	150	0.80	2,837	9,000	0%	-50%	35%	8,000	133	150	0.343	0.343	0.944	1.417	0.137	151	134
		TOTALS FOR SITE	**36**	**66**	**595**	**2837**	**9135**					**Max Fire Flow =**	**150**							**Max Fire Flow =**	**133**	**150**	**0.34**	**0.34**	**0.94**	**1.42**	**0.14**	**151**	**134**
																												Sum of Maximum Day Flows + OBC Fire Flow (L/s) =	**151**
																												Sum of Maximum Day Flows + FUS Fire Flow (L/s) =	**134**

Assumptions:

1 The building area is based on the Site Plan by Fryett Turner Architect., which includes 36 units. Assumed 1.83 persons per unit as Region of Waterloo Land Budget. (refer to section 4.1.8). The building volume is based on a building height of 19.3 taken from the Site Plan by Fryett Turner Architect.

2 The building is classified as occupancy group C (Residential Occupancy) and group E (Mercantile Occupancy) , conservatively assumed all commercial. The construction type is non combustible.

3 Average Daily Demand for the building is based on "Design Guidelines for Drinking-Water Systems" (MOE, 2008):

Residential = 450 L/cap/day

4 Peaking Factors based on "*Design Guidelines for Drinking-Water Systems*" (MOE, 2008):

Average Day =	1
Maximum Day =	2.75
Peak Hour =	4.13
Minimum Hour =	0.4

Appendix C

Sanitary Sewer Design Sheet

350 St. Andrew Street West, Fergus
Township of Centre Wellington

Project Number: 48790-100
Date: November 24, 2021
Design By: CXM
Checked By: LEI
File: Q:\48790\100\Sanitary Sewer Design Sheet.xls

SANITARY SEWER DESIGN SHEET

ENGINEERING AND PUBLIC WORKS

Drainage Area Plan No: N/A

Design Parameters

Average Daily Flow			Resid. Density (ppu)			
Residential	0.00405	L/s/c	Singles	3.30	Mannings "*n*"	0.013
Commercial	1.16	L/s/ha	Semi's	3.30	Min. Velocity	0.8 m/sec
Industrial	1.0	L/s/ha	Row	2.48	Max. Velocity	3.0 m/sec
School	2.5	L/s/ha	Appt's	1.83		
Resid. Infiltration Rate	0.15	L/s/ha				

Residential Harmon Peaking Factor $F = 1 + (14 / (4 + P^{0.5}))$
Commercial Peaking Factor = 2.5

LOCATION				RESIDENTIAL AREAS and POPULATION								SCHOOL, INSTITUTIONAL			COMMERCIAL			INDUSTRIAL				INFILTRATION			DESIGN						
STREET	AREA NO.	MANHOLE LOCATION		AREA	PROP. DENSITY		POPUL.	CUMMULATIVE		PEAK FACTOR "F"	PEAK RES. FLOW	HECTARES AND FLOW OF EACH ZONING									TOTALS-C-I FLOW	AREA	CUMUL AREA	INFIL FLOW	TOTAL VOLUME FLOW	LENGTH	SLOPE	PIPE SIZE	CAPACITY	FULL FLOW VELOCITY	ACTUAL VELOCITY
												2.50 *L/s/ha*			1.16 *L/s/ha*			1.00 *L/s/ha*													
		FROM MH	TO MH		ZONE	UNITS 1.83		AREA	POPUL.			AREA	CUMUL AREA	PEAK FLOW	AREA	CUMUL AREA	PEAK FLOW	AREA	CUMUL AREA	PEAK FLOW											
				ha	*p/unit*	*p/unit*	1000s	ha	*1000s*		*L/sec*	*ha*	*ha*	*L/sec*	*ha*	*ha*	*L/sec*	*ha*	*ha*	*L/sec*	*L/sec*	*ha*	*ha*	*L/sec*	*L/sec*	*m*	*%*	*mm*	*L/sec*	*m/s*	*m/s*
					36.00		0.066	0.000	0.066	4.2890	1.1446	0.00	0.00	0	0.12	0.12	0.3335	0.00	0.00	0.0000	0.3335	0.12	0.12	0.0173	1.4954	3.4	2.00	150	21.5267	1.219	0.700

Appendix D

Storm Sewer Design Sheet

350 St. Andrew Street West, Fergus
TOWNSHIP OF CENTRE WELLINGTON

Project Number:	48790-100
Date:	June 15, 2021
Design By:	CXM
Checked By:	LEI
File:	Q:\48790\100\Storm Sewer Design Sheet.xlsx

STORM SEWER DESIGN SHEET
ENGINEERING AND PUBLIC WORKS

Drainage Area Plan No: Figure 2.0

Design Parameters

5 YEAR STORM

Q=kAIC, k=0.00278
Intensity (I) = $a/(tc+b)^c$
a = 1593
b = 11.0
c = 0.8789

Manning's "n"	0.013
Min. Velocity	0.60 m/s
Max. Velocity	6.00 m/s

LOCATION				STORMWATER FLOW 5 YEAR STORM								DESIGN						
STREET	AREA NUMBER	MANHOLE LOCATION FROM MH	MANHOLE LOCATION TO MH	AREA (A)	RUNOFF COEFF. (C)	A x C	CUMUL. A x C	CONCENTRATION TIME TOTAL	CONCENTRATION TIME IN PIPE	RAIN INTENSITY (I)	FLOW (Q)	PIPE SIZE	LENGTH	SLOPE	CAPACITY	FULL FLOW VELOCITY	ACTUAL VELOCITY	PIPE FULL
				ha		*ha*	*ha*	*min*	*min*	*mm/hr*	*L/s*	*mm*	*m*	*%*	*L/s*	*m/s*	*m/s*	*%*
		OGS1	Headwall	0.136	0.85	0.1156	0.1156	10.0000	0.1047	109.67742	35.24681	300	11.2	2.60	155.92529	2.2059	1.7825	22.60

*Runoff coefficient adjusted to match MIDUSS flows

350 St. Andrew Street West, Fergus
TOWNSHIP OF CENTRE WELLINGTON

Project Number: 48790-100
Date: June 15, 2021
Design By: CXM
Checked By: LEI
File: Q:\48790\100\Storm Sewer Design Sheet.xlsx

STORM SEWER DESIGN SHEET

ENGINEERING AND PUBLIC WORKS

Drainage Area Plan No: Figure 2.0

Design Parameters

100 YEAR STORM

Q=kAIC, k=0.00278
Intensity (I) = a/(tc+b)^c
a = 4688
b = 17.0
c = 0.9624

Manning's "n" 0.013
Min. Velocity 0.60 m/s
Max. Velocity 6.00 m/s

LOCATION				STORMWATER FLOW 100 YEAR STORM								DESIGN						
STREET	AREA NUMBER	MANHOLE LOCATION FROM MH	TO MH	AREA (A)	RUNOFF COEFF. (C)	A x C	CUMUL. A x C	CONCENTRATION TIME TOTAL	IN PIPE	RAIN INTENSITY (I)	FLOW (Q)	PIPE SIZE	LENGTH	SLOPE	CAPACITY	FULL FLOW VELOCITY	ACTUAL VELOCITY	PIPE FULL
				ha		*ha*	*ha*	*min*	*min*	*mm/hr*	*L/s*	*mm*	*m*	*%*	*L/s*	*m/s*	*m/s*	*%*
		OGS1	Headwall	0.136	0.89	0.1210	0.1210	10.0000	0.0883	196.53645	66.13279	300	11.2	2.60	155.92529	2.2059	2.1148	42.41

*Runoff coefficient adjusted to match MIDUSS flows

Appendix E

MIDUSS Output

Pre-Development

```
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"                MIDUSS version                         Version 2.25  rev. 473"
"                MIDUSS created                       Sunday, February 7, 2010"
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"                Output filename:                             2 Year Pre B.out"
"                Licensee name:                                              A"
"                Company                                             Microsoft"
"                Date & Time last used:                 6/15/2021 at 4:54:14 PM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"      743.000   Coefficient A"
"        6.000   Constant B"
"        0.799   Exponent C"
"        0.400   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity           109.374    mm/hr"
"             Total depth                  34.259    mm"
"            6   002hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 101"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          101   Site to River"
"       49.000   % Impervious"
"        0.100   Total Area"
"       57.000   Flow length"
"        5.000   Overland Slope"
"        0.051   Pervious Area"
"       57.000   Pervious length"
"        5.000   Pervious slope"
"        0.049   Impervious Area"
"       57.000   Impervious length"
"        5.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.176   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.839   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
```

```
"        0.518   Impervious Initial abstraction"
"                     0.010     0.000     0.000     0.000 c.m/sec"
"             Catchment 101         Pervious   Impervious Total Area "
"             Surface Area          0.051      0.049      0.100      hectare"
"             Time of concentration  29.357     2.467      7.278      minutes"
"             Time to Centroid      139.063    91.654     100.136    minutes"
"             Rainfall depth        34.259     34.259     34.259     mm"
"             Rainfall volume       17.47      16.79      34.26      c.m"
"             Rainfall losses       28.240     5.512      17.103     mm"
"             Runoff depth          6.018      28.746     17.155     mm"
"             Runoff volume         3.07       14.09      17.16      c.m"
"             Runoff coefficient    0.176      0.839      0.501      "
"             Maximum flow          0.001      0.010      0.010      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.010     0.010     0.000     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.010     0.010     0.010     0.000"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                 0.010    c.m/sec"
"             Hydrograph volume           17.155    c.m"
"                     0.010     0.010     0.010     0.010"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.010     0.000     0.010     0.010"
" 33          CATCHMENT 102"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          102   External to River"
"       86.000   % Impervious"
"        0.039   Total Area"
"       60.000   Flow length"
"        5.000   Overland Slope"
"        0.005   Pervious Area"
"       60.000   Pervious length"
"        5.000   Pervious slope"
"        0.034   Impervious Area"
"       60.000   Impervious length"
"        5.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.176   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
```

```
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.839   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.007     0.000     0.010     0.010 c.m/sec"
"             Catchment 102          Pervious   Impervious Total Area "
"             Surface Area           0.005      0.034      0.039      hectare"
"             Time of concentration  30.275     2.544      3.459      minutes"
"             Time to Centroid       140.177    91.780     93.376     minutes"
"             Rainfall depth         34.259     34.259     34.259     mm"
"             Rainfall volume        1.87       11.49      13.36      c.m"
"             Rainfall losses        28.237     5.515      8.696      mm"
"             Runoff depth           6.021      28.743     25.562     mm"
"             Runoff volume          0.33       9.64       9.97       c.m"
"             Runoff coefficient     0.176      0.839      0.746      "
"             Maximum flow           0.000      0.007      0.007      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.007     0.007     0.010     0.010"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.007     0.007     0.007     0.010"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                 0.017    c.m/sec"
"             Hydrograph volume           27.124    c.m"
"                     0.007     0.007     0.007     0.017"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.007     0.000     0.007     0.017"
" 33          CATCHMENT 103"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          103   To ROW"
"       68.000   % Impervious"
"        0.015   Total Area"
"       12.000   Flow length"
"        2.000   Overland Slope"
"        0.005   Pervious Area"
"       12.000   Pervious length"
"        2.000   Pervious slope"
"        0.010   Impervious Area"
"       12.000   Impervious length"
```

```
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.175   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.836   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.002     0.000     0.007     0.017 c.m/sec"
"             Catchment 103          Pervious   Impervious Total Area "
"             Surface Area           0.005      0.010      0.015      hectare"
"             Time of concentration  15.173     1.275      2.524      minutes"
"             Time to Centroid       121.806    89.817     92.692     minutes"
"             Rainfall depth         34.259     34.259     34.259     mm"
"             Rainfall volume        1.64       3.49       5.14       c.m"
"             Rainfall losses        28.247     5.613      12.856     mm"
"             Runoff depth           6.012      28.646     21.403     mm"
"             Runoff volume          0.29       2.92       3.21       c.m"
"             Runoff coefficient     0.175      0.836      0.625      "
"             Maximum flow           0.000      0.002      0.002      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.002     0.002     0.007     0.017"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.002     0.002     0.002     0.017"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                 0.020    c.m/sec"
"             Hydrograph volume           30.335    c.m"
"                     0.002     0.002     0.002     0.020"
" 40          HYDROGRAPH   Confluence    1"
"            7   Confluence "
"            1   Node #"
"                Total"
"             Maximum flow                 0.020    c.m/sec"
"             Hydrograph volume           30.335    c.m"
"                     0.002     0.020     0.002     0.000"
" 38          START/RE-START TOTALS 1"
"            3   Runoff Totals on EXIT"
"             Total Catchment area                    0.154    hectare"
"             Total Impervious area                   0.093    hectare"
"             Total % impervious                     60.221"
```

```
" 19          EXIT"
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"               MIDUSS created                       Sunday, February 7, 2010"
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"               Output filename:                            5 Year Pre B.out"
"               Licensee name:                                              A"
"               Company                                             Microsoft"
"               Date & Time last used:                 6/15/2021 at 5:04:37 PM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"           1   Chicago storm"
"     1593.000   Coefficient A"
"       11.000   Constant B"
"        0.879   Exponent C"
"        0.400   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"            Maximum intensity           139.288    mm/hr"
"            Total depth                  47.265    mm"
"           6   005hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 101"
"           1   Triangular SCS"
"           1   Equal length"
"           1   SCS method"
"         101   Site to River"
"       49.000   % Impervious"
"        0.100   Total Area"
"       57.000   Flow length"
"        5.000   Overland Slope"
"        0.051   Pervious Area"
"       57.000   Pervious length"
"        5.000   Pervious slope"
"        0.049   Impervious Area"
"       57.000   Impervious length"
"        5.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.258   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.876   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
```

```
"        0.518   Impervious Initial abstraction"
"                    0.015     0.000     0.000     0.000 c.m/sec"
"             Catchment 101         Pervious   Impervious Total Area "
"             Surface Area          0.051      0.049      0.100      hectare"
"             Time of concentration 21.361     2.211      6.700      minutes"
"             Time to Centroid      124.556    89.111     97.420     minutes"
"             Rainfall depth        47.265     47.265     47.265     mm"
"             Rainfall volume       24.10      23.16      47.26      c.m"
"             Rainfall losses       35.081     5.849      20.757     mm"
"             Runoff depth          12.184     41.416     26.508     mm"
"             Runoff volume         6.21       20.29      26.51      c.m"
"             Runoff coefficient    0.258      0.876      0.561      "
"             Maximum flow          0.002      0.015      0.015      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"           4   Add Runoff "
"                    0.015     0.015     0.000     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"           8   Copy to Outflow"
"                    0.015     0.015     0.015     0.000"
" 40          HYDROGRAPH   Combine    1"
"           6   Combine "
"           1   Node #"
"               Total"
"             Maximum flow                 0.015    c.m/sec"
"             Hydrograph volume           26.508    c.m"
"                    0.015     0.015     0.015     0.015"
" 40          HYDROGRAPH Start - New Tributary"
"           2   Start - New Tributary"
"                    0.015     0.000     0.015     0.015"
" 33          CATCHMENT 102"
"           1   Triangular SCS"
"           1   Equal length"
"           1   SCS method"
"         102   External to River"
"       86.000   % Impervious"
"        0.039   Total Area"
"       60.000   Flow length"
"        5.000   Overland Slope"
"        0.005   Pervious Area"
"       60.000   Pervious length"
"        5.000   Pervious slope"
"        0.034   Impervious Area"
"       60.000   Impervious length"
"        5.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.258   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
```

```
"       8.467   Pervious Initial abstraction"
"       0.015   Impervious Manning 'n'"
"      98.000   Impervious SCS Curve No."
"       0.876   Impervious Runoff coefficient"
"       0.100   Impervious Ia/S coefficient"
"       0.518   Impervious Initial abstraction"
"                    0.010     0.000     0.015     0.015 c.m/sec"
"               Catchment 102          Pervious   Impervious Total Area "
"               Surface Area           0.005      0.034      0.039      hectare"
"               Time of concentration  22.028     2.280      3.183      minutes"
"               Time to Centroid       125.392    89.229     90.881     minutes"
"               Rainfall depth         47.265     47.265     47.265     mm"
"               Rainfall volume        2.58       15.85      18.43      c.m"
"               Rainfall losses        35.087     5.863      9.954      mm"
"               Runoff depth           12.178     41.402     37.311     mm"
"               Runoff volume          0.66       13.89      14.55      c.m"
"               Runoff coefficient     0.258      0.876      0.789      "
"               Maximum flow           0.000      0.010      0.010      c.m/sec"
" 40            HYDROGRAPH Add Runoff "
"              4   Add Runoff "
"                    0.010     0.010     0.015     0.015"
" 40            HYDROGRAPH Copy to Outflow"
"              8   Copy to Outflow"
"                    0.010     0.010     0.010     0.015"
" 40            HYDROGRAPH   Combine    1"
"              6   Combine "
"              1   Node #"
"                  Total"
"               Maximum flow                 0.025    c.m/sec"
"               Hydrograph volume           41.059    c.m"
"                    0.010     0.010     0.010     0.025"
" 40            HYDROGRAPH Start - New Tributary"
"              2   Start - New Tributary"
"                    0.010     0.000     0.010     0.025"
" 33            CATCHMENT 103"
"              1   Triangular SCS"
"              1   Equal length"
"              1   SCS method"
"            103   To ROW"
"      68.000   % Impervious"
"       0.015   Total Area"
"      12.000   Flow length"
"       2.000   Overland Slope"
"       0.005   Pervious Area"
"      12.000   Pervious length"
"       2.000   Pervious slope"
"       0.010   Impervious Area"
"      12.000   Impervious length"
```

```
"       2.000   Impervious slope"
"       0.250   Pervious Manning 'n'"
"      75.000   Pervious SCS Curve No."
"       0.258   Pervious Runoff coefficient"
"       0.100   Pervious Ia/S coefficient"
"       8.467   Pervious Initial abstraction"
"       0.015   Impervious Manning 'n'"
"      98.000   Impervious SCS Curve No."
"       0.869   Impervious Runoff coefficient"
"       0.100   Impervious Ia/S coefficient"
"       0.518   Impervious Initial abstraction"
"                    0.003     0.000     0.010     0.025 c.m/sec"
"               Catchment 103          Pervious   Impervious Total Area "
"               Surface Area           0.005      0.010      0.015      hectare"
"               Time of concentration  11.040     1.143      2.355      minutes"
"               Time to Centroid       111.809    87.596     90.561     minutes"
"               Rainfall depth         47.265     47.265     47.265     mm"
"               Rainfall volume        2.27       4.82       7.09       c.m"
"               Rainfall losses        35.092     6.212      15.454     mm"
"               Runoff depth           12.173     41.053     31.811     mm"
"               Runoff volume          0.58       4.19       4.77       c.m"
"               Runoff coefficient     0.258      0.869      0.673      "
"               Maximum flow           0.000      0.003      0.003      c.m/sec"
" 40            HYDROGRAPH Add Runoff "
"              4   Add Runoff "
"                    0.003     0.003     0.010     0.025"
" 40            HYDROGRAPH Copy to Outflow"
"              8   Copy to Outflow"
"                    0.003     0.003     0.003     0.025"
" 40            HYDROGRAPH   Combine    1"
"              6   Combine "
"              1   Node #"
"                  Total"
"               Maximum flow                 0.028    c.m/sec"
"               Hydrograph volume           45.831    c.m"
"                    0.003     0.003     0.003     0.028"
" 40            HYDROGRAPH   Confluence    1"
"              7   Confluence "
"              1   Node #"
"                  Total"
"               Maximum flow                 0.028    c.m/sec"
"               Hydrograph volume           45.831    c.m"
"                    0.003     0.028     0.003     0.000"
" 38            START/RE-START TOTALS 1"
"              3   Runoff Totals on EXIT"
"               Total Catchment area                    0.154    hectare"
"               Total Impervious area                   0.093    hectare"
"               Total % impervious                     60.221"
```

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" 19          EXIT"
```

```
"                MIDUSS Output ----------------------------------------------->"
"                MIDUSS version                          Version 2.25  rev. 473"
"                MIDUSS created                        Sunday, February 7, 2010"
"           10   Units used:                                          ie METRIC"
"                Job folder:                                Q:\48790\100\MIDUSS"
"                Output filename:                             10 Year Pre B.out"
"                Licensee name:                                                A"
"                Company                                               Microsoft"
"                Date & Time last used:                 6/15/2021 at 5:06:32 PM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     2221.000   Coefficient A"
"       12.000   Constant B"
"        0.908   Exponent C"
"        0.400   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity           169.551    mm/hr"
"             Total depth                  56.290    mm"
"            6   010hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 101"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          101   Site to River"
"       49.000   % Impervious"
"        0.100   Total Area"
"       57.000   Flow length"
"        5.000   Overland Slope"
"        0.051   Pervious Area"
"       57.000   Pervious length"
"        5.000   Pervious slope"
"        0.049   Impervious Area"
"       57.000   Impervious length"
"        5.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.306   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.894   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
```

```
"        0.518   Impervious Initial abstraction"
"                     0.019     0.000     0.000     0.000 c.m/sec"
"             Catchment 101         Pervious   Impervious Total Area "
"             Surface Area          0.051      0.049      0.100      hectare"
"             Time of concentration  18.011     2.034      6.234      minutes"
"             Time to Centroid      118.402    87.865     95.891     minutes"
"             Rainfall depth        56.290     56.290     56.290     mm"
"             Rainfall volume       28.71      27.58      56.29      c.m"
"             Rainfall losses       39.043     5.943      22.824     mm"
"             Runoff depth          17.248     50.347     33.466     mm"
"             Runoff volume         8.80       24.67      33.47      c.m"
"             Runoff coefficient    0.306      0.894      0.595      "
"             Maximum flow          0.003      0.018      0.019      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.019     0.019     0.000     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.019     0.019     0.019     0.000"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                  0.019    c.m/sec"
"             Hydrograph volume            33.466    c.m"
"                     0.019     0.019     0.019     0.019"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.019     0.000     0.019     0.019"
" 33          CATCHMENT 102"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          102   External to River"
"       86.000   % Impervious"
"        0.039   Total Area"
"       60.000   Flow length"
"        5.000   Overland Slope"
"        0.005   Pervious Area"
"       60.000   Pervious length"
"        5.000   Pervious slope"
"        0.034   Impervious Area"
"       60.000   Impervious length"
"        5.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.306   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
```

```
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.894   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.012     0.000     0.019     0.019 c.m/sec"
"             Catchment 102          Pervious   Impervious Total Area "
"             Surface Area           0.005      0.034      0.039      hectare"
"             Time of concentration  18.574     2.098      2.968      minutes"
"             Time to Centroid       119.122    87.960     89.606     minutes"
"             Rainfall depth         56.290     56.290     56.290     mm"
"             Rainfall volume        3.07       18.88      21.95      c.m"
"             Rainfall losses        39.047     5.968      10.599     mm"
"             Runoff depth           17.243     50.322     45.691     mm"
"             Runoff volume          0.94       16.88      17.82      c.m"
"             Runoff coefficient     0.306      0.894      0.812      "
"             Maximum flow           0.000      0.012      0.012      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.012     0.012     0.019     0.019"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.012     0.012     0.012     0.019"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                 0.031    c.m/sec"
"             Hydrograph volume           51.286    c.m"
"                     0.012     0.012     0.012     0.031"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.012     0.000     0.012     0.031"
" 33          CATCHMENT 103"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          103   To ROW"
"       68.000   % Impervious"
"        0.015   Total Area"
"       12.000   Flow length"
"        2.000   Overland Slope"
"        0.005   Pervious Area"
"       12.000   Pervious length"
"        2.000   Pervious slope"
"        0.010   Impervious Area"
"       12.000   Impervious length"
```

```
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.305   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.880   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.004     0.000     0.012     0.031 c.m/sec"
"             Catchment 103          Pervious   Impervious Total Area "
"             Surface Area           0.005      0.010      0.015      hectare"
"             Time of concentration  9.309      1.051      2.210      minutes"
"             Time to Centroid       107.485    86.522     89.463     minutes"
"             Rainfall depth         56.290     56.290     56.290     mm"
"             Rainfall volume        2.70       5.74       8.44       c.m"
"             Rainfall losses        39.117     6.770      17.121     mm"
"             Runoff depth           17.173     49.520     39.169     mm"
"             Runoff volume          0.82       5.05       5.88       c.m"
"             Runoff coefficient     0.305      0.880      0.696      "
"             Maximum flow           0.000      0.004      0.004      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.004     0.004     0.012     0.031"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.004     0.004     0.004     0.031"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                 0.035    c.m/sec"
"             Hydrograph volume           57.161    c.m"
"                     0.004     0.004     0.004     0.035"
" 40          HYDROGRAPH   Confluence    1"
"            7   Confluence "
"            1   Node #"
"                Total"
"             Maximum flow                 0.035    c.m/sec"
"             Hydrograph volume           57.161    c.m"
"                     0.004     0.035     0.004     0.000"
" 38          START/RE-START TOTALS 1"
"            3   Runoff Totals on EXIT"
"             Total Catchment area                    0.154    hectare"
"             Total Impervious area                   0.093    hectare"
"             Total % impervious                     60.221"
```

```
" 19          EXIT"
```

```
"               MIDUSS Output ----------------------------------------------->"
"               MIDUSS version                         Version 2.25  rev. 473"
"               MIDUSS created                       Sunday, February 7, 2010"
"          10   Units used:                                         ie METRIC"
"               Job folder:                               Q:\48790\100\MIDUSS"
"               Output filename:                            25 Year Pre B.out"
"               Licensee name:                                              A"
"               Company                                             Microsoft"
"               Date & Time last used:                6/15/2021 at 5:07:37 PM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     3158.000   Coefficient A"
"       15.000   Constant B"
"        0.936   Exponent C"
"        0.400   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity           191.557    mm/hr"
"             Total depth                  68.266    mm"
"            6   025hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 101"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          101   Site to River"
"       49.000   % Impervious"
"        0.100   Total Area"
"       57.000   Flow length"
"        5.000   Overland Slope"
"        0.051   Pervious Area"
"       57.000   Pervious length"
"        5.000   Pervious slope"
"        0.049   Impervious Area"
"       57.000   Impervious length"
"        5.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.362   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.909   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
```

```
"        0.518   Impervious Initial abstraction"
"                        0.022     0.000     0.000     0.000 c.m/sec"
"             Catchment 101         Pervious   Impervious Total Area "
"             Surface Area          0.051      0.049      0.100      hectare"
"             Time of concentration  15.769     1.929      5.985      minutes"
"             Time to Centroid      114.281    87.223     95.153     minutes"
"             Rainfall depth        68.266     68.266     68.266     mm"
"             Rainfall volume       34.82      33.45      68.27      c.m"
"             Rainfall losses       43.550     6.213      25.255     mm"
"             Runoff depth          24.716     62.053     43.012     mm"
"             Runoff volume         12.61      30.41      43.01      c.m"
"             Runoff coefficient    0.362      0.909      0.630      "
"             Maximum flow          0.005      0.021      0.022      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                        0.022     0.022     0.000     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                        0.022     0.022     0.022     0.000"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                 0.022    c.m/sec"
"             Hydrograph volume           43.012    c.m"
"                        0.022     0.022     0.022     0.022"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                        0.022     0.000     0.022     0.022"
" 33          CATCHMENT 102"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          102   External to River"
"       86.000   % Impervious"
"        0.039   Total Area"
"       60.000   Flow length"
"        5.000   Overland Slope"
"        0.005   Pervious Area"
"       60.000   Pervious length"
"        5.000   Pervious slope"
"        0.034   Impervious Area"
"       60.000   Impervious length"
"        5.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.362   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
```

```
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.908   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.015     0.000     0.022     0.022 c.m/sec"
"             Catchment 102          Pervious   Impervious Total Area "
"             Surface Area           0.005      0.034      0.039      hectare"
"             Time of concentration  16.262     1.990      2.859      minutes"
"             Time to Centroid       114.902    87.306     88.986     minutes"
"             Rainfall depth         68.266     68.266     68.266     mm"
"             Rainfall volume        3.73       22.90      26.62      c.m"
"             Rainfall losses        43.576     6.258      11.483     mm"
"             Runoff depth           24.690     62.008     56.784     mm"
"             Runoff volume          1.35       20.80      22.15      c.m"
"             Runoff coefficient     0.362      0.908      0.832      "
"             Maximum flow           0.001      0.014      0.015      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.015     0.015     0.022     0.022"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.015     0.015     0.015     0.022"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                  0.037    c.m/sec"
"             Hydrograph volume            65.157    c.m"
"                     0.015     0.015     0.015     0.037"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.015     0.000     0.015     0.037"
" 33          CATCHMENT 103"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          103   To ROW"
"       68.000   % Impervious"
"        0.015   Total Area"
"       12.000   Flow length"
"        2.000   Overland Slope"
"        0.005   Pervious Area"
"       12.000   Pervious length"
"        2.000   Pervious slope"
"        0.010   Impervious Area"
"       12.000   Impervious length"
```

```
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.362   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.891   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.005     0.000     0.015     0.037 c.m/sec"
"             Catchment 103          Pervious   Impervious Total Area "
"             Surface Area           0.005      0.010      0.015      hectare"
"             Time of concentration  8.150      0.997      2.144      minutes"
"             Time to Centroid       104.799    85.986     89.002     minutes"
"             Rainfall depth         68.266     68.266     68.266     mm"
"             Rainfall volume        3.28       6.96       10.24      c.m"
"             Rainfall losses        43.573     7.407      18.980     mm"
"             Runoff depth           24.693     60.859     49.286     mm"
"             Runoff volume          1.19       6.21       7.39       c.m"
"             Runoff coefficient     0.362      0.891      0.722      "
"             Maximum flow           0.001      0.005      0.005      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.005     0.005     0.015     0.037"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.005     0.005     0.005     0.037"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                  0.041    c.m/sec"
"             Hydrograph volume            72.550    c.m"
"                     0.005     0.005     0.005     0.041"
" 40          HYDROGRAPH   Confluence    1"
"            7   Confluence "
"            1   Node #"
"                Total"
"             Maximum flow                  0.041    c.m/sec"
"             Hydrograph volume            72.550    c.m"
"                     0.005     0.041     0.005     0.000"
" 38          START/RE-START TOTALS 1"
"            3   Runoff Totals on EXIT"
"             Total Catchment area                       0.154    hectare"
"             Total Impervious area                      0.093    hectare"
"             Total % impervious                        60.221"
```

```
    " 19            EXIT"
```

```
"               MIDUSS Output ----------------------------------------------->"
"               MIDUSS version                           Version 2.25  rev. 473"
"               MIDUSS created                         Sunday, February 7, 2010"
"          10   Units used:                                           ie METRIC"
"               Job folder:                                Q:\48790\100\MIDUSS"
"               Output filename:                              50 Year Pre B.out"
"               Licensee name:                                                A"
"               Company                                               Microsoft"
"               Date & Time last used:                   6/15/2021 at 5:08:46 PM"
" 31         TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32         STORM Chicago storm"
"            1   Chicago storm"
"     3886.000   Coefficient A"
"       16.000   Constant B"
"        0.950   Exponent C"
"        0.400   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"            Maximum intensity           215.802    mm/hr"
"            Total depth                  77.647    mm"
"            6   050hyd   Hydrograph extension used in this file"
" 33         CATCHMENT 101"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          101   Site to River"
"       49.000   % Impervious"
"        0.100   Total Area"
"       57.000   Flow length"
"        5.000   Overland Slope"
"        0.051   Pervious Area"
"       57.000   Pervious length"
"        5.000   Pervious slope"
"        0.049   Impervious Area"
"       57.000   Impervious length"
"        5.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.400   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.919   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
```

```
"        0.518   Impervious Initial abstraction"
"                    0.026     0.000     0.000     0.000 c.m/sec"
"            Catchment 101         Pervious   Impervious Total Area "
"            Surface Area          0.051      0.049      0.100      hectare"
"            Time of concentration 14.308     1.836      5.722      minutes"
"            Time to Centroid      111.538    86.702     94.440     minutes"
"            Rainfall depth        77.647     77.647     77.647     mm"
"            Rainfall volume       39.60      38.05      77.65      c.m"
"            Rainfall losses       46.620     6.297      26.861     mm"
"            Runoff depth          31.028     71.351     50.786     mm"
"            Runoff volume         15.82      34.96      50.79      c.m"
"            Runoff coefficient    0.400      0.919      0.654      "
"            Maximum flow          0.007      0.024      0.026      c.m/sec"
" 40         HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.026     0.026     0.000     0.000"
" 40         HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                    0.026     0.026     0.026     0.000"
" 40         HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"            Maximum flow                 0.026    c.m/sec"
"            Hydrograph volume           50.786    c.m"
"                    0.026     0.026     0.026     0.026"
" 40         HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                    0.026     0.000     0.026     0.026"
" 33         CATCHMENT 102"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          102   External to River"
"       86.000   % Impervious"
"        0.039   Total Area"
"       60.000   Flow length"
"        5.000   Overland Slope"
"        0.005   Pervious Area"
"       60.000   Pervious length"
"        5.000   Pervious slope"
"        0.034   Impervious Area"
"       60.000   Impervious length"
"        5.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.400   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
```

```
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.918   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.017     0.000     0.026     0.026 c.m/sec"
"             Catchment 102          Pervious   Impervious Total Area "
"             Surface Area           0.005      0.034      0.039      hectare"
"             Time of concentration  14.755     1.893      2.744      minutes"
"             Time to Centroid       112.097    86.778     88.453     minutes"
"             Rainfall depth         77.647     77.647     77.647     mm"
"             Rainfall volume        4.24       26.04      30.28      c.m"
"             Rainfall losses        46.607     6.333      11.971     mm"
"             Runoff depth           31.041     71.314     65.676     mm"
"             Runoff volume          1.69       23.92      25.61      c.m"
"             Runoff coefficient     0.400      0.918      0.846      "
"             Maximum flow           0.001      0.017      0.017      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.017     0.017     0.026     0.026"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.017     0.017     0.017     0.026"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                  0.042    c.m/sec"
"             Hydrograph volume            76.400    c.m"
"                     0.017     0.017     0.017     0.042"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.017     0.000     0.017     0.042"
" 33          CATCHMENT 103"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          103   To ROW"
"       68.000   % Impervious"
"        0.015   Total Area"
"       12.000   Flow length"
"        2.000   Overland Slope"
"        0.005   Pervious Area"
"       12.000   Pervious length"
"        2.000   Pervious slope"
"        0.010   Impervious Area"
"       12.000   Impervious length"
```

```
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.398   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.896   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.006     0.000     0.017     0.042 c.m/sec"
"             Catchment 103          Pervious   Impervious Total Area "
"             Surface Area           0.005      0.010      0.015      hectare"
"             Time of concentration  7.395      0.949      2.063      minutes"
"             Time to Centroid       102.975    85.545     88.558     minutes"
"             Rainfall depth         77.647     77.647     77.647     mm"
"             Rainfall volume        3.73       7.92       11.65      c.m"
"             Rainfall losses        46.729     8.038      20.419     mm"
"             Runoff depth           30.919     69.609     57.228     mm"
"             Runoff volume          1.48       7.10       8.58       c.m"
"             Runoff coefficient     0.398      0.896      0.737      "
"             Maximum flow           0.001      0.005      0.006      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.006     0.006     0.017     0.042"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.006     0.006     0.006     0.042"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                  0.048    c.m/sec"
"             Hydrograph volume            84.984    c.m"
"                     0.006     0.006     0.006     0.048"
" 40          HYDROGRAPH   Confluence    1"
"            7   Confluence "
"            1   Node #"
"                Total"
"             Maximum flow                  0.048    c.m/sec"
"             Hydrograph volume            84.984    c.m"
"                     0.006     0.048     0.006     0.000"
" 38          START/RE-START TOTALS 1"
"            3   Runoff Totals on EXIT"
"             Total Catchment area                       0.154    hectare"
"             Total Impervious area                      0.093    hectare"
"             Total % impervious                        60.221"
```

" 19 EXIT"

```
"               MIDUSS Output ----------------------------------------------->"
"               MIDUSS version                         Version 2.25  rev. 473"
"               MIDUSS created                       Sunday, February 7, 2010"
"          10   Units used:                                         ie METRIC"
"               Job folder:                             Q:\48790\100\MIDUSS"
"               Output filename:                            100 Year Pre B.out"
"               Licensee name:                                              A"
"               Company                                             Microsoft"
"               Date & Time last used:                 6/15/2021 at 5:10:03 PM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     4688.000   Coefficient A"
"       17.000   Constant B"
"        0.962   Exponent C"
"        0.400   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity           239.354    mm/hr"
"             Total depth                  87.079    mm"
"            6   100hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 101"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          101   Site to River"
"       49.000   % Impervious"
"        0.100   Total Area"
"       57.000   Flow length"
"        5.000   Overland Slope"
"        0.051   Pervious Area"
"       57.000   Pervious length"
"        5.000   Pervious slope"
"        0.049   Impervious Area"
"       57.000   Impervious length"
"        5.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.433   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.926   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
```

```
"        0.518   Impervious Initial abstraction"
"                     0.029     0.000     0.000     0.000 c.m/sec"
"             Catchment 101         Pervious   Impervious Total Area "
"             Surface Area          0.051      0.049      0.100      hectare"
"             Time of concentration 13.189     1.759      5.503      minutes"
"             Time to Centroid      109.372    86.267     93.835     minutes"
"             Rainfall depth        87.079     87.079     87.079     mm"
"             Rainfall volume       44.41      42.67      87.08      c.m"
"             Rainfall losses       49.342     6.449      28.324     mm"
"             Runoff depth          37.737     80.631     58.755     mm"
"             Runoff volume         19.25      39.51      58.75      c.m"
"             Runoff coefficient    0.433      0.926      0.675      "
"             Maximum flow          0.009      0.027      0.029      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.029     0.029     0.000     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.029     0.029     0.029     0.000"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                 0.029    c.m/sec"
"             Hydrograph volume           58.755    c.m"
"                     0.029     0.029     0.029     0.029"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.029     0.000     0.029     0.029"
" 33          CATCHMENT 102"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          102   External to River"
"       86.000   % Impervious"
"        0.039   Total Area"
"       60.000   Flow length"
"        5.000   Overland Slope"
"        0.005   Pervious Area"
"       60.000   Pervious length"
"        5.000   Pervious slope"
"        0.034   Impervious Area"
"       60.000   Impervious length"
"        5.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.434   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
```

```
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.926   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.019     0.000     0.029     0.029 c.m/sec"
"             Catchment 102          Pervious   Impervious Total Area "
"             Surface Area           0.005      0.034      0.039      hectare"
"             Time of concentration  13.601     1.814      2.649      minutes"
"             Time to Centroid       109.890    86.347     88.015     minutes"
"             Rainfall depth         87.079     87.079     87.079     mm"
"             Rainfall volume        4.75       29.21      33.96      c.m"
"             Rainfall losses        49.309     6.439      12.441     mm"
"             Runoff depth           37.770     80.640     74.638     mm"
"             Runoff volume          2.06       27.05      29.11      c.m"
"             Runoff coefficient     0.434      0.926      0.857      "
"             Maximum flow           0.001      0.019      0.019      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.019     0.019     0.029     0.029"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.019     0.019     0.019     0.029"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                  0.048    c.m/sec"
"             Hydrograph volume            87.864    c.m"
"                     0.019     0.019     0.019     0.048"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.019     0.000     0.019     0.048"
" 33          CATCHMENT 103"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          103   To ROW"
"       68.000   % Impervious"
"        0.015   Total Area"
"       12.000   Flow length"
"        2.000   Overland Slope"
"        0.005   Pervious Area"
"       12.000   Pervious length"
"        2.000   Pervious slope"
"        0.010   Impervious Area"
"       12.000   Impervious length"
```

```
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.430   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.900   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.006     0.000     0.019     0.048 c.m/sec"
"             Catchment 103          Pervious   Impervious Total Area "
"             Surface Area           0.005      0.010      0.015      hectare"
"             Time of concentration  6.817      0.909      1.994      minutes"
"             Time to Centroid       101.498    85.189     88.185     minutes"
"             Rainfall depth         87.079     87.079     87.079     mm"
"             Rainfall volume        4.18       8.88       13.06      c.m"
"             Rainfall losses        49.611     8.719      21.805     mm"
"             Runoff depth           37.469     78.360     65.275     mm"
"             Runoff volume          1.80       7.99       9.79       c.m"
"             Runoff coefficient     0.430      0.900      0.750      "
"             Maximum flow           0.001      0.006      0.006      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.006     0.006     0.019     0.048"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.006     0.006     0.006     0.048"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                  0.054    c.m/sec"
"             Hydrograph volume            97.655    c.m"
"                     0.006     0.006     0.006     0.054"
" 40          HYDROGRAPH   Confluence    1"
"            7   Confluence "
"            1   Node #"
"                Total"
"             Maximum flow                  0.054    c.m/sec"
"             Hydrograph volume            97.655    c.m"
"                     0.006     0.054     0.006     0.000"
" 38          START/RE-START TOTALS 1"
"            3   Runoff Totals on EXIT"
"             Total Catchment area                    0.154    hectare"
"             Total Impervious area                   0.093    hectare"
"             Total % impervious                     60.221"
```

```
                                       100 Year Pre B
        " 19           EXIT"
```

Post-Development

MTE

```
"               MIDUSS Output ----------------------------------------------->"
"               MIDUSS version                          Version 2.25  rev. 473"
"               MIDUSS created                        Sunday, February 7, 2010"
"           10  Units used:                                          ie METRIC"
"               Job folder:                                Q:\48790\100\MIDUSS"
"               Output filename:                             2 Year Post B.out"
"               Licensee name:                                               A"
"               Company                                              Microsoft"
"               Date & Time last used:                  6/15/2021 at 5:11:20 PM"
" 31          TIME PARAMETERS"
"        5.000  Time Step"
"      180.000  Max. Storm length"
"     1500.000  Max. Hydrograph"
" 32          STORM Chicago storm"
"            1  Chicago storm"
"      743.000  Coefficient A"
"        6.000  Constant B"
"        0.799  Exponent C"
"        0.400  Fraction R"
"      180.000  Duration"
"        1.000  Time step multiplier"
"            Maximum intensity           109.374    mm/hr"
"            Total depth                  34.259    mm"
"            6  002hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 201"
"            1  Triangular SCS"
"            1  Equal length"
"            1  SCS method"
"          201  To OGS to River"
"       86.000  % Impervious"
"        0.136  Total Area"
"       55.000  Flow length"
"        5.000  Overland Slope"
"        0.019  Pervious Area"
"       55.000  Pervious length"
"        5.000  Pervious slope"
"        0.117  Impervious Area"
"       55.000  Impervious length"
"        5.000  Impervious slope"
"        0.250  Pervious Manning 'n'"
"       75.000  Pervious SCS Curve No."
"        0.176  Pervious Runoff coefficient"
"        0.100  Pervious Ia/S coefficient"
"        8.467  Pervious Initial abstraction"
"        0.015  Impervious Manning 'n'"
"       98.000  Impervious SCS Curve No."
"        0.839  Impervious Runoff coefficient"
"        0.100  Impervious Ia/S coefficient"
```

```
"        0.518  Impervious Initial abstraction"
"                    0.025     0.000     0.000     0.000 c.m/sec"
"             Catchment 201         Pervious   Impervious Total Area "
"             Surface Area          0.019      0.117      0.136      hectare"
"             Time of concentration 28.735     2.415      3.281      minutes"
"             Time to Centroid      138.302    91.574     93.113     minutes"
"             Rainfall depth        34.259     34.259     34.259     mm"
"             Rainfall volume       6.52       40.07      46.59      c.m"
"             Rainfall losses       28.245     5.507      8.690      mm"
"             Runoff depth          6.014      28.752     25.568     mm"
"             Runoff volume         1.15       33.63      34.77      c.m"
"             Runoff coefficient    0.176      0.839      0.746      "
"             Maximum flow          0.000      0.025      0.025      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4  Add Runoff "
"                    0.025     0.025     0.000     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8  Copy to Outflow"
"                    0.025     0.025     0.025     0.000"
" 40          HYDROGRAPH   Combine    1"
"            6  Combine "
"            1  Node #"
"               Total"
"             Maximum flow                 0.025    c.m/sec"
"             Hydrograph volume           34.773    c.m"
"                    0.025     0.025     0.025     0.025"
" 40          HYDROGRAPH Start - New Tributary"
"            2  Start - New Tributary"
"                    0.025     0.000     0.025     0.025"
" 33          CATCHMENT 202"
"            1  Triangular SCS"
"            1  Equal length"
"            1  SCS method"
"          202  To River Uncontrolled"
"        0.000  % Impervious"
"        0.010  Total Area"
"        8.000  Flow length"
"       30.000  Overland Slope"
"        0.010  Pervious Area"
"        8.000  Pervious length"
"       30.000  Pervious slope"
"        0.000  Impervious Area"
"        8.000  Impervious length"
"       30.000  Impervious slope"
"        0.250  Pervious Manning 'n'"
"       75.000  Pervious SCS Curve No."
"        0.175  Pervious Runoff coefficient"
"        0.100  Pervious Ia/S coefficient"
```

```
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.000   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.000     0.000     0.025     0.025 c.m/sec"
"             Catchment 202          Pervious   Impervious Total Area "
"             Surface Area           0.010      0.000      0.010      hectare"
"             Time of concentration  5.280      0.444      5.280      minutes"
"             Time to Centroid       109.784    89.198     109.784    minutes"
"             Rainfall depth         34.259     34.259     34.259     mm"
"             Rainfall volume        3.43       0.00       3.43       c.m"
"             Rainfall losses        28.272     8.000      28.272     mm"
"             Runoff depth           5.986      26.258     5.986      mm"
"             Runoff volume          0.60       0.00       0.60       c.m"
"             Runoff coefficient     0.175      0.000      0.175      "
"             Maximum flow           0.000      0.000      0.000      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.000     0.000     0.025     0.025"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.000     0.000     0.000     0.025"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                  0.025    c.m/sec"
"             Hydrograph volume            35.372    c.m"
"                     0.000     0.000     0.000     0.025"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.000     0.000     0.000     0.025"
" 33          CATCHMENT 203"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          203   To ROW Uncontrolled"
"      100.000   % Impervious"
"        0.008   Total Area"
"        4.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"        4.000   Pervious length"
"        2.000   Pervious slope"
"        0.008   Impervious Area"
"        4.000   Impervious length"
```

```
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.000   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.799   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.002     0.000     0.000     0.025 c.m/sec"
"             Catchment 203          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.008      0.008      hectare"
"             Time of concentration  7.849      0.660      0.660      minutes"
"             Time to Centroid       112.917    89.380     89.380     minutes"
"             Rainfall depth         34.259     34.259     34.259     mm"
"             Rainfall volume        0.00       2.74       2.74       c.m"
"             Rainfall losses        28.256     6.900      6.900      mm"
"             Runoff depth           6.003      27.359     27.359     mm"
"             Runoff volume          0.00       2.19       2.19       c.m"
"             Runoff coefficient     0.000      0.799      0.799      "
"             Maximum flow           0.000      0.002      0.002      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.002     0.002     0.000     0.025"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.002     0.002     0.002     0.025"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                  0.027    c.m/sec"
"             Hydrograph volume            37.560    c.m"
"                     0.002     0.002     0.002     0.027"
" 40          HYDROGRAPH   Confluence    1"
"            7   Confluence "
"            1   Node #"
"                Total"
"             Maximum flow                  0.027    c.m/sec"
"             Hydrograph volume            37.560    c.m"
"                     0.002     0.027     0.002     0.000"
" 38          START/RE-START TOTALS 1"
"            3   Runoff Totals on EXIT"
"             Total Catchment area                       0.154    hectare"
"             Total Impervious area                      0.125    hectare"
"             Total % impervious                        81.143"
```

```
                                     2 Year Post B
      " 19          EXIT"
```

```
"                MIDUSS Output ----------------------------------------------->"
"                MIDUSS version                         Version 2.25  rev. 473"
"                MIDUSS created                       Sunday, February 7, 2010"
"           10   Units used:                                         ie METRIC"
"                Job folder:                                Q:\48790\100\MIDUSS"
"                Output filename:                             5 Year Post B.out"
"                Licensee name:                                               A"
"                Company                                              Microsoft"
"                Date & Time last used:                  6/15/2021 at 5:17:27 PM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     1593.000   Coefficient A"
"       11.000   Constant B"
"        0.879   Exponent C"
"        0.400   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity           139.288    mm/hr"
"             Total depth                  47.265    mm"
"            6   005hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 201"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          201   To OGS to River"
"       86.000   % Impervious"
"        0.136   Total Area"
"       55.000   Flow length"
"        5.000   Overland Slope"
"        0.019   Pervious Area"
"       55.000   Pervious length"
"        5.000   Pervious slope"
"        0.117   Impervious Area"
"       55.000   Impervious length"
"        5.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.258   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.877   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
```

```
"        0.518   Impervious Initial abstraction"
"                  0.035     0.000     0.000     0.000 c.m/sec"
"             Catchment 201         Pervious   Impervious Total Area "
"             Surface Area          0.019      0.117      0.136      hectare"
"             Time of concentration  20.908     2.164      3.020      minutes"
"             Time to Centroid       123.988    89.042     90.637     minutes"
"             Rainfall depth        47.265     47.265     47.265     mm"
"             Rainfall volume       9.00       55.28      64.28      c.m"
"             Rainfall losses       35.083     5.811      9.909      mm"
"             Runoff depth          12.181     41.454     37.356     mm"
"             Runoff volume         2.32       48.48      50.80      c.m"
"             Runoff coefficient    0.258      0.877      0.790      "
"             Maximum flow          0.001      0.035      0.035      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                  0.035     0.035     0.000     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                  0.035     0.035     0.035     0.000"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                 0.035    c.m/sec"
"             Hydrograph volume           50.804    c.m"
"                  0.035     0.035     0.035     0.035"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                  0.035     0.000     0.035     0.035"
" 33          CATCHMENT 202"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          202   To River Uncontrolled"
"        0.000   % Impervious"
"        0.010   Total Area"
"        8.000   Flow length"
"       30.000   Overland Slope"
"        0.010   Pervious Area"
"        8.000   Pervious length"
"       30.000   Pervious slope"
"        0.000   Impervious Area"
"        8.000   Impervious length"
"       30.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.253   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
```

```
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.000   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.001     0.000     0.035     0.035 c.m/sec"
"              Catchment 202          Pervious   Impervious Total Area "
"              Surface Area           0.010      0.000      0.010      hectare"
"              Time of concentration  3.841      0.398      3.841      minutes"
"              Time to Centroid       103.099    86.953     103.099    minutes"
"              Rainfall depth         47.265     47.265     47.265     mm"
"              Rainfall volume        4.73       0.00       4.73       c.m"
"              Rainfall losses        35.293     10.215     35.293     mm"
"              Runoff depth           11.972     37.050     11.972     mm"
"              Runoff volume          1.20       0.00       1.20       c.m"
"              Runoff coefficient     0.253      0.000      0.253      "
"              Maximum flow           0.001      0.000      0.001      c.m/sec"
" 40           HYDROGRAPH Add Runoff "
"             4   Add Runoff "
"                     0.001     0.001     0.035     0.035"
" 40           HYDROGRAPH Copy to Outflow"
"             8   Copy to Outflow"
"                     0.001     0.001     0.001     0.035"
" 40           HYDROGRAPH   Combine    1"
"             6   Combine "
"             1   Node #"
"                 Total"
"              Maximum flow                 0.035    c.m/sec"
"              Hydrograph volume           52.001    c.m"
"                     0.001     0.001     0.001     0.035"
" 40           HYDROGRAPH Start - New Tributary"
"             2   Start - New Tributary"
"                     0.001     0.000     0.001     0.035"
" 33           CATCHMENT 203"
"             1   Triangular SCS"
"             1   Equal length"
"             1   SCS method"
"           203   To ROW Uncontrolled"
"      100.000   % Impervious"
"        0.008   Total Area"
"        4.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"        4.000   Pervious length"
"        2.000   Pervious slope"
"        0.008   Impervious Area"
"        4.000   Impervious length"
```

```
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.000   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.817   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.003     0.000     0.001     0.035 c.m/sec"
"              Catchment 203          Pervious   Impervious Total Area "
"              Surface Area           0.000      0.008      0.008      hectare"
"              Time of concentration  5.711      0.591      0.591      minutes"
"              Time to Centroid       105.292    87.269     87.269     minutes"
"              Rainfall depth         47.265     47.265     47.265     mm"
"              Rainfall volume        0.00       3.78       3.78       c.m"
"              Rainfall losses        35.157     8.635      8.635      mm"
"              Runoff depth           12.108     38.630     38.630     mm"
"              Runoff volume          0.00       3.09       3.09       c.m"
"              Runoff coefficient     0.000      0.817      0.817      "
"              Maximum flow           0.000      0.003      0.003      c.m/sec"
" 40           HYDROGRAPH Add Runoff "
"             4   Add Runoff "
"                     0.003     0.003     0.001     0.035"
" 40           HYDROGRAPH Copy to Outflow"
"             8   Copy to Outflow"
"                     0.003     0.003     0.003     0.035"
" 40           HYDROGRAPH   Combine    1"
"             6   Combine "
"             1   Node #"
"                 Total"
"              Maximum flow                 0.038    c.m/sec"
"              Hydrograph volume           55.091    c.m"
"                     0.003     0.003     0.003     0.038"
" 40           HYDROGRAPH   Confluence    1"
"             7   Confluence "
"             1   Node #"
"                 Total"
"              Maximum flow                 0.038    c.m/sec"
"              Hydrograph volume           55.091    c.m"
"                     0.003     0.038     0.003     0.000"
" 38           START/RE-START TOTALS 1"
"             3   Runoff Totals on EXIT"
"              Total Catchment area                     0.154    hectare"
"              Total Impervious area                    0.125    hectare"
"              Total % impervious                      81.143"
```

5 Year Post B

" 19 EXIT"

```
"                MIDUSS Output ----------------------------------------------->"
"                MIDUSS version                          Version 2.25  rev. 473"
"                MIDUSS created                        Sunday, February 7, 2010"
"           10   Units used:                                          ie METRIC"
"                Job folder:                                Q:\48790\100\MIDUSS"
"                Output filename:                            10 Year Post B.out"
"                Licensee name:                                               A"
"                Company                                              Microsoft"
"                Date & Time last used:                  6/15/2021 at 5:20:16 PM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     2221.000   Coefficient A"
"       12.000   Constant B"
"        0.908   Exponent C"
"        0.400   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity           169.551    mm/hr"
"             Total depth                  56.290    mm"
"            6   010hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 201"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          201   To OGS to River"
"       86.000   % Impervious"
"        0.136   Total Area"
"       55.000   Flow length"
"        5.000   Overland Slope"
"        0.019   Pervious Area"
"       55.000   Pervious length"
"        5.000   Pervious slope"
"        0.117   Impervious Area"
"       55.000   Impervious length"
"        5.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.306   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.895   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
```

```
"        0.518   Impervious Initial abstraction"
"                     0.044     0.000     0.000     0.000 c.m/sec"
"             Catchment 201          Pervious   Impervious Total Area "
"             Surface Area           0.019      0.117      0.136      hectare"
"             Time of concentration  17.630     1.991      2.817      minutes"
"             Time to Centroid       117.933    87.805     89.396     minutes"
"             Rainfall depth         56.290     56.290     56.290     mm"
"             Rainfall volume        10.72      65.84      76.55      c.m"
"             Rainfall losses        39.044     5.936      10.571     mm"
"             Runoff depth           17.247     50.354     45.719     mm"
"             Runoff volume          3.28       58.89      62.18      c.m"
"             Runoff coefficient     0.306      0.895      0.812      "
"             Maximum flow           0.001      0.044      0.044      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.044     0.044     0.000     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.044     0.044     0.044     0.000"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                 0.044    c.m/sec"
"             Hydrograph volume           62.178    c.m"
"                     0.044     0.044     0.044     0.044"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.044     0.000     0.044     0.044"
" 33          CATCHMENT 202"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          202   To River Uncontrolled"
"        0.000   % Impervious"
"        0.010   Total Area"
"        8.000   Flow length"
"       30.000   Overland Slope"
"        0.010   Pervious Area"
"        8.000   Pervious length"
"       30.000   Pervious slope"
"        0.000   Impervious Area"
"        8.000   Impervious length"
"       30.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.299   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
```

```
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.000   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                    0.001     0.000     0.044     0.044 c.m/sec"
"              Catchment 202          Pervious   Impervious Total Area "
"              Surface Area           0.010      0.000      0.010      hectare"
"              Time of concentration  3.239      0.366      3.239      minutes"
"              Time to Centroid       100.047    85.821     100.047    minutes"
"              Rainfall depth         56.290     56.290     56.290     mm"
"              Rainfall volume        5.63       0.00       5.63       c.m"
"              Rainfall losses        39.475     11.671     39.475     mm"
"              Runoff depth           16.815     44.619     16.815     mm"
"              Runoff volume          1.68       0.00       1.68       c.m"
"              Runoff coefficient     0.299      0.000      0.299      "
"              Maximum flow           0.001      0.000      0.001      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"             4   Add Runoff "
"                    0.001     0.001     0.044     0.044"
" 40          HYDROGRAPH Copy to Outflow"
"             8   Copy to Outflow"
"                    0.001     0.001     0.001     0.044"
" 40          HYDROGRAPH   Combine    1"
"             6   Combine "
"             1   Node #"
"                 Total"
"              Maximum flow                 0.044    c.m/sec"
"              Hydrograph volume           63.859    c.m"
"                    0.001     0.001     0.001     0.044"
" 40          HYDROGRAPH Start - New Tributary"
"             2   Start - New Tributary"
"                    0.001     0.000     0.001     0.044"
" 33          CATCHMENT 203"
"             1   Triangular SCS"
"             1   Equal length"
"             1   SCS method"
"           203   To ROW Uncontrolled"
"      100.000   % Impervious"
"        0.008   Total Area"
"        4.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"        4.000   Pervious length"
"        2.000   Pervious slope"
"        0.008   Impervious Area"
"        4.000   Impervious length"
```

```
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.000   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.821   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                    0.003     0.000     0.001     0.044 c.m/sec"
"              Catchment 203          Pervious   Impervious Total Area "
"              Surface Area           0.000      0.008      0.008      hectare"
"              Time of concentration  4.816      0.544      0.544      minutes"
"              Time to Centroid       101.857    86.209     86.209     minutes"
"              Rainfall depth         56.290     56.290     56.290     mm"
"              Rainfall volume        0.00       4.50       4.50       c.m"
"              Rainfall losses        39.133     10.076     10.076     mm"
"              Runoff depth           17.157     46.214     46.214     mm"
"              Runoff volume          0.00       3.70       3.70       c.m"
"              Runoff coefficient     0.000      0.821      0.821      "
"              Maximum flow           0.000      0.003      0.003      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"             4   Add Runoff "
"                    0.003     0.003     0.001     0.044"
" 40          HYDROGRAPH Copy to Outflow"
"             8   Copy to Outflow"
"                    0.003     0.003     0.003     0.044"
" 40          HYDROGRAPH   Combine    1"
"             6   Combine "
"             1   Node #"
"                 Total"
"              Maximum flow                 0.048    c.m/sec"
"              Hydrograph volume           67.556    c.m"
"                    0.003     0.003     0.003     0.048"
" 40          HYDROGRAPH   Confluence    1"
"             7   Confluence "
"             1   Node #"
"                 Total"
"              Maximum flow                 0.048    c.m/sec"
"              Hydrograph volume           67.556    c.m"
"                    0.003     0.048     0.003     0.000"
" 38          START/RE-START TOTALS 1"
"             3   Runoff Totals on EXIT"
"              Total Catchment area                    0.154    hectare"
"              Total Impervious area                   0.125    hectare"
"              Total % impervious                     81.143"
```

10 Year Post B

" 19 EXIT"

```
"               MIDUSS Output ----------------------------------------------->"
"               MIDUSS version                            Version 2.25  rev. 473"
"               MIDUSS created                          Sunday, February 7, 2010"
"          10   Units used:                                            ie METRIC"
"               Job folder:                                  Q:\48790\100\MIDUSS"
"               Output filename:                                25 Year Post B.out"
"               Licensee name:                                                 A"
"               Company                                                Microsoft"
"               Date & Time last used:                   6/15/2021 at 5:21:40 PM"
" 31         TIME PARAMETERS"
"       5.000   Time Step"
"     180.000   Max. Storm length"
"    1500.000   Max. Hydrograph"
" 32         STORM Chicago storm"
"           1   Chicago storm"
"    3158.000   Coefficient A"
"      15.000   Constant B"
"       0.936   Exponent C"
"       0.400   Fraction R"
"     180.000   Duration"
"       1.000   Time step multiplier"
"            Maximum intensity           191.557    mm/hr"
"            Total depth                  68.266    mm"
"           6   025hyd   Hydrograph extension used in this file"
" 33         CATCHMENT 201"
"           1   Triangular SCS"
"           1   Equal length"
"           1   SCS method"
"         201   To OGS to River"
"      86.000   % Impervious"
"       0.136   Total Area"
"      55.000   Flow length"
"       5.000   Overland Slope"
"       0.019   Pervious Area"
"      55.000   Pervious length"
"       5.000   Pervious slope"
"       0.117   Impervious Area"
"      55.000   Impervious length"
"       5.000   Impervious slope"
"       0.250   Pervious Manning 'n'"
"      75.000   Pervious SCS Curve No."
"       0.362   Pervious Runoff coefficient"
"       0.100   Pervious Ia/S coefficient"
"       8.467   Pervious Initial abstraction"
"       0.015   Impervious Manning 'n'"
"      98.000   Impervious SCS Curve No."
"       0.910   Impervious Runoff coefficient"
"       0.100   Impervious Ia/S coefficient"
```

```
"       0.518   Impervious Initial abstraction"
"                   0.051     0.000     0.000     0.000 c.m/sec"
"            Catchment 201         Pervious   Impervious Total Area "
"            Surface Area          0.019      0.117      0.136      hectare"
"            Time of concentration 15.435     1.889      2.713      minutes"
"            Time to Centroid      113.852    87.169     88.793     minutes"
"            Rainfall depth        68.266     68.266     68.266     mm"
"            Rainfall volume       13.00      79.84      92.84      c.m"
"            Rainfall losses       43.542     6.174      11.406     mm"
"            Runoff depth          24.724     62.092     56.860     mm"
"            Runoff volume         4.71       72.62      77.33      c.m"
"            Runoff coefficient    0.362      0.910      0.833      "
"            Maximum flow          0.002      0.051      0.051      c.m/sec"
" 40         HYDROGRAPH Add Runoff "
"           4   Add Runoff "
"                   0.051     0.051     0.000     0.000"
" 40         HYDROGRAPH Copy to Outflow"
"           8   Copy to Outflow"
"                   0.051     0.051     0.051     0.000"
" 40         HYDROGRAPH   Combine    1"
"           6   Combine "
"           1   Node #"
"               Total"
"            Maximum flow                 0.051    c.m/sec"
"            Hydrograph volume           77.330    c.m"
"                   0.051     0.051     0.051     0.051"
" 40         HYDROGRAPH Start - New Tributary"
"           2   Start - New Tributary"
"                   0.051     0.000     0.051     0.051"
" 33         CATCHMENT 202"
"           1   Triangular SCS"
"           1   Equal length"
"           1   SCS method"
"         202   To River Uncontrolled"
"       0.000   % Impervious"
"       0.010   Total Area"
"       8.000   Flow length"
"      30.000   Overland Slope"
"       0.010   Pervious Area"
"       8.000   Pervious length"
"      30.000   Pervious slope"
"       0.000   Impervious Area"
"       8.000   Impervious length"
"      30.000   Impervious slope"
"       0.250   Pervious Manning 'n'"
"      75.000   Pervious SCS Curve No."
"       0.355   Pervious Runoff coefficient"
"       0.100   Pervious Ia/S coefficient"
```

```
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.000   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.002     0.000     0.051     0.051 c.m/sec"
"             Catchment 202          Pervious   Impervious Total Area "
"             Surface Area           0.010      0.000      0.010      hectare"
"             Time of concentration  2.836      0.347      2.836      minutes"
"             Time to Centroid       98.136     85.221     98.136     minutes"
"             Rainfall depth         68.266     68.266     68.266     mm"
"             Rainfall volume        6.83       0.00       6.83       c.m"
"             Rainfall losses        44.015     13.504     44.015     mm"
"             Runoff depth           24.252     54.762     24.252     mm"
"             Runoff volume          2.43       0.00       2.43       c.m"
"             Runoff coefficient     0.355      0.000      0.355      "
"             Maximum flow           0.002      0.000      0.002      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.002     0.002     0.051     0.051"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.002     0.002     0.002     0.051"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                  0.052    c.m/sec"
"             Hydrograph volume            79.755    c.m"
"                     0.002     0.002     0.002     0.052"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.002     0.000     0.002     0.052"
" 33          CATCHMENT 203"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          203   To ROW Uncontrolled"
"      100.000   % Impervious"
"        0.008   Total Area"
"        4.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"        4.000   Pervious length"
"        2.000   Pervious slope"
"        0.008   Impervious Area"
"        4.000   Impervious length"
```

```
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.000   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.827   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.004     0.000     0.002     0.052 c.m/sec"
"             Catchment 203          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.008      0.008      hectare"
"             Time of concentration  4.216      0.516      0.516      minutes"
"             Time to Centroid       99.932     85.693     85.693     minutes"
"             Rainfall depth         68.266     68.266     68.266     mm"
"             Rainfall volume        0.00       5.46       5.46       c.m"
"             Rainfall losses        43.778     11.785     11.785     mm"
"             Runoff depth           24.488     56.481     56.481     mm"
"             Runoff volume          0.00       4.52       4.52       c.m"
"             Runoff coefficient     0.000      0.827      0.827      "
"             Maximum flow           0.000      0.004      0.004      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.004     0.004     0.002     0.052"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.004     0.004     0.004     0.052"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                  0.056    c.m/sec"
"             Hydrograph volume            84.274    c.m"
"                     0.004     0.004     0.004     0.056"
" 40          HYDROGRAPH   Confluence    1"
"            7   Confluence "
"            1   Node #"
"                Total"
"             Maximum flow                  0.056    c.m/sec"
"             Hydrograph volume            84.274    c.m"
"                     0.004     0.056     0.004     0.000"
" 38          START/RE-START TOTALS 1"
"            3   Runoff Totals on EXIT"
"             Total Catchment area                    0.154    hectare"
"             Total Impervious area                   0.125    hectare"
"             Total % impervious                     81.143"
```

25 Year Post B

```
" 19          EXIT"
```

```
"                MIDUSS Output ---------------------------------------------->"
"                MIDUSS version                         Version 2.25  rev. 473"
"                MIDUSS created                       Sunday, February 7, 2010"
"           10   Units used:                                         ie METRIC"
"                Job folder:                               Q:\48790\100\MIDUSS"
"                Output filename:                           50 Year Post B.out"
"                Licensee name:                                              A"
"                Company                                              Microsoft"
"                Date & Time last used:                6/15/2021 at 5:23:33 PM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     3886.000   Coefficient A"
"       16.000   Constant B"
"        0.950   Exponent C"
"        0.400   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity          215.802    mm/hr"
"             Total depth                 77.647    mm"
"            6   050hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 201"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          201   To OGS to River"
"       86.000   % Impervious"
"        0.136   Total Area"
"       55.000   Flow length"
"        5.000   Overland Slope"
"        0.019   Pervious Area"
"       55.000   Pervious length"
"        5.000   Pervious slope"
"        0.117   Impervious Area"
"       55.000   Impervious length"
"        5.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.400   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.919   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
```

```
"        0.518   Impervious Initial abstraction"
"                     0.059     0.000     0.000     0.000 c.m/sec"
"             Catchment 201          Pervious   Impervious Total Area "
"             Surface Area           0.019      0.117      0.136      hectare"
"             Time of concentration  14.004     1.797      2.604      minutes"
"             Time to Centroid       111.160    86.644     88.266     minutes"
"             Rainfall depth         77.647     77.647     77.647     mm"
"             Rainfall volume        14.78      90.82      105.60     c.m"
"             Rainfall losses        46.596     6.287      11.931     mm"
"             Runoff depth           31.051     71.360     65.717     mm"
"             Runoff volume          5.91       83.46      89.37      c.m"
"             Runoff coefficient     0.400      0.919      0.846      "
"             Maximum flow           0.003      0.058      0.059      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.059     0.059     0.000     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.059     0.059     0.059     0.000"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                  Total"
"             Maximum flow                 0.059    c.m/sec"
"             Hydrograph volume           89.375    c.m"
"                     0.059     0.059     0.059     0.059"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.059     0.000     0.059     0.059"
" 33          CATCHMENT 202"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          202   To River Uncontrolled"
"        0.000   % Impervious"
"        0.010   Total Area"
"        8.000   Flow length"
"       30.000   Overland Slope"
"        0.010   Pervious Area"
"        8.000   Pervious length"
"       30.000   Pervious slope"
"        0.000   Impervious Area"
"        8.000   Impervious length"
"       30.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.393   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
```

```
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.000   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.002     0.000     0.059     0.059 c.m/sec"
"              Catchment 202          Pervious   Impervious Total Area "
"              Surface Area           0.010      0.000      0.010      hectare"
"              Time of concentration  2.573      0.330      2.573      minutes"
"              Time to Centroid       96.770     84.736     96.770     minutes"
"              Rainfall depth         77.647     77.647     77.647     mm"
"              Rainfall volume        7.76       0.00       7.76       c.m"
"              Rainfall losses        47.096     14.952     47.095     mm"
"              Runoff depth           30.552     62.695     30.552     mm"
"              Runoff volume          3.06       0.00       3.06       c.m"
"              Runoff coefficient     0.393      0.000      0.393      "
"              Maximum flow           0.002      0.000      0.002      c.m/sec"
" 40           HYDROGRAPH Add Runoff "
"             4   Add Runoff "
"                     0.002     0.002     0.059     0.059"
" 40           HYDROGRAPH Copy to Outflow"
"             8   Copy to Outflow"
"                     0.002     0.002     0.002     0.059"
" 40           HYDROGRAPH   Combine    1"
"             6   Combine "
"             1   Node #"
"                 Total"
"              Maximum flow                 0.060    c.m/sec"
"              Hydrograph volume           92.430    c.m"
"                     0.002     0.002     0.002     0.060"
" 40           HYDROGRAPH Start - New Tributary"
"             2   Start - New Tributary"
"                     0.002     0.000     0.002     0.060"
" 33           CATCHMENT 203"
"             1   Triangular SCS"
"             1   Equal length"
"             1   SCS method"
"           203   To ROW Uncontrolled"
"      100.000   % Impervious"
"        0.008   Total Area"
"        4.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"        4.000   Pervious length"
"        2.000   Pervious slope"
"        0.008   Impervious Area"
"        4.000   Impervious length"
```

```
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.000   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.831   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.004     0.000     0.002     0.060 c.m/sec"
"              Catchment 203          Pervious   Impervious Total Area "
"              Surface Area           0.000      0.008      0.008      hectare"
"              Time of concentration  3.825      0.491      0.491      minutes"
"              Time to Centroid       98.561     85.235     85.235     minutes"
"              Rainfall depth         77.647     77.647     77.647     mm"
"              Rainfall volume        0.00       6.21       6.21       c.m"
"              Rainfall losses        47.145     13.130     13.130     mm"
"              Runoff depth           30.503     64.517     64.517     mm"
"              Runoff volume          0.00       5.16       5.16       c.m"
"              Runoff coefficient     0.000      0.831      0.831      "
"              Maximum flow           0.000      0.004      0.004      c.m/sec"
" 40           HYDROGRAPH Add Runoff "
"             4   Add Runoff "
"                     0.004     0.004     0.002     0.060"
" 40           HYDROGRAPH Copy to Outflow"
"             8   Copy to Outflow"
"                     0.004     0.004     0.004     0.060"
" 40           HYDROGRAPH   Combine    1"
"             6   Combine "
"             1   Node #"
"                 Total"
"              Maximum flow                 0.064    c.m/sec"
"              Hydrograph volume           97.591    c.m"
"                     0.004     0.004     0.004     0.064"
" 40           HYDROGRAPH   Confluence    1"
"             7   Confluence "
"             1   Node #"
"                 Total"
"              Maximum flow                 0.064    c.m/sec"
"              Hydrograph volume           97.591    c.m"
"                     0.004     0.064     0.004     0.000"
" 38           START/RE-START TOTALS 1"
"             3   Runoff Totals on EXIT"
"              Total Catchment area                     0.154    hectare"
"              Total Impervious area                    0.125    hectare"
"              Total % impervious                      81.143"
```

```
" 19          EXIT"
```

```
"               MIDUSS Output ----------------------------------------------->"
"               MIDUSS version                         Version 2.25  rev. 473"
"               MIDUSS created                     Sunday, February 7, 2010"
"          10   Units used:                                       ie METRIC"
"               Job folder:                             Q:\48790\100\MIDUSS"
"               Output filename:                          100 Year Post B.out"
"               Licensee name:                                            A"
"               Company                                           Microsoft"
"               Date & Time last used:                6/15/2021 at 5:24:39 PM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"           1   Chicago storm"
"     4688.000   Coefficient A"
"       17.000   Constant B"
"        0.962   Exponent C"
"        0.400   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"            Maximum intensity           239.354    mm/hr"
"            Total depth                  87.079    mm"
"           6   100hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 201"
"           1   Triangular SCS"
"           1   Equal length"
"           1   SCS method"
"         201   To OGS to River"
"       86.000   % Impervious"
"        0.136   Total Area"
"       55.000   Flow length"
"        5.000   Overland Slope"
"        0.019   Pervious Area"
"       55.000   Pervious length"
"        5.000   Pervious slope"
"        0.117   Impervious Area"
"       55.000   Impervious length"
"        5.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.433   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.926   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
```

```
"        0.518   Impervious Initial abstraction"
"                 0.066     0.000     0.000     0.000 c.m/sec"
"            Catchment 201         Pervious   Impervious Total Area "
"            Surface Area          0.019      0.117      0.136      hectare"
"            Time of concentration  12.909     1.721      2.513      minutes"
"            Time to Centroid      109.018    86.221     87.834     minutes"
"            Rainfall depth        87.079     87.079     87.079     mm"
"            Rainfall volume       16.58      101.85     118.43     c.m"
"            Rainfall losses       49.357     6.436      12.445     mm"
"            Runoff depth          37.722     80.644     74.634     mm"
"            Runoff volume         7.18       94.32      101.50     c.m"
"            Runoff coefficient    0.433      0.926      0.857      "
"            Maximum flow          0.003      0.066      0.066      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"           4   Add Runoff "
"                 0.066     0.066     0.000     0.000"
" 40          HYDROGRAPH Copy to Outflow"
"           8   Copy to Outflow"
"                 0.066     0.066     0.066     0.000"
" 40          HYDROGRAPH   Combine    1"
"           6   Combine "
"           1   Node #"
"               Total"
"            Maximum flow                 0.066    c.m/sec"
"            Hydrograph volume          101.503    c.m"
"                 0.066     0.066     0.066     0.066"
" 40          HYDROGRAPH Start - New Tributary"
"           2   Start - New Tributary"
"                 0.066     0.000     0.066     0.066"
" 33          CATCHMENT 202"
"           1   Triangular SCS"
"           1   Equal length"
"           1   SCS method"
"         202   To River Uncontrolled"
"        0.000   % Impervious"
"        0.010   Total Area"
"        8.000   Flow length"
"       30.000   Overland Slope"
"        0.010   Pervious Area"
"        8.000   Pervious length"
"       30.000   Pervious slope"
"        0.000   Impervious Area"
"        8.000   Impervious length"
"       30.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.427   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
```

```
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.000   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.002     0.000     0.066     0.066 c.m/sec"
"             Catchment 202          Pervious   Impervious Total Area "
"             Surface Area           0.010      0.000      0.010      hectare"
"             Time of concentration  2.372      0.316      2.372      minutes"
"             Time to Centroid       95.700     84.344     95.700     minutes"
"             Rainfall depth         87.079     87.079     87.079     mm"
"             Rainfall volume        8.71       0.00       8.71       c.m"
"             Rainfall losses        49.929     16.380     49.929     mm"
"             Runoff depth           37.150     70.699     37.150     mm"
"             Runoff volume          3.72       0.00       3.72       c.m"
"             Runoff coefficient     0.427      0.000      0.427      "
"             Maximum flow           0.002      0.000      0.002      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.002     0.002     0.066     0.066"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.002     0.002     0.002     0.066"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                  0.068    c.m/sec"
"             Hydrograph volume           105.218    c.m"
"                     0.002     0.002     0.002     0.068"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.002     0.000     0.002     0.068"
" 33          CATCHMENT 203"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          203   To ROW Uncontrolled"
"      100.000   % Impervious"
"        0.008   Total Area"
"        4.000   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"        4.000   Pervious length"
"        2.000   Pervious slope"
"        0.008   Impervious Area"
"        4.000   Impervious length"
```

```
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.000   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.833   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.004     0.000     0.002     0.068 c.m/sec"
"             Catchment 203          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.008      0.008      hectare"
"             Time of concentration  3.526      0.470      0.470      minutes"
"             Time to Centroid       97.400     84.859     84.859     minutes"
"             Rainfall depth         87.079     87.079     87.079     mm"
"             Rainfall volume        0.00       6.97       6.97       c.m"
"             Rainfall losses        50.131     14.538     14.538     mm"
"             Runoff depth           36.948     72.542     72.542     mm"
"             Runoff volume          0.00       5.80       5.80       c.m"
"             Runoff coefficient     0.000      0.833      0.833      "
"             Maximum flow           0.000      0.004      0.004      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.004     0.004     0.002     0.068"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.004     0.004     0.004     0.068"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total"
"             Maximum flow                  0.073    c.m/sec"
"             Hydrograph volume           111.021    c.m"
"                     0.004     0.004     0.004     0.073"
" 40          HYDROGRAPH   Confluence    1"
"            7   Confluence "
"            1   Node #"
"                Total"
"             Maximum flow                  0.073    c.m/sec"
"             Hydrograph volume           111.021    c.m"
"                     0.004     0.073     0.004     0.000"
" 38          START/RE-START TOTALS 1"
"            3   Runoff Totals on EXIT"
"             Total Catchment area                    0.154    hectare"
"             Total Impervious area                   0.125    hectare"
"             Total % impervious                     81.143"
```

```
" 19          EXIT"
```

Appendix F

Stormceptor Sizing Output

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

06/15/2021

Province:	Ontario
City:	Fergus
Nearest Rainfall Station:	WATERLOO WELLINGTON AP
NCDC Rainfall Station Id:	9387
Years of Rainfall Data:	34
Site Name:	
Drainage Area (ha):	0.14
% Imperviousness:	86.00

Runoff Coefficient 'c': 0.81

Project Name:	350 St Andrew St W
Project Number:	45433
Designer Name:	Christine Metrie
Designer Company:	MTE Consultants
Designer Email:	cmetrie@mte85.com
Designer Phone:	519-743-6500
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Particle Size Distribution:	Fine
Target TSS Removal (%):	80.0
Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	4.48
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	88
EFO6	91
EFO8	92
EFO10	92
EFO12	92

Recommended Stormceptor EFO Model:	**EFO4**
Estimated Net Annual Sediment (TSS) Load Reduction (%):	**88**
Water Quality Runoff Volume Capture (%):	**> 90**

THIRD-PARTY TESTING AND VERIFICATION

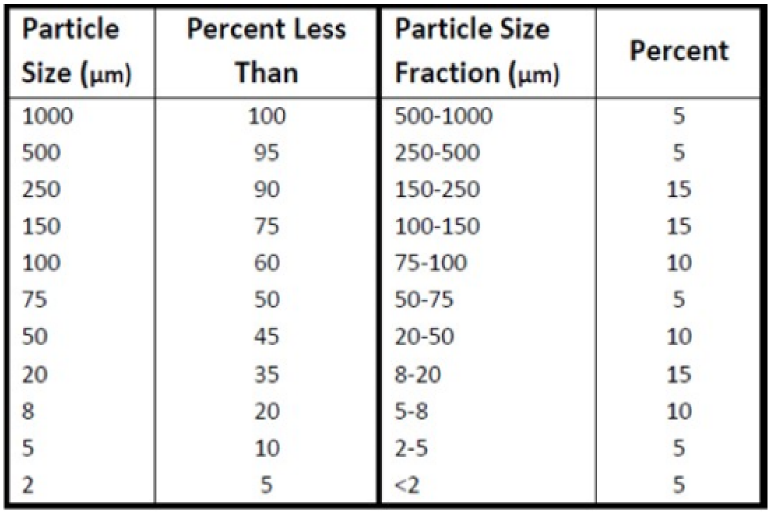
►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

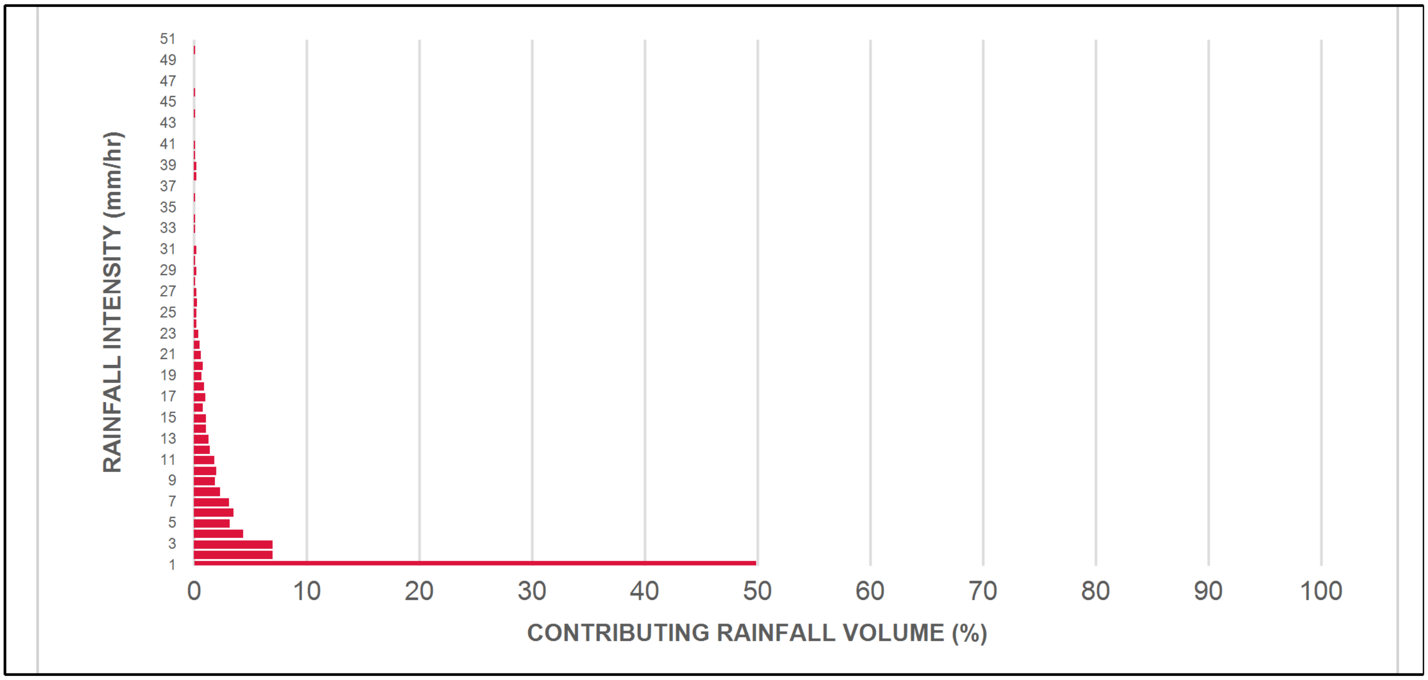


Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

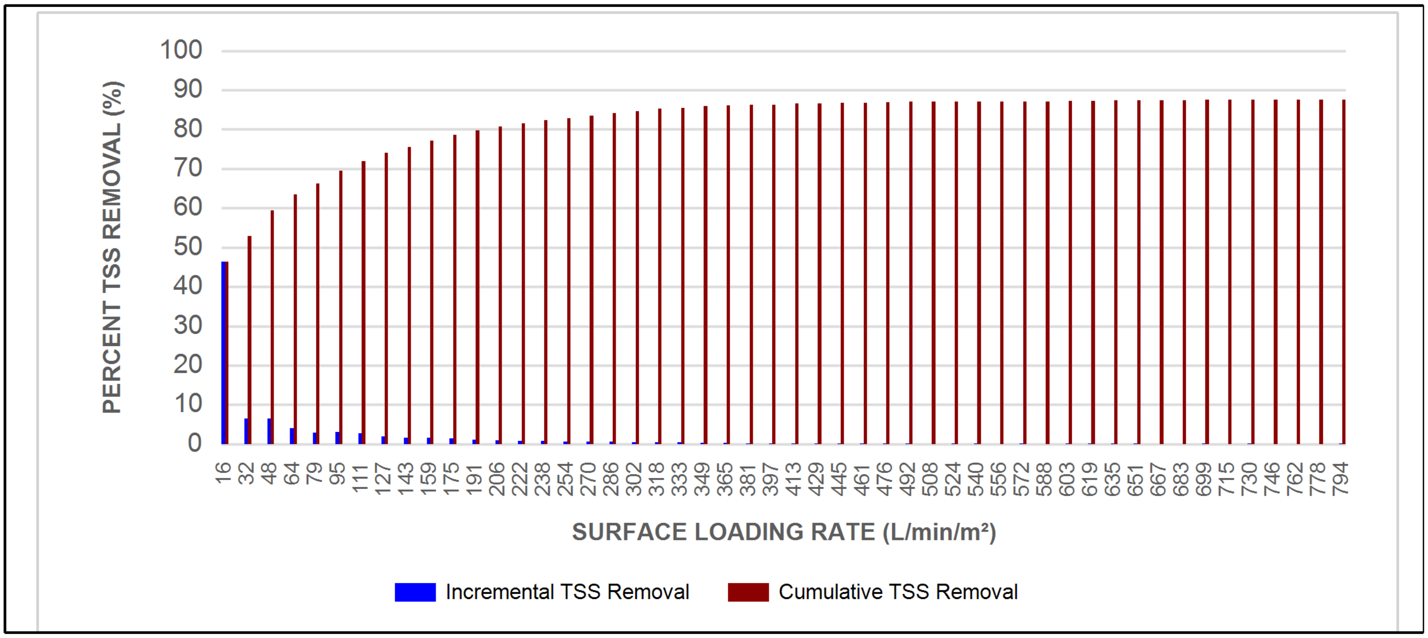
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.9	49.9	0.32	19.0	16.0	93	46.4	46.4
2	7.0	56.9	0.64	38.0	32.0	93	6.5	52.9
3	7.0	63.9	0.95	57.0	48.0	93	6.5	59.4
4	4.4	68.3	1.27	76.0	64.0	91	4.0	63.4
5	3.2	71.5	1.59	95.0	79.0	89	2.8	66.3
6	3.5	75.0	1.91	114.0	95.0	88	3.1	69.4
7	3.1	78.1	2.22	133.0	111.0	86	2.7	72.0
8	2.3	80.4	2.54	152.0	127.0	85	1.9	74.0
9	1.9	82.3	2.86	171.0	143.0	83	1.6	75.5
10	2.0	84.3	3.18	191.0	159.0	81	1.6	77.2
11	1.8	86.1	3.49	210.0	175.0	79	1.4	78.6
12	1.4	87.5	3.81	229.0	191.0	77	1.1	79.7
13	1.3	88.8	4.13	248.0	206.0	76	1.0	80.7
14	1.1	89.9	4.45	267.0	222.0	74	0.8	81.5
15	1.1	91.0	4.76	286.0	238.0	73	0.8	82.3
16	0.8	91.8	5.08	305.0	254.0	72	0.6	82.8
17	1.0	92.8	5.40	324.0	270.0	70	0.7	83.5
18	0.9	93.7	5.72	343.0	286.0	69	0.6	84.2
19	0.7	94.4	6.03	362.0	302.0	67	0.5	84.6
20	0.8	95.2	6.35	381.0	318.0	66	0.5	85.2
21	0.6	95.8	6.67	400.0	333.0	64	0.4	85.5
22	0.5	96.3	6.99	419.0	349.0	63	0.3	85.9
23	0.4	96.7	7.30	438.0	365.0	62	0.2	86.1
24	0.2	96.9	7.62	457.0	381.0	60	0.1	86.2
25	0.2	97.1	7.94	476.0	397.0	59	0.1	86.3

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.3	97.4	8.26	495.0	413.0	58	0.2	86.5
27	0.2	97.6	8.57	514.0	429.0	57	0.1	86.6
28	0.1	97.7	8.89	534.0	445.0	57	0.1	86.7
29	0.2	97.9	9.21	553.0	461.0	56	0.1	86.8
30	0.1	98.0	9.53	572.0	476.0	56	0.1	86.9
31	0.2	98.2	9.85	591.0	492.0	55	0.1	87.0
32	0.0	98.2	10.16	610.0	508.0	55	0.0	87.0
33	0.1	98.3	10.48	629.0	524.0	54	0.1	87.0
34	0.1	98.4	10.80	648.0	540.0	54	0.1	87.1
35	0.0	98.4	11.12	667.0	556.0	54	0.0	87.1
36	0.1	98.5	11.43	686.0	572.0	53	0.1	87.1
37	0.0	98.5	11.75	705.0	588.0	53	0.0	87.1
38	0.2	98.7	12.07	724.0	603.0	52	0.1	87.2
39	0.2	98.9	12.39	743.0	619.0	52	0.1	87.3
40	0.1	99.0	12.70	762.0	635.0	52	0.1	87.4
41	0.1	99.1	13.02	781.0	651.0	52	0.1	87.4
42	0.0	99.1	13.34	800.0	667.0	52	0.0	87.4
43	0.0	99.1	13.66	819.0	683.0	52	0.0	87.4
44	0.1	99.2	13.97	838.0	699.0	52	0.1	87.5
45	0.0	99.2	14.29	857.0	715.0	51	0.0	87.5
46	0.1	99.3	14.61	877.0	730.0	51	0.1	87.5
47	0.0	99.3	14.93	896.0	746.0	51	0.0	87.5
48	0.0	99.3	15.24	915.0	762.0	51	0.0	87.5
49	0.0	99.3	15.56	934.0	778.0	51	0.0	87.5
50	0.1	99.4	15.88	953.0	794.0	51	0.1	87.6
Estimated Net Annual Sediment (TSS) Load Reduction =								**88 %**

RAINFALL DATA FROM WATERLOO WELLINGTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter (m)	Model Diameter (ft)	Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter (mm)	Max Inlet Pipe Diameter (in)	Max Outlet Pipe Diameter (mm)	Max Outlet Pipe Diameter (in)	Peak Conveyance Flow Rate (L/s)	Peak Conveyance Flow Rate (cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

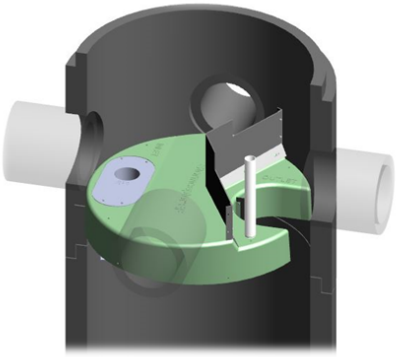
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

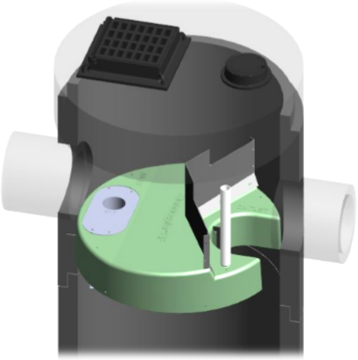
DESIGN FLEXIBILITY

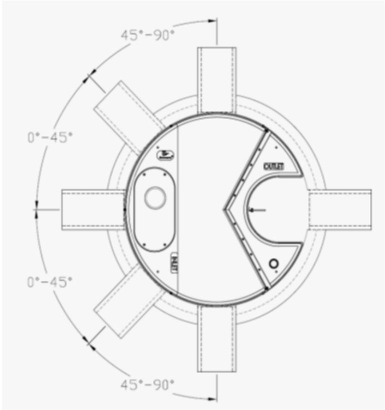
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.







INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.
0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.
45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft^3)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity
** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft^3)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD PERFORMANCE SPECIFICATION FOR “OIL GRIT SEPARATOR” (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program’s **Procedure for Laboratory Testing of Oil-Grit Separators**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The minimum sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program’s **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of completed third-party Light Liquid Re-entrainment Simulation Testing in accordance with the Canadian ETV **Program’s Procedure for Laboratory Testing of Oil-Grit Separators,** with results reported within the Canadian ETV or ISO 14034 ETV verification. This re-entrainment testing is conducted with the device pre-loaded with low density polyethylene (LDPE) plastic beads as a surrogate for light liquids such as oil and fuel. Testing is conducted on the same OGS unit tested for sediment removal to assess whether light liquids captured after a spill are effectively retained at high flow rates.

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m2 to 2600 L/min/m2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program’s **Procedure for Laboratory Testing of Oil-Grit Separators.**However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.