WRIGHT LANDS
(788-790 RIVER ROAD)

CONCEPTUAL SITE SERVICING AND STORMWATER MANAGEMENT REPORT

REGIONAL
THE REGIONAL GROUP

Prepared for:

Nicolls Island Holdings Inc. (c/o Regional Group)
1737 Woodward Drive, 2nd Floor
Ottawa, Ontario
K2C 0P9

Prepared By:

NOVATECH
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario
K2M 1P6

August 5, 2020

Novatech File: 116037
Ref. No.: R-2020-024

NOVATECH
Engineers, Planners & Landscape Architects

August 5, 2020

City of Ottawa
Planning and Growth Management Department
Development Review (Urban Services - South) Branch
Infrastructure Approvals Division
110 Laurier Avenue West, 4th Floor
Ottawa, ON K1P 1J1

Attention: **Ms. Tracey Scaramozzino, MCIP RPP**
Planner II

Mr. Golam Sharif, P.Eng.
Project Manager

Reference: **Wright Lands (788-790 River Road)**
Conceptual Site Servicing and Stormwater Management Report
Novatech File No.: 116037

In support of the Draft Plan of Subdivision application for the above-noted site, you will find enclosed the Conceptual Site Servicing and Stormwater Management Report for the Wright Lands, also known as 788-790 River Road (Subject Site).

This report addresses the approach to site servicing and stormwater management for the Subject Site, which have been developed based on the requirements of the City of Ottawa and Rideau Valley Conservation Authority.

Should you have any questions, or require additional information, please contact me.

Yours truly,

NOVATECH

Bassam Bahia, M.Eng., P. Eng.
Project Manager | Land Development

cc: Jamie Batchelor, Rideau Valley Conservation Authority
Taylor Marquis/Erin O'Connor, Regional Group

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Background

This report addresses the approach to site servicing for the Wright Lands, also known as 788-790 River Road (Subject Site), which is being proposed by Nicolls Island Holdings Inc. (Developer).

The Subject Site is located within the western limits of the Riverside South Community (RSC). More specifically, the Subject Site is at the north-west corner of the River Road and Nicholls Island Road intersection, as shown on **Figure 1.1** – Key Plan. The Subject Site is bound to the north by an existing residence fronting River Road and a vegetated ravine, to the east by existing residences fronting River Road, to the south by future development lands (Alphon Lands), and to the west by the RCMP Long Island Campgrounds operated by the RCMP Employees Association.

The existing land usage is mainly agricultural, with a vegetated area and single residential dwelling fronting River Road (to be demolished), as shown on **Figure 1.2** – Existing Conditions Plan. The grade of the Subject Site generally slopes from south-east to north-west towards the RCMP Long Island Campgrounds with a grade difference of 8.0 metres from River Road to the western property line.

The existing residence to the north and the existing residences to the east fronting River Road are currently serviced with private services (i.e. well and septic).

As the Alphon Lands to the south, also known as 425 Nicolls Island Road, are identified in the RSC servicing area, they have been considered in the approach to site servicing outlined in this report.

1.2 Development Intent

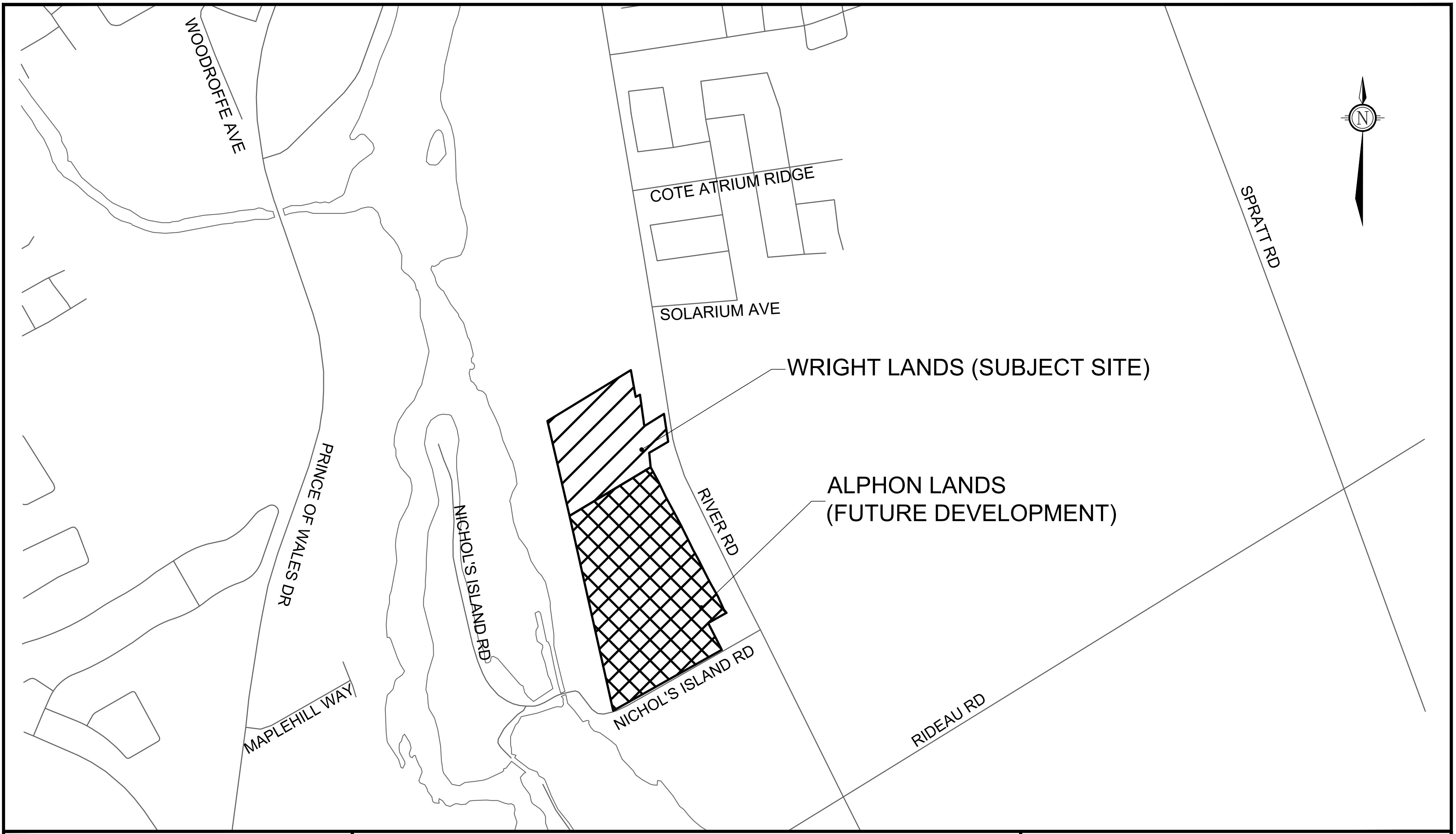
The Subject Site has an area 4.83 ha, and the proposed subdivision will comprise of residential housing, public right-of-ways (ROW), a lift station block, an open space block, and a River Road ROW taking block as shown in **Table 1.1**. The development will contain a City of Ottawa municipal road allowance of 18.0 metres wide. The proposed development is shown on **Figure 1.3** – Site Plan.

Table 1.1: Land Use, Development Potential, and Yield

Unit Type[1]	Number of Units	Area
Singles	27	1.33
Townhomes	27	1.04
Local Roads	-	0.76
Lift Station Block	-	0.03
Open Space Block	-	0.04
River Road ROW Taking Block	-	1.63
TOTAL	**54**	**4.83 ha**

[1] The development does not consist of semis, or multi-unit residential / apartments.

The Subject Site is located within the service area in the City of Ottawa Official Plan; therefore, the site has been designed with city water and sanitary sewage collection.



NOVATECH
Engineers, Planners & Landscape Architects
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada K2M 1P6

Telephone (613) 254-9643
Facsimile (613) 254-5867
Website www.novatech-eng.com

CITY OF OTTAWA
WRIGHT LANDS
788-790 RIVER ROAD

KEY PLAN

SCALE
NOT TO SCALE

DATE	JOB	FIGURE
JUL 2020	116037	1.1

C:\temp\AcPublish_29548\116037 - Fig 1.1 - Keyplan.dwg, Fig 1.1 - KP, Jul 21, 2020 - 3:25pm, mdias

SHT8X11.DWG - 216mmx279mm

M:\2016\116037\CAD\Design\Figures\Design Brief\116037 - Fig 1.2 - Existing Conditions.dwg, Fig 1.2, Jul 24, 2020 - 3:15pm, dcoffey

NOVATECH

Engineers, Planners & Landscape Architects

Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada K2M 1P6

Telephone	(613) 254-9643
Facsimile	(613) 254-5867
Website	www.novatech-eng.com

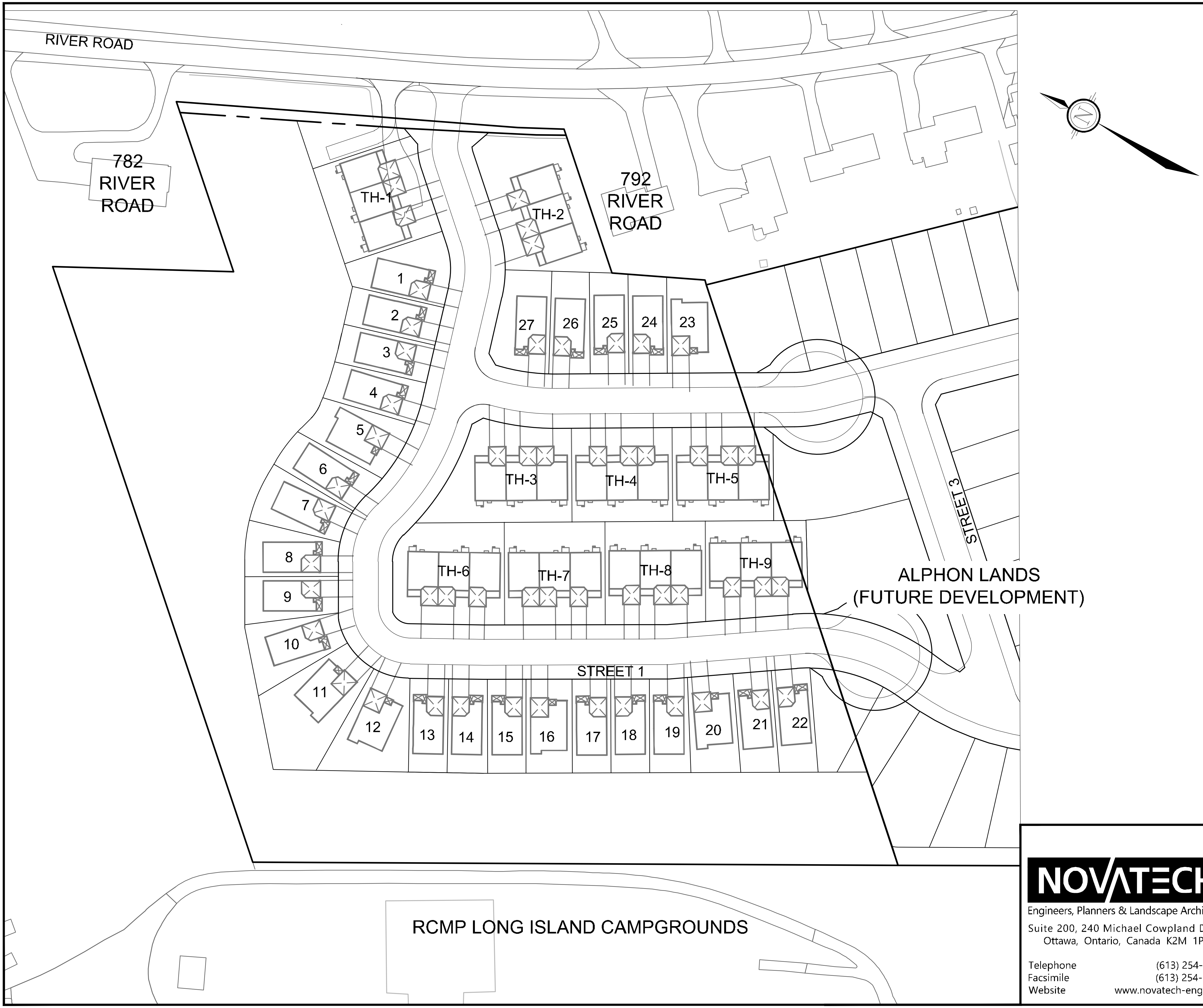
CITY OF OTTAWA
WRIGHT LANDS
788 - 790 RIVER ROAD

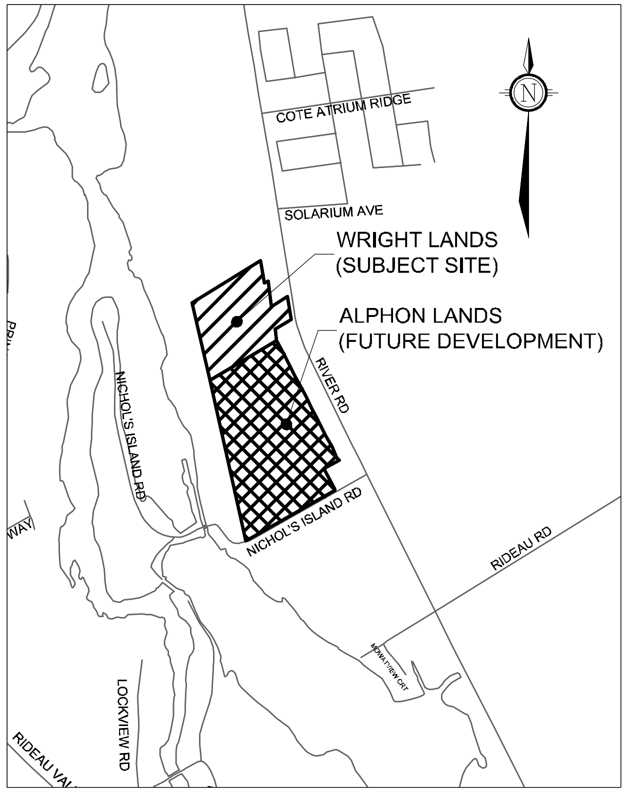
EXISTING CONDITIONS

SCALE
NOT TO SCALE

DATE	JOB	FIGURE
JUL 2020	116037	1.2

SHT8X11.DWG - 216mmx279mm





NOVATECH

Engineers, Planners & Landscape Architects

Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada K2M 1P6

Telephone	(613) 254-9643
Facsimile	(613) 254-5867
Website	www.novatech-eng.com

CITY OF OTTAWA
WRIGHT LANDS
788-790 RIVER ROAD

SITE PLAN

SCALE		
1:1250		
DATE JUL 2020	JOB 116037	FIGURE 1.3

M:\2016\116037\CAD\Design\Figures\Design Brief\116037-FIGURES.dwg, FIG 1.3 (REPORT), Jul 24, 2020 - 1:43pm, bsweet

SHT11X17.DWG - 279mmX432mm

Design of the project has been undertaken in accordance with the Riverside South Community Infrastructure Servicing Study Update – Rideau River Area (ISSU), which serves as a Master Servicing Study for the Rideau River area which includes the Subject Site.

1.3 Report Objective

This report assesses the adequacy of existing and proposed services to support the proposed development. This report will be provided to the various agencies for approval and to obtain any applicable permits.

The City of Ottawa Applicant Study and Plan Identification List along with proof of a pre-consultation meeting is provided in **Appendix A**.

The City of Ottawa Servicing Study Guidelines for Development Applications checklist has been completed and is provided in **Appendix B**.

2.0 REFERENCES AND SUPPORTING DOCUMENTS

2.1 Guidelines and Supporting Studies

The following guidelines and supporting documents were utilized in the preparation of this report:

- **City of Ottawa Official Plan** (OP)
  City of Ottawa, adopted by Council 2003.
- **City of Ottawa Infrastructure Master Plan** (IMP)
  City of Ottawa, November 2013.
- **City of Ottawa Water Distribution Guidelines** (OWDG)
  City of Ottawa, October 2012.
- **Revisions to OWDG** (ISTB-2010-01, ISTB-2014-02, ISTB-2018-02, ISTB-2018-04)
  City of Ottawa, December 2010, May 2014, March 2018, and June 2018.
- **City of Ottawa Sewer Design Guidelines** (OSDG)
  City of Ottawa, October 2012.
- **Revisions to OSDG** (ISTB-2016-01, ISTB-2018-01, & ISTB-2018-03)
  City of Ottawa, September 2016 and March 2018.
- **Design Guidelines for Sewage Works and Drinking Water System** (MOE Guidelines)
  Ontario’s Ministry of the Environment, 2008.
- **Stormwater Management Planning and Design Manual** (MOE SWM Guidelines)
  Ontario’s Ministry of the Environment, 2003.
- **Riverside South Community Design Plan** (CDP)
  City of Ottawa, June 2016.
- **Riverside South Community Master Drainage Plan Update – Rideau River Study Area** (MDP)
  Stantec, March 2016.
- **Riverside South Community Infrastructure Servicing Study Update – Rideau River Area** (ISSU)
  Stantec, June 2017.
- **Riverside South Pond 5 Facility Design Brief** (Pond 5 DB)
  Stantec, May 2018.
- **Design Brief – River Road Reconstruction Summerhill Street to South of Solarium Avenue, Riverside South Community, Rideau River Area** (River Road DB)
  IBI Group, August 2018.
- **Deign Brief – River’s Edge - Phase 1 Riverside South Community** (River’s Edge DB)
  IBI Group, May 2019.

2.2 Geotechnical Investigation

Golder Associates (Golder) conducted a geotechnical investigation (**Appendix F**) in support of the proposed residential development:

Geotechnical Investigation – Proposed Residential Development Nicolls Island Road – Parcel - 'A', Riverside South, Ottawa, Ontario; Report No. 1534482, Golder Associates Ltd., August 2020.

Based on the geotechnical study, it is not anticipated that there will be any significant geotechnical concerns with respect to servicing and developing the site. The borehole locations are provided as **Figure 2.1**. A summary of the geotechnical report findings is provided in **Table 2.1** below.

Table 2.1: Summary of Geotechnical Servicing and Grading Considerations

Parameter	Summary	
Sub-Soil Conditions	Sandy Silt to Silty Sand/Silty Clay to Clay/Glacial Till	
Grade Raise Restriction	1.5 m within Assessment Area A; 2.7 m within Assessment Area B Alternate methods of increasing the permissible grade raise could include use of lightweight fill or preloading/surcharging the Areas.	
OHSA Soil Type	Type 3	
Groundwater Considerations	Low to Moderate groundwater flow	
Pipe Bedding / Backfill	Pipe Bedding	150 mm Granular A
	Pipe Cover	300 mm Granular A or B
	Backfill	Native Material
Pavement Structure	40mm Wear Course	(SuperPave 12.5)
	50mm Binder Course	(SuperPave 19.0)
	150mm Base	(Granular A)
	600mm Subbase	(Granular B Type I or II)
Landscape Consideration	To be determined during detailed design.	

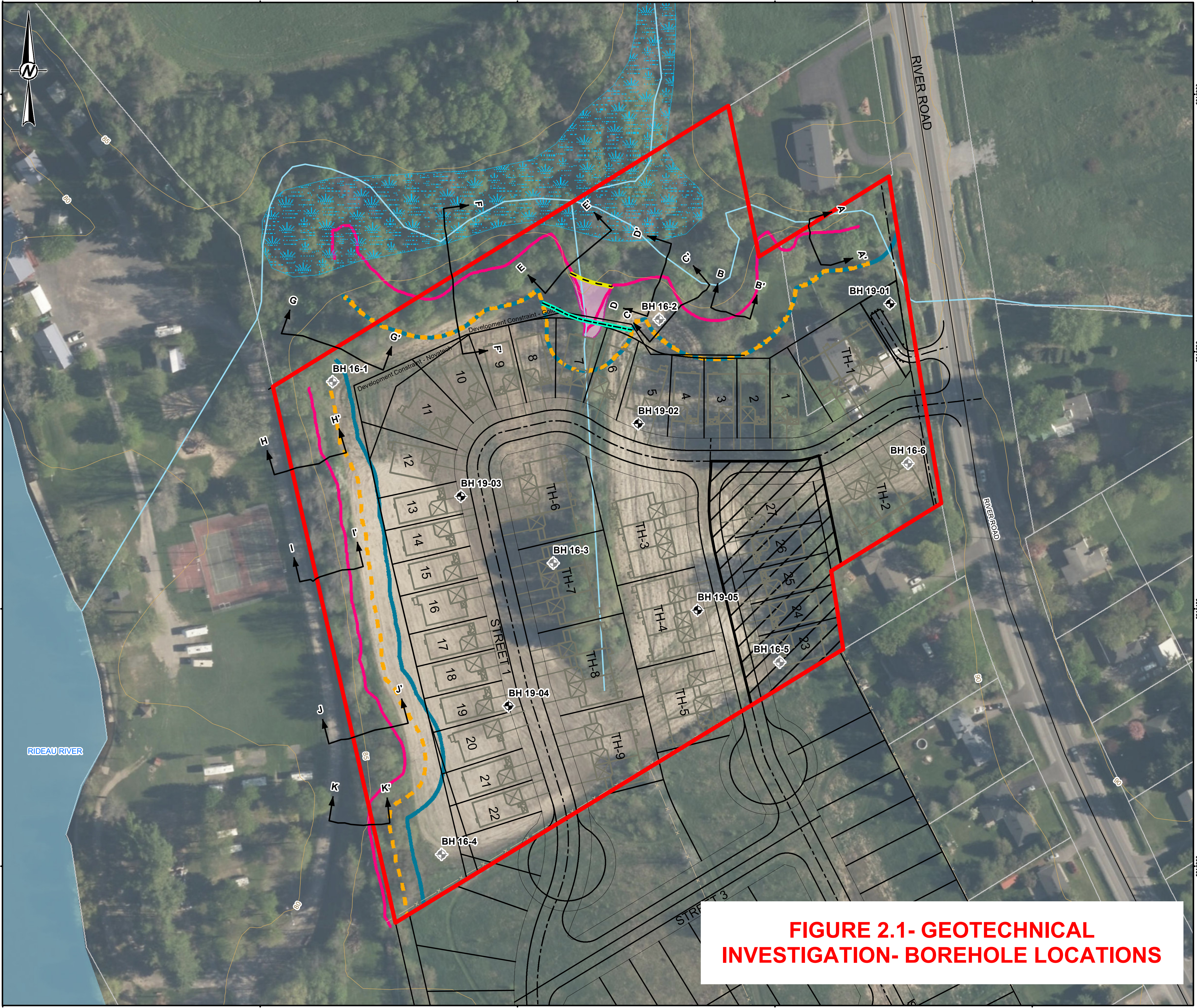


FIGURE 2.1- GEOTECHNICAL INVESTIGATION- BOREHOLE LOCATIONS

KEY MAP

SCALE 1:50,000

LEGEND

⌖ APPROXIMATE BOREHOLE LOCATION
⌖ PROPOSED BOREHOLE LOCATION
— ROADWAY
— TOPOGRAPHIC CONTOUR, metres
x— FENCE
— WATERCOURSE
— NEW TOP OF SLOPE
— NEW FINAL SETBACK
— TOP OF SLOPE
— 15 m OFFSET FROM TOP OF SLOPE
— LIMIT OF HAZARD
A A' SLOPE CROSS-SECTION LOCATION
▨ BACKFILLED AREA
☐ PROPERTY PARCEL
▨ WETLAND
▨ WATERBODY
☐ STUDY AREA
▨ AREA A

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. NEW TOP OF SLOPE AND NEW FINAL SETBACK, AND BACKFILLED AREA DIGITIZED FROM CLIENT PLAN, 116037-CP11, MARCH 14, 2019.
2. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2014
3. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, GARMIN, USGS, INTERMAP, INCREMENT P, NRCAN, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), ESRI KOREA, ESRI (THAILAND), NGCC, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
4. BASE PLAN PROVIDED IN ELECTRONIC FORMAT FROM THE REGIONAL GROUP, MAY 2019
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: MTM ZONE 9 VERTICAL DATUM: CGVD28

0 15 30 60
1:1,500 METRES

CLIENT
THE REGIONAL GROUP

PROJECT
NICOLLS ISLAND ROAD
GEOTECHNICAL INVESTIGATION
PARCEL 'A', OTTAWA, ONTARIO

TITLE
SITE PLAN AND LOCATION OF CROSS-SECTIONS

CONSULTANT
GOLDER

YYYY-MM-DD	2020-03-19
DESIGNED	AG
PREPARED	ABD/BR
REVIEWED	AG
APPROVED	MSS

PROJECT NO.	PHASE	REV.	FIGURE
1534482	20000	A	1

3.0 SERVICING AND GRADING

3.1 River Road

Modifications will be required to River Road to provide access to the proposed subdivision and the lift station. Additionally, in order to service the Subject Site, an extension of the off-site storm and sanitary sewers along River Road will be required.

An extension of the off-site watermain along River Road will also be required but it is anticipated that the City of Ottawa will complete this work in 2020, in advance of Subject Site servicing.

Refer to **Figure 3.1** – Proposed Servicing Layout Plan for the off-site extensions.

3.2 General Servicing

The Subject Site will be serviced using local storm and sanitary sewers, lift station, and watermain. The storm / stormwater management, sanitary and water servicing strategy is discussed in further detail in the following sections.

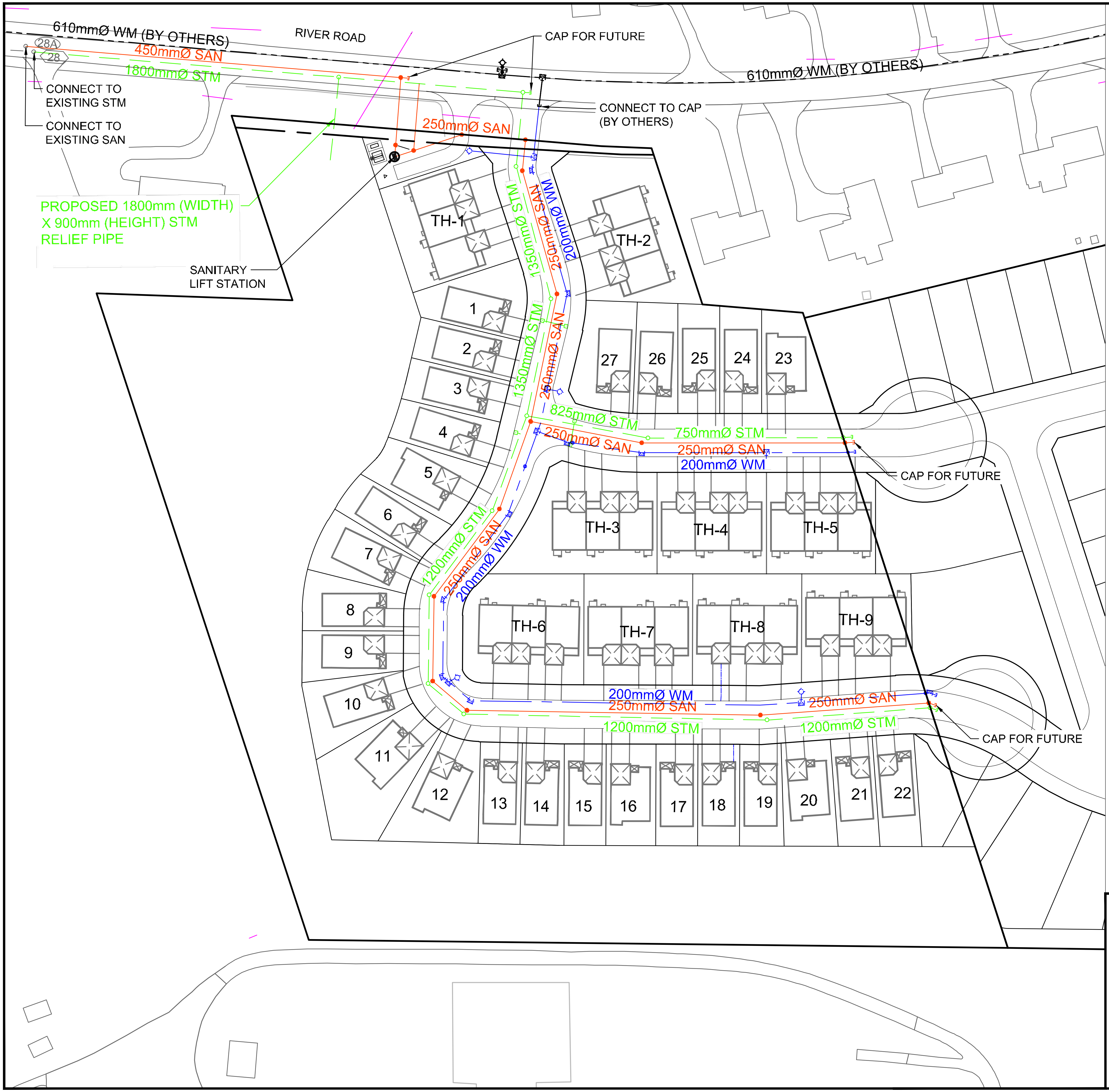
Refer to **Figure 3.1** – Proposed Servicing Layout Plan for the on-site servicing.

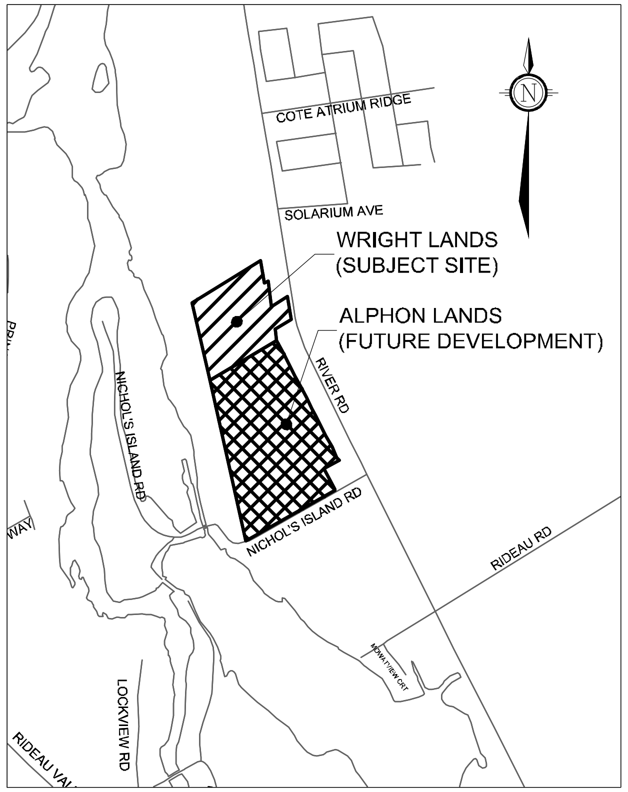
3.3 General Grading

The local roadway within the Subject Site will be graded in a saw-toothed pattern to promote surface storage of stormwater. The grading will direct emergency overland flows from the local road towards the existing ravine which will ultimately outlet to the Rideau River.

The lots will be graded from front to back to direct surface drainage to the rear yard areas.

Refer to **Figure 3.2** – Macro Grading, Erosion and Sediment Control Plan.





LEGEND

- — - — - EXISTING WATERMAIN
- ⌖ EXISTING HYDRANT
- —·—··—·— PROPOSED WATERMAIN BY OTHERS
- — - — - PROPOSED WATERMAIN
- ⌖ PROPOSED HYDRANT
- —●— EXISTING SANITARY SEWER
- —●— PROPOSED SANITARY SEWER
- —○— — — EXISTING STORM SEWER
- —○— — — PROPOSED STORM SEWER
- ——— *EXISTING CULVERT*

NOVATECH
Engineers, Planners & Landscape Architects
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada K2M 1P6

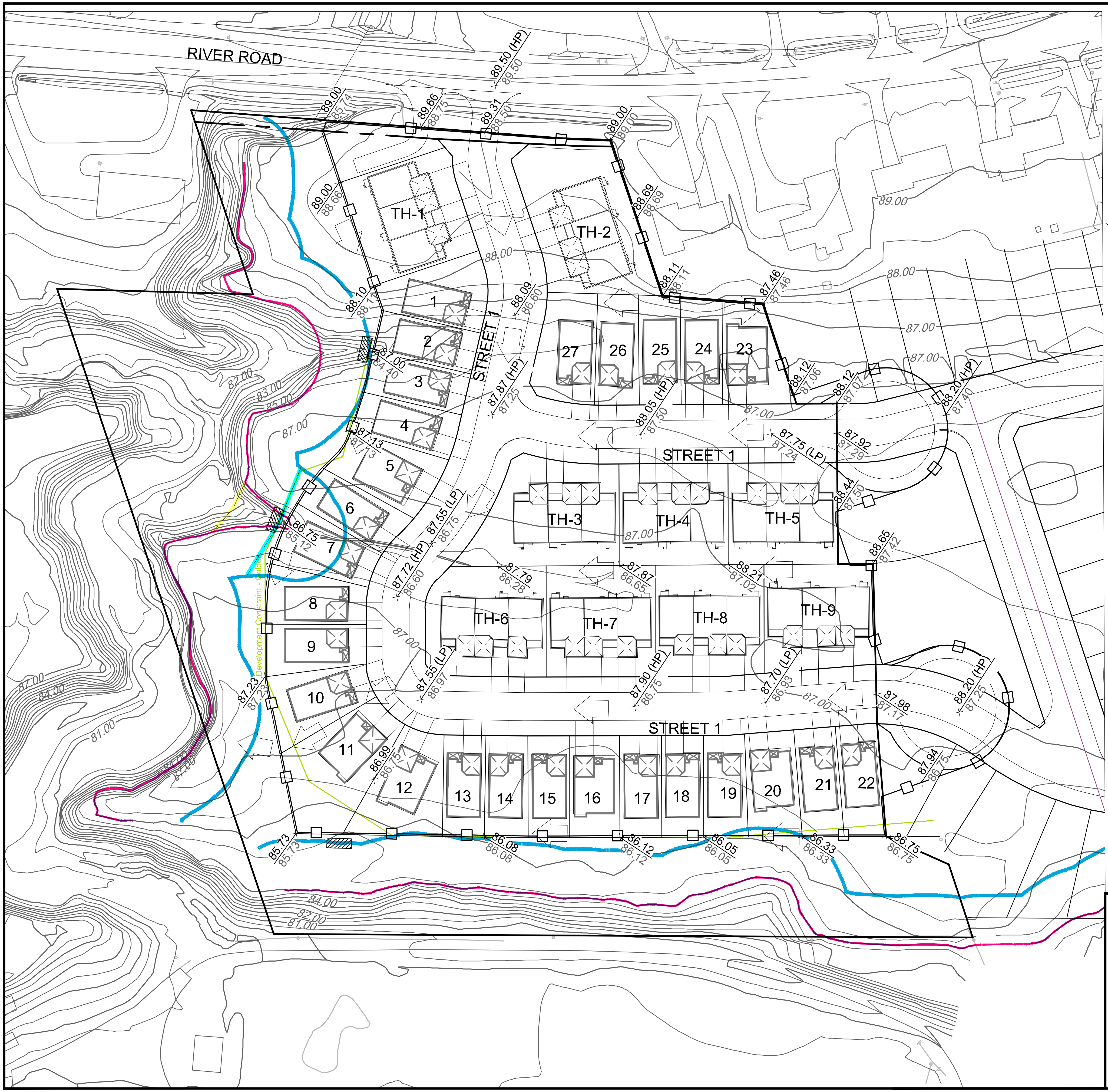
Telephone	(613) 254-9643
Facsimile	(613) 254-5867
Website	www.novatech-eng.com

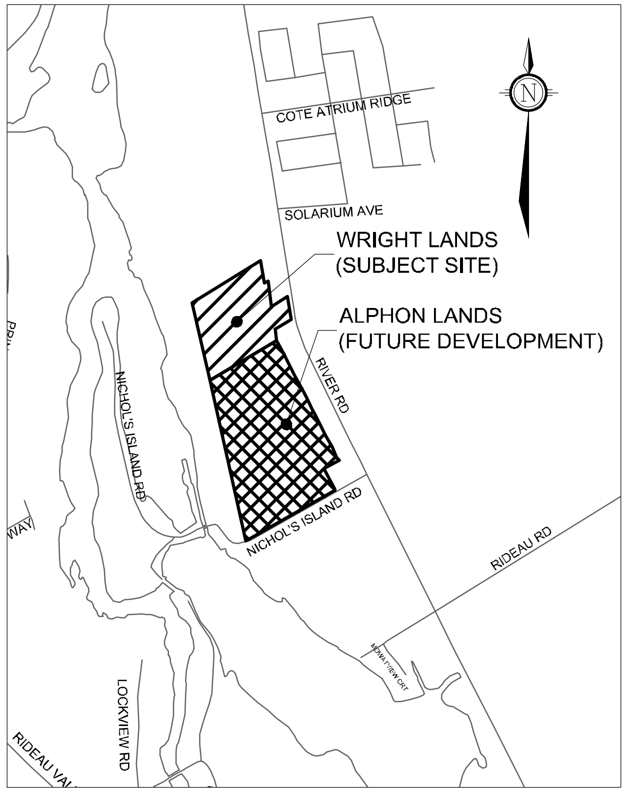
CITY OF OTTAWA
WRIGHT LANDS
788-790 RIVER ROAD

PROPOSED SERVICING LAYOUT PLAN

SCALE		
1:1250		
DATE	JOB	FIGURE
JUL 2020	116037	3.1

M:\2016\116037\CAD\Design\Figures\Design Brief\116037-FIGURES.dwg, FIG 3.1, Jul 24, 2020 - 1:43pm, bsweet





LEGEND

— — — —	NEW TOP OF SLOPE (REFER TO GOLDER REPORT)
— — — —	NEW FINAL SETBACK (REFER TO GOLDER REPORT)
———	TOP OF SLOPE (REFER TO GOLDER REPORT)
———	15m OFFSET FROM TOP OF SLOPE (REFER TO GOLDER REPORT)
———	DEVELOPMENT CONSTRAINTS (REFER TO GOLDER REPORT)
127.55 127.45	PROPOSED ELEVATION *EXISTING ELEVATION*
127.55(HP)	PROPOSED HIGH POINT ELEVATION
127.55(LP)	PROPOSED LOW POINT ELEVATION
⇦	EMERGENCY OVERLAND FLOW
—□—	LIGHT DUTY SILT FENCE BARRIER AS PER OPSD 219.110
▨	TEMPORARY LIGHT-DUTY STRAW BALE BARRIER AS PER OPSD 219.180

NOVATECH
Engineers, Planners & Landscape Architects
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada K2M 1P6

Telephone	(613) 254-9643
Facsimile	(613) 254-5867
Website	www.novatech-eng.com

CITY OF OTTAWA
WRIGHT LANDS
788-790 RIVER ROAD

MACRO GRADING, EROSION AND SEDIMENT CONTROL PLAN

SCALE 1:1250

DATE	JOB	FIGURE
JUL 2020	116037	3.2

M:\2016\116037\CAD\Design\116037-GR.dwg, FIG 3.2, Jul 24, 2020 - 1:41pm, bsweet

SHT11X17.DWG - 279mmX432mm

4.0 STORM SERVICING AND STORMWATER MANAGEMENT

The proposed storm servicing and stormwater management strategy for the Subject Site (Wright Lands) and upstream areas (Alphon Lands) has been conceptually designed to adhere to the criteria established in the OSDG and associated technical bulletins.

4.1 Existing Drainage Conditions

Under existing conditions, storm runoff from the Subject Site (and Alphon Lands) generally flows overland north / westerly towards an existing watercourse that travels along a private laneway / roadside ditch before outletting to the Rideau River. A small amount of drainage is directed to the River Road roadside ditch system; ultimately outletting to the existing ravine along the northern edge of the Subject Site. Refer to **Figure 1.2** – Existing Conditions.

4.2 Previous Studies

The storm servicing and stormwater management strategy for the Wright Lands has been previously established in the following studies for the Riverside South Community.

Riverside South Community MDP Update (Stantec, 2016)

The *'Riverside South Community Master Drainage Plan (MDP) Update – Rideau River Study Area' (Stantec, March 2016)* outlined the requirements for Riverside South Pond 5 and overall stormwater strategy for the Riverside South area tributary to the Rideau River. The Wright and Alphon Lands were represented as areas R3-1 & R3-2; refer to excerpt provided in **Appendix C**. These areas were to be serviced by a proposed 1800mm dia. storm sewer on River Road, connecting to a 3000mm dia. storm sewer that outlets to the south Pond 5 forebay.

Riverside South Community ISSU (Stantec, 2017)

The *'Riverside South Community Infrastructure Servicing Study Update – Rideau River Area (ISSU)' (Stantec, June 2017)* provided the conceptual storm sewer sizing and modelling for the trunk storm sewers. This included the storm sewer from Pond 5 to node N49 (i.e. MH28) on River Road (site outlet).

Riverside South Pond 5 Facility (Stantec, 2018)

The *'Riverside South Pond 5 Design Brief' (Stantec, May 7, 2018) outlined the detailed design for Riverside South Pond 5.* This pond is primarily a water quality pond. As such, the inlet structure upstream the north and south pond forebays direct higher flows to the Rideau River.

As part of the Pond 5 design a hydrologic / hydraulic stormwater management model (PCSWMM) was developed. The PCSWMM model accounts for the proposed ultimate built-out conditions of the contributing areas to the pond. The PCSWMM model also includes the physical features of the Pond 5 inlet and outlet structures. The components of the inlet and outlet structures are represented in the PCSWMM model as orifices, weirs, and closed circular conduits (pipes). The reported Pond 5 water levels based on this configuration were as follows:

Return Period	*Water Level Elev.*
100-year	83.97m
100-year (+20%)	84.00m

River Road Reconstruction (IBI, 2018)

The 'Design Brief – River Road Reconstruction Summerhill Street to South of Solarium Avenue, Riverside South Community, Rideau River Area' (IBI Group, August 2018) furthered the design for the storm sewer on River Road. The design for the 1800mm dia. storm sewer on River Road included the Wright and Alphon Lands as Area EXT-6; refer to attached excerpts. Per the storm sewer design sheet Area EXT-6 had the following properties:

Drainage Area:	17.38 ha
Runoff Coefficient:	0.63
Peak Flow (2-year):	1,768.36 L/s

River's Edge Phase 1 (IBI, 2019)

The 'Deign Brief – River's Edge - Phase 1 Riverside South Community' (IBI Group, May 2019) provided an updated Riverside South Pond 5 PCSWMM model. The River's Edge PCSWMM model incorporated the storm sewer servicing and stormwater management criteria presented in Technical Bulletin 2016-01 to the OSDG. Technical Bulletin 2016-01 reduced the sizing requirements for storm sewers and allowing more stormwater to pond on the surface. This in turn lowered the inlet flow rates into the receiving storm sewer from the River's Edge development and ultimately reduced hydraulic grade line (HGL) elevations. No modifications were made in the PCSWMM model to the features representing Pond 5; however, the reduction in peak flows resulted in lower Pond 5 water levels, as follows:

Return Period	*Water Level Elev.*
100-year	83.83m
100-year (+20%)	84.92m

Proposed Wright Subdivision – Downstream HGL Review (Novatech, 2020)

The PCSWMM model updated by IBI for River's Edge was provided to Novatech for review with respect to HGL elevations for the Proposed Wright Subdivision. Specifically, the impact to the estimated HGL elevation at Node N49 (i.e. MH 28) located within River Road, 100 m north of the Wright property. The limit of Novatech's review was primarily within the vicinity of the Pond 5 and its southern inlet. It was noted that the model configuration for the bypass structure in MH166, located immediately upstream the south Pond 5 forebay, caused stability issues that could artificially raise upstream HGL elevations. The proposed conceptual design for the Wright Lands is based on the downstream HGL elevation estimated as part of Novatech's review (i.e. 85.40m at MH 28).

4.3 Proposed Storm Infrastructure

On-Site Works

The proposed on-site works for the Subject Site will require approximately 450 m of on-site storm sewers with conceptual sizes ranging from 300mm to 1350mm (to be confirmed at detailed design). Runoff from the proposed development will outlet into the existing and proposed (off-site) storm sewers on River Road; ultimately outletting to Pond 5. Refer to **Figure 4.1** – Post-Development Storm Drainage Area Plan.

Off-Site Works

The proposed off-site works will require extending an 1800mm dia. off-site storm sewer within the River Road road allowance, approximately 150 m south towards the entrance for the Wright Lands. The extension will require reinstatement of the existing road to match existing conditions or better. This extension will service both the Wright and Alphon Lands.

The 1800mm dia. storm sewer on River Road was initially sized by Stantec (2016) during the MDP Update. This storm sewer size has been carried forward with the conceptual storm servicing design for the Subject Site and will need to be confirmed during detail design.

Off-Site Works (Relief Pipe)

A relief pipe is proposed outlet into the watercourse that is situated in the existing ravine along the northern portion of the Subject Site. This watercourse has an existing 1200mm dia. CSP culvert crossing River Road. Proposed to be constructed adjacent the culvert is a 1800mm (width) x 900mm (height) relief pipe (MH 102). The intent of the relief pipe is to reduce the HGL elevations within the storm sewer system. For further information refer to Downstream HGL Analysis memorandum provided in **Appendix C**.

4.3.1 Minor System (Storm Sewers)

Storm servicing for the proposed subdivision will be provided using a dual-drainage system. Runoff from frequent events (2-year return period) will be conveyed by storm sewers (minor system), while flows from large storm events that exceed the capacity of the minor system will be conveyed overland along defined overland flow routes (major system) to adjacent roadways.

Storm Sewer Design Criteria

The following storm sewer design criteria is from the OSDG:

- Rational Method (Q) = 2.78CIA, where
    - Q = peak flow (L/s)
    - C = runoff coefficient
        - C = (0.70 * %Imp.) + 0.20
    - I = rainfall intensity for a 2-year return period (mm/hr)
        - $I_{2yr} = 732.951 / [(Tc(min) + 6.199)]^{0.810}$
    - A = site area (ha)
- Minimum Pipe Size = 250 mm
- Minimum / Maximum Full Flow Velocity = 0.8 m/s / 3.0 m/s

The proposed storm sewers have been conceptually sized to convey an uncontrolled peak flow corresponding to a 2-year return period. Refer to the storm sewer design sheets provided in **Appendix C**. Note that storm sewer sizes will need to be confirmed during detail design.

Hydraulic Grade Line (HGL) Criteria

The hydraulic grade line (HGL) elevation for a 100-year storm event needs to have a minimum 0.30m clearance from the proposed underside of footing (USF) elevation. This is to be confirmed during detailed design using a hydrologic / hydraulic model of the proposed storm sewer and stormwater management system.

Inlet Control Devices (ICDs)

Inlet control devices (ICDs) will be required to restrict inflows to the minor system. Rear yard catch basins are to be connected in series with an ICD installed at the outlet of the most downstream structure. Road catchbasins will include ICDs sized to not have surface ponding during a 2-year storm event, but store stormwater on the surface for larger events. Confirmation of ICD sizes will be required during detail design.

4.3.2 Major System (Overland Flow)

Major System (Overland Flow) Criteria

Runoff from storms that exceed the minor system capacity are to be conveyed overland within the right-of-way or defined drainage easements. The following overland flow criteria is from the OSDG:

- The roads are to be graded to ensure that the 100-year peak overland flows are confined within the right-of-way at a maximum depth of 0.35 m (static + dynamic flow).
- That the product of velocity x depth does not exceed 0.60 during the 100-year event.

During detailed design the major system will be evaluated using a hydrologic / hydraulic model to ensure that the maximum total flow depth (static + dynamic) will be restricted to 0.35 m during the 100-year storm event; and water levels will not touch the building envelop / lowest opening during the Stress Test event (100-year +20%).

Major System (Overland Flow) Route

Under proposed conditions portions of the Subject Site will sheet drain uncontrolled to the watercourse along the north / west portions of the site. Major system overland flow from the roadway will be directed to the existing ravine between Lots 10 and 11.

Refer to **Figure 3.2** – Macro Grading, Erosion and Sediment Control Plan for the proposed general grading of the Subject Site.

4.4 Proposed Stormwater Management Strategy

Stormwater Quality Control

Pond 5 provides additional water quality and quantity control for the Subject Site (and Alphon Lands). It was designed to provide an Enhanced level of water quality control, corresponding to 80% long-term TSS removal.

A comparison of the proposed drainage area characteristics and those allocated for the design of the Pond 5 DB is provided in **Table 4.1**. The site characteristics resemble those allocated for the design of Pond 5, as such no additional water quality treatment is required. This is to be reconfirmed at the detailed design stage.

Table 4.1: Comparison of Drainage Area Characteristic (Pond 5)

Design	Catchment ID	Parameters	Description
Stantec (2018)	**R3-1 & R3-1 (EXT-6)**	**17.38 ha C=0.63**	**Allocated Areas to River Road (MH28)**
Novatech (2020)	A-01 - A-11, B-01 - B-04, EXT-01, EXT-02	15.19 ha C=0.60	Controlled / External Areas to River Road (MH28)
	U-01 - U-04	1.75 ha C=0.21	Uncontrolled Rear Yards Directed to Adjacent Watercourse (Rideau River)
	TOTAL	**16.94 ha C=0.56**	**Total Drainage Area (Controlled + Uncontrolled)**

Stormwater Quantity Control

Stormwater management is required to control release rates to the proposed storm sewers. As such, ICDs will be needed to control HGL elevations within the storm sewer system. This will result in ponding within the road right-of-ways (i.e. sawtoothed grading) to store stormwater on the surface. No rear yard storage has been accounted for in the preliminary modelling.

Stormwater Quantity Control – Alphon Lands

Stormwater management has been assumed for the Alphon Lands. The preliminary PCSWMM model accounts for 100 m^3/ha of surface storage for subcatchments B01 & B02/04. This represents storage within the road sag's with maximum ponding depths of 0.35m, per Technical Bulletin 2016-01 of the OSDG.

Stormwater Quantity Control – External Drainage Areas

The external drainage areas represent uncontrolled runoff from the existing dwellings fronting River Road. Uncontrolled flows from these areas are to be included in the proposed design for the Alphon Lands. For conceptual purposes they have been included in the PCSWMM model as uncontrolled areas draining directly to MH 76.

Best Management Practices and Low Impact Development

The proposed development will explore the use of best management practices (BMPs) and low impact development (LID) techniques to reduce the impacts of development on the hydrologic cycle and mitigate the reduction in groundwater infiltration / recharge resulting from the proposed development. The use and implementation of BMPs and LIDs will be reviewed during the detailed design process and may include measures such as the use of bioretention / infiltration systems within the rights-of-way. However, given the close proximity of the Rideau River, infiltration based BMPs may not be suitable for this site.

4.5 Preliminary SWM Modeling

A conceptual stormwater management model (PCSWMM) for the Subject Site was prepared to estimate post-development peak flows and preliminary HGL elevations.

4.5.1 PCSWMM Model Parameters

Design Storms

The PCSWMM model includes the following synthetic design storms based on the City of Ottawa IDF data presented in the City of Ottawa Sewer Design Guidelines (October 2012):

- 3-hour Chicago Storm Distribution (10-minute time step)
- 12-hour SCS Storm Distribution (30-minute time step)

Each storm distribution includes the 2-year, 5-year, 100-year, and 100-year (+20%) return periods. The 100-year (+20%) storm event was used to ‘stress test’ the proposed storm drainage and stormwater management system.

The 3-hour Chicago storm distribution provides the most conservative results and is consistent with the analysis used for both Pond 5 DB and the proposed storm sewer on River Road DB.

PCSWMM Model Schematics, Output Data and Modeling Files

PCSWMM model schematics and output data for the 2-year and 100-year 3-hour Chicago storms are provided in **Appendix C**. The PCSWMM modeling files are provided on the enclosed CD.

Subcatchment Areas / Runoff Coefficients

- The conceptual PCSWMM model is based on the total drainage areas to each storm sewer run based on the preliminary grading plan (**Figure 3.2** – Macro Grading, Erosion and Sediment Control Plan). Refer to **Figure 4.1** – Post-Development Storm Drainage Area Plan.
- The weighted runoff coefficients and percent impervious values for each subcatchment are provided in **Appendix C**. As per the OSDG, the percent impervious values are based on the following equation:

  % Imp. = (C – 0.20) / 0.7

Depression Storage

- The default values for depression storage (1.57mm impervious / 4.67 mm pervious) have been applied to all catchments.
- The ‘zero impervious’ parameter (areas with no depression storage) for front yard subcatchments is set to 50%. For rear yard subcatchments this parameters is set to 100%.

Subarea Routing

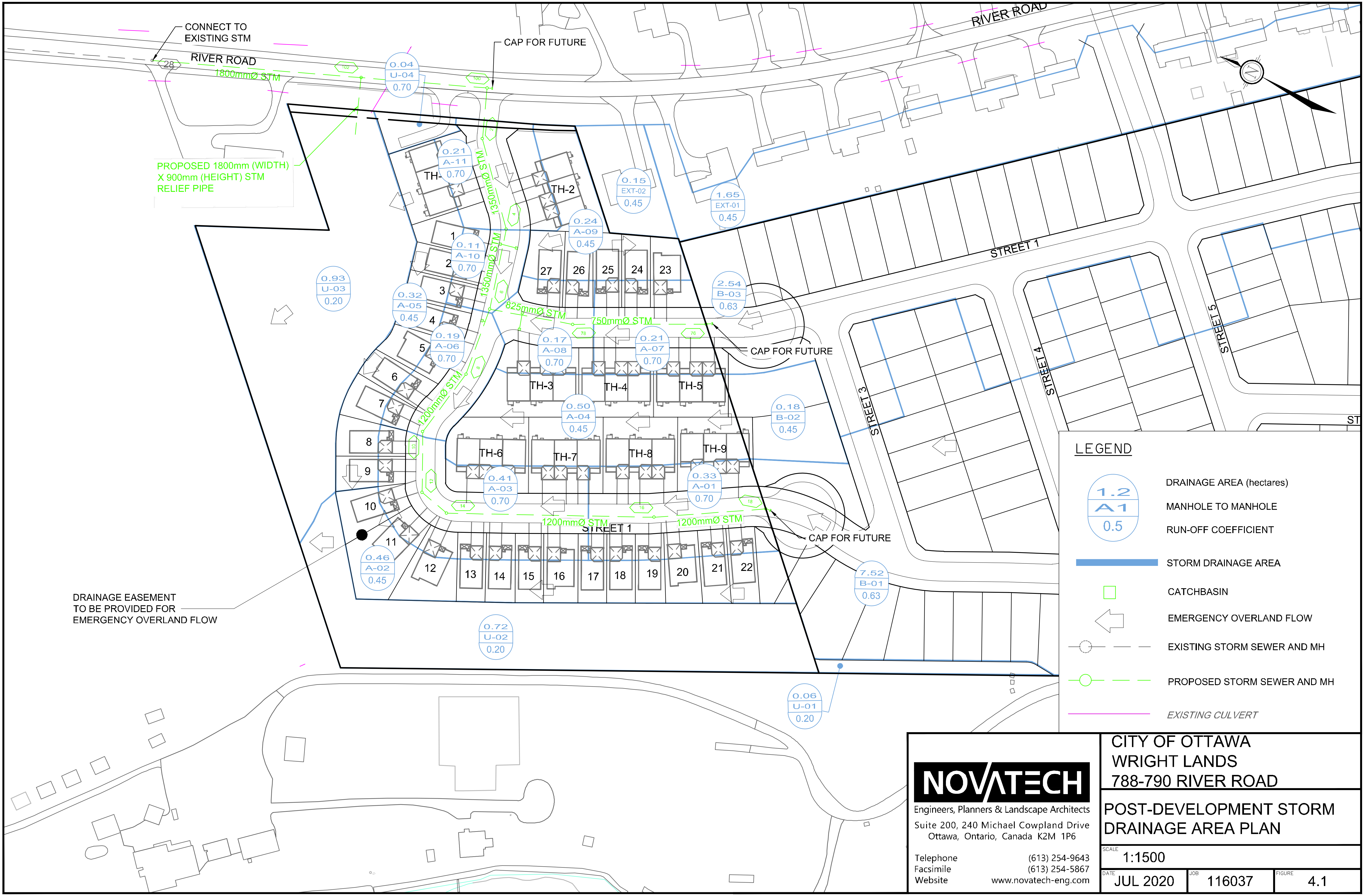
- Subarea routing for all subcatchments is ‘direct to outlet’.

Equivalent Width

- The equivalent width parameter for all subcatchments is based on the measured flow path. The equivalent width for double loaded subcatchments is based on the OSDG.

Inlets / Orifices / Outlet Rating Curves

Each inlet to the minor system has been sized to provide the equivalent flow rate as the 2-year subcatchment runoff (no surface ponding during the 2-year). The theoretical 2-year orifice size for the inlets within low-points has been calculated based on an assumed head of 1.40m. As such, during larger storm events peak flows will increase based on the additional head due to surface ponding. A summary of the theoretical orifice sizes is provided in **Appendix C**.



CITY OF OTTAWA
WRIGHT LANDS
788-790 RIVER ROAD

NOVATECH
Engineers, Planners & Landscape Architects
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada K2M 1P6

Telephone	(613) 254-9643
Facsimile	(613) 254-5867
Website	www.novatech-eng.com

POST-DEVELOPMENT STORM DRAINAGE AREA PLAN

SCALE 1:1500

DATE JUL 2020

JOB 116037

FIGURE 4.1

M:\2016\116037\CAD\Design\Figures\Design Brief\116037-FIGURES.dwg, FIG 4.1, Jul 24, 2020 - 1:43pm, bsweet

The model includes a set of catchbasins on a continuous grade. In this case an outlet rating curve is used to represent the inlet capture rate of the grate (per Appendix 7-A of the OSDG). The rating curve has been 'capped' based on the 2-year runoff from the subcatchment.

Minor System Conduits (Bend / Exit Losses)

- The minor system network was created in Civil3D and imported into PCSWMM.
- The following exit losses have been inputted into the model. They represent the loss coefficient based on the bend angle, as per the Appendix 6-B in the OSDG.

Bend Angle	Loss Coefficient
0	0.00
15	0.09
30	0.21
45	0.39
60	0.64
75	0.96
90	1.32

Major System Conduits

- Major system conduits (road network) have been defined using an irregular transect representing an 18m right-of-way with a 3% crossfall from the centerline of the road to the bottom of curb.
- Junctions at high points have an invert elevation that represents either the bottom of curb or the road centerline, depending on the path of the overland flow route.

Downstream Boundary Condition (Minor System)

- The storm sewer outlet is the proposed maintenance hole (MH 28) on River Road.
- The boundary condition for the storm outfall representing MH 28 was set at the 100-year HGL elevation of the outgoing sewer (85.40m). This is based on the changes recommended in the Downstream HGL Analysis memorandum provided in **Appendix C**. This analysis will have to be confirmed with the City of Ottawa. It represents an ultimate buildout condition of the vacant lands within the Pond 5 watershed.

4.5.2 Hydraulic Grade Line (HGL)

The 100-year HGL elevations within the storm sewer system was evaluated using a fixed HGL of 85.40m at proposed MH28 on River Road, per the memo provided in **Appendix C**. This HGL elevation surcharges the storm sewer at MH 28 by 0.75m (obvert elevation = 84.65m). The on-site storm sewers have been sized primarily to reduce HGL elevations and associated hydraulic losses. A summary of the 100-year & 100-year (+20%) HGL elevations is provided in **Appendix C**. Minimum USF elevations (to be confirmed during detail design) are to be set 0.30m higher than the 100-year HGL elevations.

4.5.3 Summary of Peak Flows (PCSWMM)

Table 4.2 provides a summary of the minor and major system flows from the Subject Site (and Alphon Lands) to the proposed River Road storm, and the direct flows to the Rideau River.

Table 4.2: Summary of Peak Flows (PCSWMM)

Outfall	**Description**	**100-year Peak Flow(1) (L/s)**	
		3-hour Chicago	**12-hour SCS**
Minor System	To MH 28 (River Road / Pond 5)	1,817	1,631
Major System	Major System Overland Flow to Watercourse (Rideau River)	203	0
	Uncontrolled Overland Flow to Watercourse (Rideau River)	169	179
OVERALL TOTAL		**2,190**	**1,810**

(1) *PCSWMM model results; fixed outfall at 85.40m (100-year HGL elevation at MH 28 on River Road, per Memo).*

The PCSWMM model is based on the conceptual grading and storm servicing design. At detailed design, the proposed grading and servicing design will be refined to ensure that the minor and major system criteria are met. This will also include a comparison of post- to pre-development flows to ensure the required base flows to the ravine and downstream culverts are also being met.

5.0 SANITARY SEWER SYSTEM

5.1 Existing Sanitary Infrastructure

The sanitary outlet for the Subject Site is an existing 450mm trunk sanitary sewer located within River Road approximately 150 m north of the Subject Site.

As per the ISSU and the River Road DB, it is proposed that the 450mm trunk sanitary sewer within River Road be extended to the Subject Site. Excerpts from the ISSU and River Road DB have been included for reference in **Appendix D**. The excerpts include the:

- ISSU sanitary drainage plan and sanitary design sheet;
- Email correspondence (July 20, 2017) outlining the ISSU deviation/ drainage limit shift;
- Deviation Report Memo (July 25, 2017) detailing the ISSU deviation/ drainage limit shift;
- River Road DB sanitary drainage plan and sanitary design sheet.

Refer to **Figure 3.1** – Proposed Servicing Layout Plan for an illustration of the proposed sanitary connection and layout details.

5.2 Proposed Sanitary Infrastructure

Off-site works

The proposed off-site works will require extending an off-site trunk sanitary sewer within the River Road ROW 115 m to the Subject Site. The extension will require reinstatement of the existing road to match existing conditions or better.

As per the ISSU and River Road DB the trunk sanitary sewer will be capped to allow for future extension along River Road to service the existing residences to the east of the Subject Site fronting River Road.

On-site works

The proposed on-site works will require approximately 500 m of on-site sanitary sewer to collect and direct wastewater flows to a lift station located in the north-east corner of the Subject Site. The lift station will outlet to the trunk sanitary sewer – included in the off-site works outlined above.

External Flows from Alphon Lands

The external flows from Alphon Lands have been accounted for in the proposed off-site and on-site sanitary sewers per the ISSU and River Road DB. The flows are to outlet upstream of MH 23 and 57. This area has been attributed a population of 491 people, over a drainage area of 10.3 ha, for a flow of 8.49 L/s.

External Flows from River Road

The external flows from River Road, to the south of the Subject Site, have been accounted for in the proposed off-site sanitary sewers per the ISSU and River Road DB. The flows are to outlet upstream of MH 101. This area has been attributed a population of 1,179 people, over a drainage area of 9.23 ha, for a flow of 14.52 L/s.

5.3 Sanitary Demand and Design Parameters

The peak design flow parameters in **Table 5.1** have been used in the sewer capacity analysis. Unit and population densities and all other design parameters are specified in the OSDG.

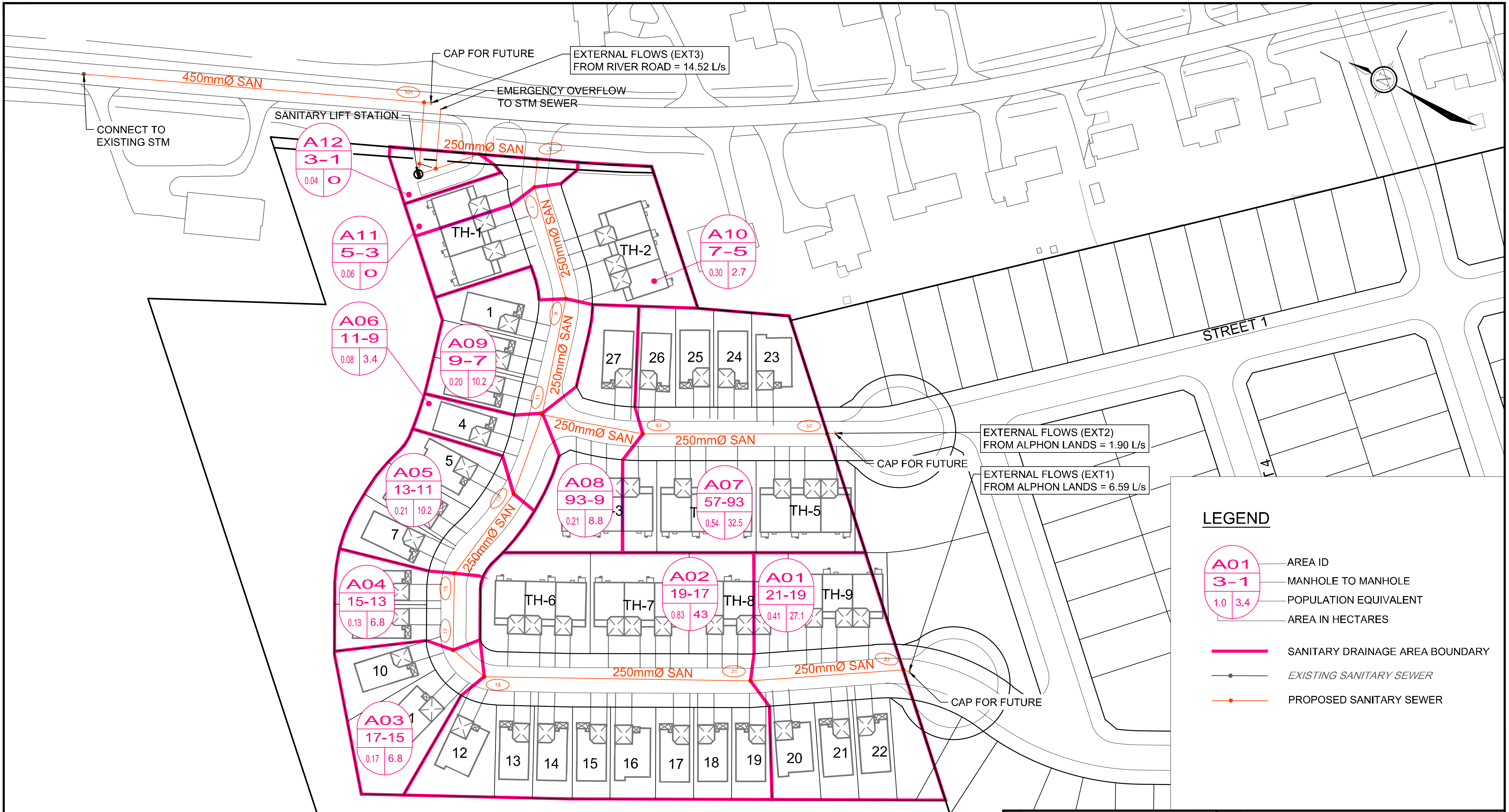
Table 5.1: Sanitary Sewer Design Parameters

Design Component	Design Parameter
Unit Population: Single Detached Home Semi-Detached /Townhomes 2-BR Apartments	 3.4 people/unit 2.7 people/unit 2.1 people/unit
Residential Flow Rate, Average Daily	280 L/cap/day
Residential Peaking Factor	Harmon Equation (min=2.0, max=4.0) Harmon Correction Factor = 0.8
Extraneous Flow Rate	0.33 L/s/ha
Minimum Pipe Size	200mm (Res)
Minimum Velocity[1]	0.6 m/s
Maximum Velocity	3.0 m/s
Minimum Pipe Cover	2.5 m (Unless frost protection provided)

[1] A minimum gradient of 0.65% is required for any initial sewer run with less than 10 residential connections.

The sanitary sewer design sheet, located in **Appendix D**, confirms the peaked sanitary flows from the Subject Site will be 2.76 L/s. Refer to **Figure 5.1** – Sanitary Drainage Area Plan for reference.

The external flows from Alphon Lands and River Road will be confirmed and reviewed during detailed design in order to optimize the sizing of the proposed on-site and off-site sanitary infrastructure.



NOVATECH
Engineers, Planners & Landscape Architects
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada K2M 1P6

Telephone	(613) 254-9643
Facsimile	(613) 254-5867
Website	www.novatech-eng.com

CITY OF OTTAWA
WRIGHT LANDS
788-790 RIVER ROAD

POST-DEVELOPMENT SANITARY
DRAINAGE AREA PLAN

SCALE

DATE JUL 2020
JOB 116037
FIGURE 5.1

M:\2016\116037\CAD\Design\Figures\Design Brief\116037-FIGURES.dwg, FIG 5.1, Jul 24, 2020 - 3:09pm, bsweet

SHT11X17.DWG - 279mmX432mm

6.0 SANITARY LIFT STATION

The sanitary lift station will be designed for the sanitary demands as discussed in Section 5.0 above and will be equipped with standby power designed in accordance with the OSDG.

Refer to **Figure 6.1** – Preliminary Sanitary Lift Station Layout, which provides a preliminary layout for the lift station block.

6.1 Wet Well

The wet well will be a prefabricated FRP station with factory installed isolation valve, pump rails, ultrasonic level controls, multitrode backup level control, vents, access hatches, and piping. The wet well will be designed to provide a minimum 5-minute cycle time for the pumps under ultimate flow conditions.

The wet well base will be at approximately 10.0 m below finish grade to provide working volume below the inlet sewer (to be confirmed as part of detailed design). Flows from the subdivision will enter the wet well through a 250mm sanitary sewer. The wet well will include an inlet basket screen to capture any large debris which could adversely affect pumps. The wet well should be operated in a manner that minimizes retention time and solids accumulation while minimizing pump starts to 5-minute intervals.

The wet well will be installed on a concrete base to provide uplift resistance.

6.2 Odour Attenuation

The lift station will be serving a small catchment area and is not expected to have significant odour production. Hydrogen sulphide is the primary source/ indicator of odour and is present in wastewater which has had time to significantly consume dissolved oxygen. The wet well operating levels will be detailed to minimize retention. The wet well ventilation pipes will be equipped with carbon filters as another layer of protection against local odors.

6.3 Sewage Pumps

The wet well will include two sewage pumps. One pump will be a duty pump and the second pump will be standby. The duty pump will cycle after each pump cycle. Each pump will be sized for peak flow. Pump calculations and pump selection will be provided during detailed design.

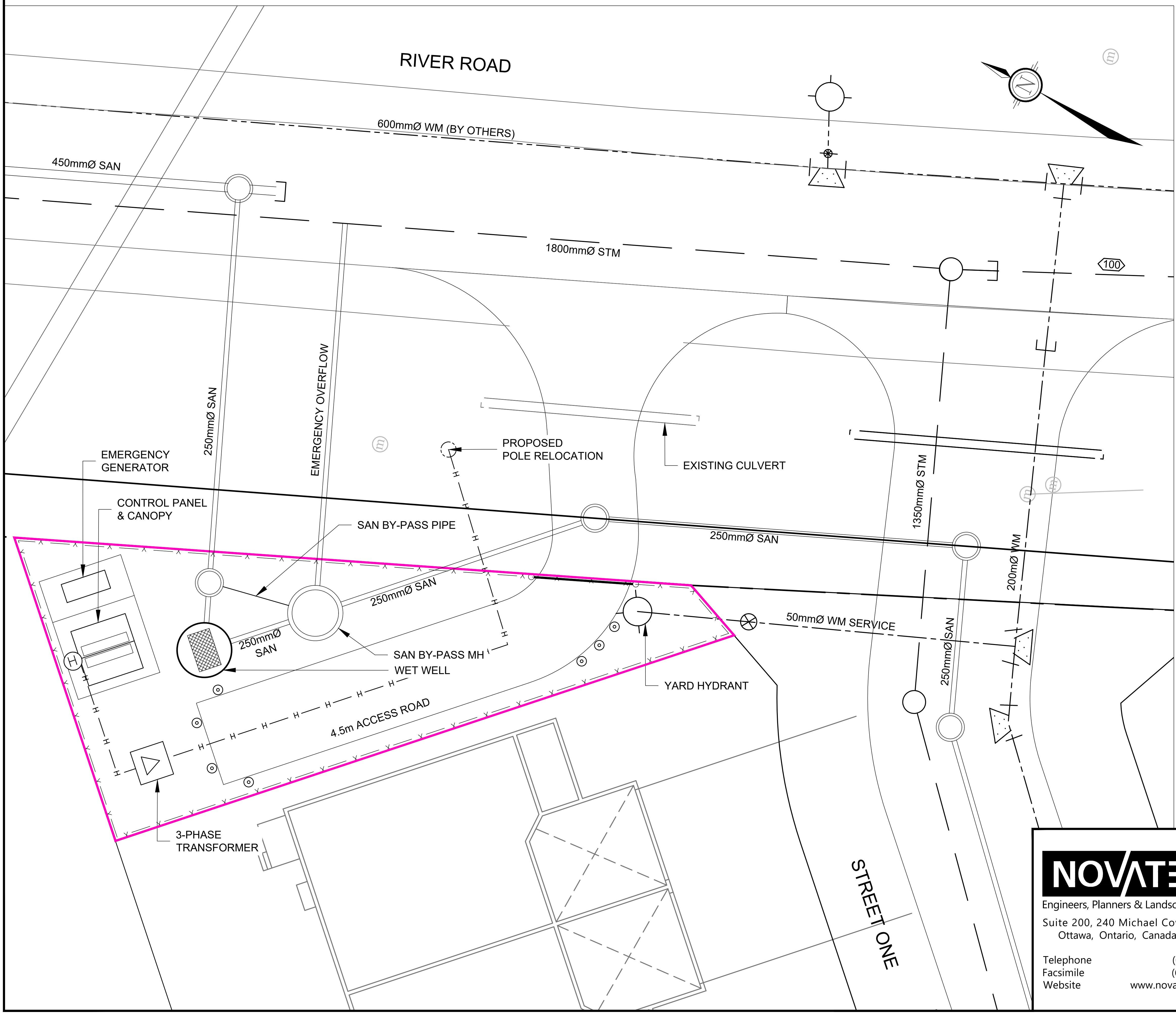
Pumps will discharge to an overflow pipe within the wet well, which will gravity feed to the sanitary trunk sewer.

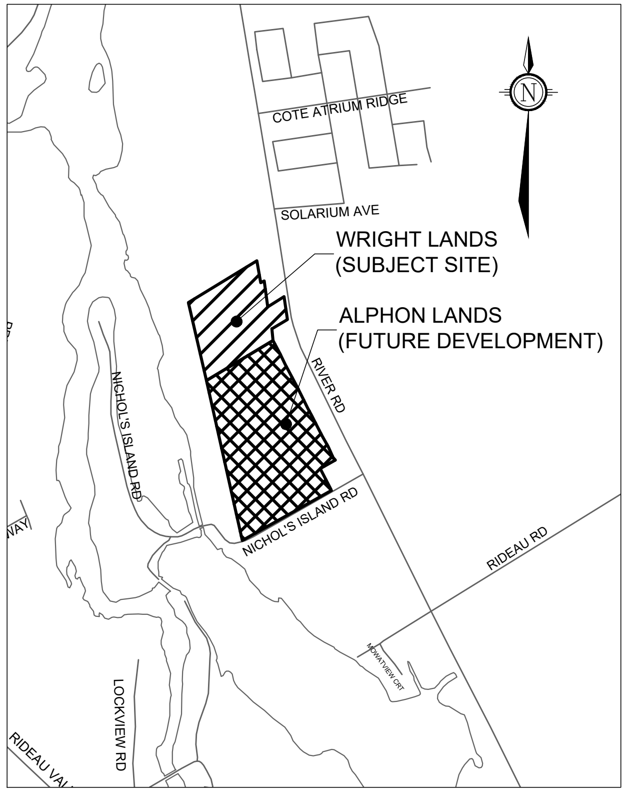
6.4 Sewage Flow Totalizer

The wet well include an ultrasonic level transmitter to provide continuous reading of wet well levels. The PLC will be programmed to record both incoming and pumped flow rates for each 1-hour interval based on rate of rise in wet well and number of pump cycles with associated on/ off levels.

6.5 Emergency Generator

An emergency generator will provide standby power in the event of a primary power failure for the lift station. The generator will be sized to power the complete station and will include a subbase double walled diesel tank with capacity for 24-hours of operation.





LEGEND

🟥	SANITARY LIFT STATION PROPERTY LIMITS
200mmØ WM	PROPOSED WATERMAIN
—⊗—	PROPOSED VALVE LOCATION
HYD	PROPOSED HYDRANT
T/F=98.45	PROPOSED TOP OF BOTTOM FLANGE
BEND	PROPOSED BEND AND THRUSTBLOCK 11.25°, 22.5°, 45° or TEE (SEE PLAN AND PROFILES)
● 5	PROPOSED SANITARY MH & SEWER
○ 6	PROPOSED STORM MH & SEWER
— H — H —	PROPOSED HYDRO SERVICE
— x — x —	PROPOSED CHAIN-LINK FENCE
⊙	PROPOSED BOLLARDS

NOVATECH
Engineers, Planners & Landscape Architects
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada K2M 1P6

Telephone (613) 254-9643
Facsimile (613) 254-5867
Website www.novatech-eng.com

CITY OF OTTAWA
WRIGHT LANDS
788-790 RIVER ROAD

PRELMINARY SANITARY LIFT
STATION LAYOUT

SCALE 1:200

DATE FEB 2020
JOB 116037
FIGURE 6.1

C:\temp\AcPublish_14556\116037-GP.dwg, FIG 6.1, Jun 30, 2020 - 12:09pm, bsweet

SHT11X17.DWG - 279mmX432mm

6.6 Bypass Manhole

The bypass manhole just upstream of the wet well will include an emergency overflow that will outlet to the storm sewer in the event of a catastrophic failure of the station. The emergency overflow sewer will be designed for peak flow and will be set above the 25-year boundary condition of the receiving system. The emergency overflow pipe will include a backflow preventer to provide protection against reverse flows.

An ultrasonic level transmitter will be provided in the bypass manhole to monitor sewage levels and provide the PLC with level readings to allow emergency overflow volumes to be calculated based on sewage level relative to an overflow weir located at the emergency overflow pipe entrance as emergency overflow volumes will need to be reported to the MECP. A full reporting protocol and operational manual will be prepared for use by the lift station operators. A copy of this protocol will also be given to the other stakeholders, so people are informed and know what to do in the event of an overflow.

6.7 Electrical/Control Panels

The lift station will include control panels and a 3mx3m canopy. The canopy will house the electrical and control panels. Separate panels will be provided for electrical distribution and control wiring.

6.8 Communications Feed

The lift station will be provided with a Rogers high speed internet feed for SCADA communications.

6.9 Process Control Narrative

A Process Control Narrative will be provided during detailed design. It will provide an overall summary of the lift station, its components, how its operation will be phased with the Alphon Lands and other design components of the facility.

7.0 WATER SUPPLY SYSTEM

7.1 Existing Water Infrastructure and City Planned Construction

The existing water supply system is currently capped within River Road approximately 255 m north of the Subject Site. As such, an extension of the off-site watermain along River Road will be required from Solarium Avenue to the Subject Site. It is anticipated that the City of Ottawa will complete this work in 2021, in advance of the Subject Site servicing. Once extended, the watermain connection point for the Subject Site will be at the proposed River Road and Street One intersection (Connection 1).

For redundancy, an additional watermain connection point is planned when the Alphon Lands proceed with development. This watermain connection point will be made at the proposed River Road and Street Five intersection (Connection 2). Although the watermain required for servicing the Wright Lands will be left unlooped in the interim, it is anticipated that the Alphon Lands will proceed with development within two years. This is in line with the OWDG which outlines dead ends should be avoided and looping should be completed when practical, however, a maximum number of seventy-five single dwelling units can be supplied on a temporary basis provided all watermain pressure and demand objectives are met and it will be looped by a future phase within two years.

The existing water supply system and City planned construction is per the ISSU and the River Road DB. Excerpts from the ISSU and River Road DB have been included for reference in **Appendix E**. The excerpts include the:

- ISSU potable water servicing plan and the maximum pressure during BSDY;

Refer to **Figure 3.1** – Proposed Servicing Layout Plan for an illustration of the proposed water supply system connections and layout details.

7.2 Proposed Water Infrastructure

Off-site works

As mentioned in Section 3.1 and Section 7.1, an extension of the off-site watermain along River Road will be required to service the Subject Site but it is anticipated that the City of Ottawa will complete this work in 2020, in advance of the Subject Site servicing.

Novatech has been in coordination with City Staff and the City's Engineer (J.L. Richards & Associates Ltd.) to coordinate the watermain connection points for both Connection 1 and Connection 2.

On-site works

The proposed on-site works will require approximately 430 m of on-site watermain 200mm in diameter. Proposed hydrant locations have been provided and will be confirmed during detailed design.

7.3 Watermain Design Parameters

Boundary conditions were provided by the City based on the OWDG water demand criteria for both existing and future conditions. For the purpose of this report, both the existing and future conditions were analysed, and results provided; even through it is anticipated that the

Barrhaven/3C zone re-configuration will occur in advance of the Subject Site servicing, as noted previously. It should also be noted that the analysis excludes the demands of the Alphon Lands – this will be included during detailed design analysis. The boundary conditions are included in **Appendix E**.

The domestic demand design parameters, fire fighting demand design scenarios and system pressure criteria design parameters are outlined in **Table 7.1** below. The system pressure design criteria used to determine the size of the watermains, required within the Subject Site, and are based on a conservative approach that considers three possible scenarios.

Table 7.1: Watermain Design Parameters and Criteria

Domestic Demand Design Parameters	**Design Parameters**
Population:	
Single Detached Home	3.4 people/unit
Semi-Detached /Townhomes	2.7 people/unit
2-BR Apartments	2.1 people/unit
Basic Day Residential Demand (BSDY)	350 L/c/d
Maximum Day Demand (MXDY)	2.5 x Basic Day
Peak Hour Demand (PKHR)	2.2 x Maximum Day
Fire Demand Design	**Design Flows**
Conventional single/town units, unless otherwise noted.	10,000L/min per FUS / OWDG TB-2014
Hydrant spacing and coding	90 to 120 m spacing per OWDG
System Pressure Criteria Design Parameters	**Criteria**
Maximum Pressure (BSDY) Condition	< 80 psi occupied areas < 100 psi unoccupied areas
Minimum Pressure (PKHR) Condition	> 40 psi
Minimum Pressure (MXDY+FF) Condition	> 20 psi

The firefighting water demands for the Subject Site have been estimated per OWDG which refers to the Fire Underwriters Survey (CGI, 1999) document, abbreviated as FUS.

In accordance with the FUS and based on the proposed zoning, there is potential for less than 3m of separation between the single family, semi-detached, and row townhome wood-framed buildings, which would require the fire area in the FUS estimate for multiple buildings to be treated as a contiguous block area. This results in a high fire flow demand which is difficult to attain from the existing system; moreover, it would trigger larger diameter watermain size within the Subject Site, creating system vulnerabilities such as water age issues. As per the ISTB-2014-02, fire flows may be capped at 167 L/s (10,000 L/min) for single family, semi-detached, and row townhome, provided certain site criteria are met. The criteria are:

- For singles: a min separation of 10m between the backs of adjacent units.
- Traditional side-by-side semi-detached or row townhomes:
    a. firewalls with a min two-hour rating to separate the block into fire areas of no more than the lesser of 7 dwelling units, or 600 m^2 of building area; and
    b. Min separation of 10 m between the backs of adjacent units.

The proposed layout of the Subject Site will meet the minimum separation of 10 meters between the backs of adjacent units. As such, the proposed layout shall meet the foregoing criteria allowing the capped fire flow of 167 L/s to be used for these unit types of residential units. Detailed FUS calculations can be found attached in **Appendix E**.

7.4 System Pressure Modeling and Results

System pressures for the Subject Site were estimated using the EPANET engine within PCSWMM.

The PCSWMM model layout is demonstrated in **Figure 7.1** – Proposed Watermain Sizing, Layout and Junction IDs and **Figure 7.2** – Ground Elevations (m).

Domestic Demand

The water demand summary for the complete build out of the Subject Site for the basic daily and peak hour demands has been provided in Error! Reference source not found. **7.2** below. For detailed results refer to the tables provided in **Appendix E.** The detailed results are also demonstrated in **Figure 7.3** – Maximum Pressures During BSDY Condition and **Figure 7.4** – Minimum Pressures During PKHR Condition.

Table 7.2: System Pressure (EPANET)

Condition	Demand (L/s)	Allowable Pressure (psi)	Max/Min Pressure (psi)
Existing Conditions			
BSDY	0.67	80 (Max)	62
PKHR	3.67	40 (Min)	51
Future Conditions			
BSDY	0.67	80 (Max)	86
PKHR	3.67	40 (Min)	79

The hydraulic analysis demonstrates that the proposed watermain sizing meets the design criteria for both conditions. It is noted that the pressure in the watermain during the Maximum Pressure (BSDY) in the future condition exceeds the maximum allowable service pressure. As such, pressure reducing valves (PRV's) will be required for houses with front yard terrace elevations below an elevation of 91.50m. PRV locations will be confirmed during detailed design.

Fire Demand

An analysis was carried out to determine the available fire flow under maximum day demand while maintaining a residual pressure of 20psi. This was completed using the EPANET fire flow analysis feature within PCSWMM.

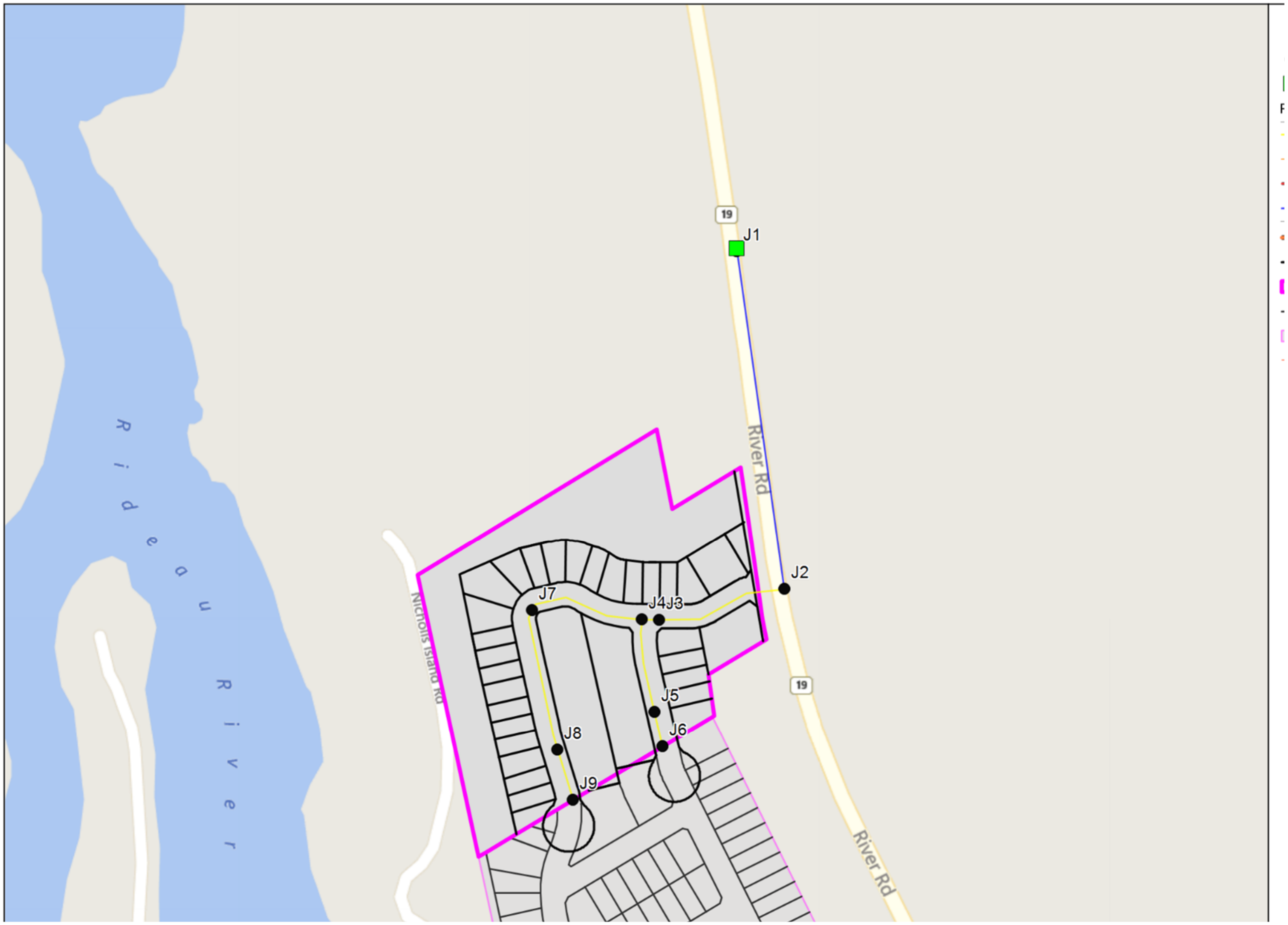
For detailed results refer to the tables provided in **Appendix E.** The detailed results are also demonstrated in **Figure 7.5** – Available Flow at 20psi During MXDY+FF Condition.

To achieve the required fire flow and optimize watermain sizes, the OWDG and its subsequent revisions (specifically ISTB-2018-02) allow for multiple hydrants to be drawn from, as opposed to drawing from a single hydrant to meet the required demand. Upon review of the results from the

Wright Lands
Job No. 116037
PCSWMM Model Schematic – FUTURE CONDITIONS

NOVATECH
Engineers, Planners & Landscape Architects

Figure 7.1 – Proposed Watermain Sizing, Layout and Junction IDs

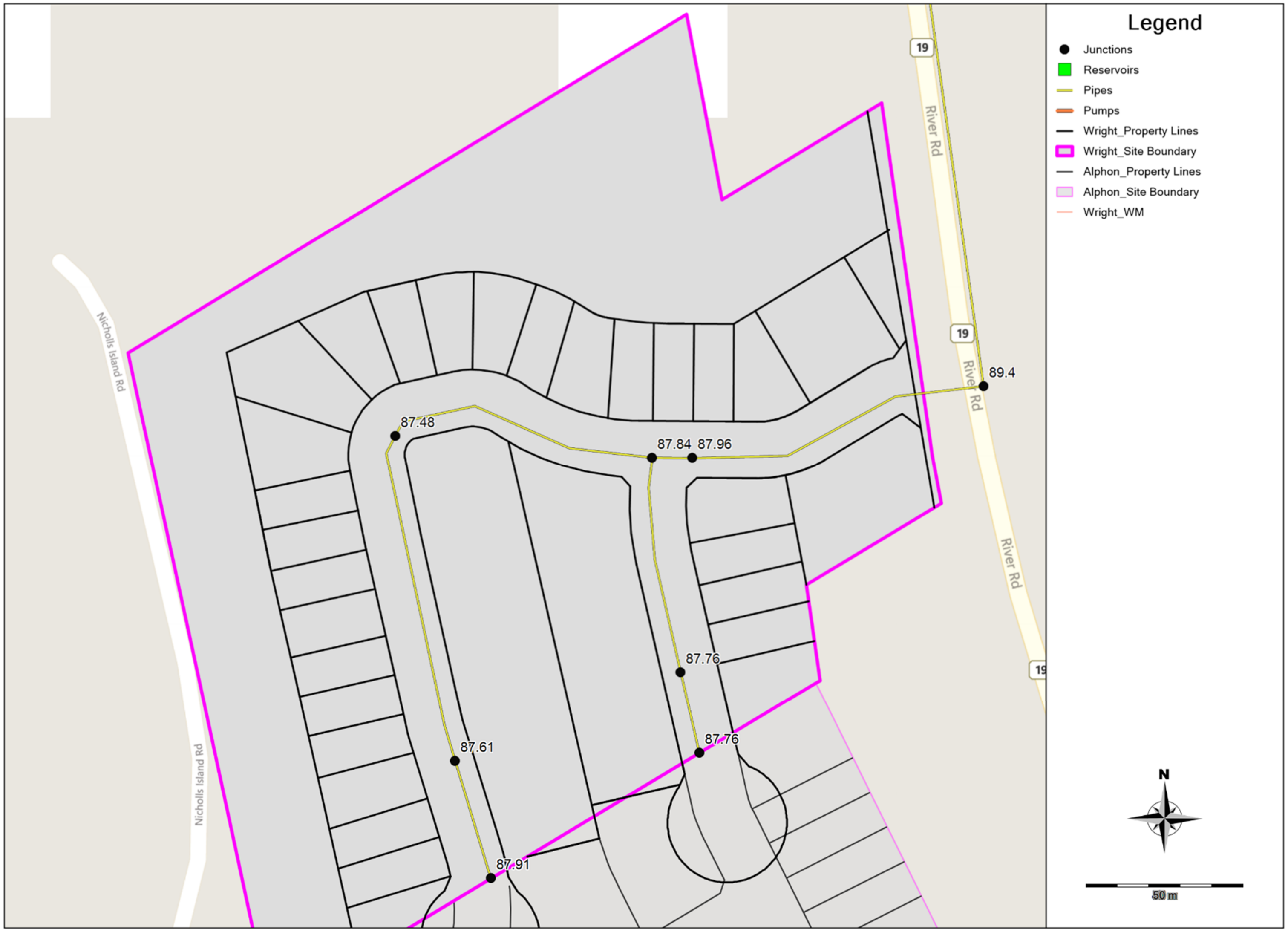


Date: 2020/07/23
M:\2016\116037\DATA\Calculations\Sewer Calcs\Water\Model Schematic_Future.docx

NOVATECH
Engineers, Planners & Landscape Architects

Wright Lands
Job No. 116037
PCSWMM Model Schematic – FUTURE CONDITIONS

Figure 7.2 – Ground Elevations (m)

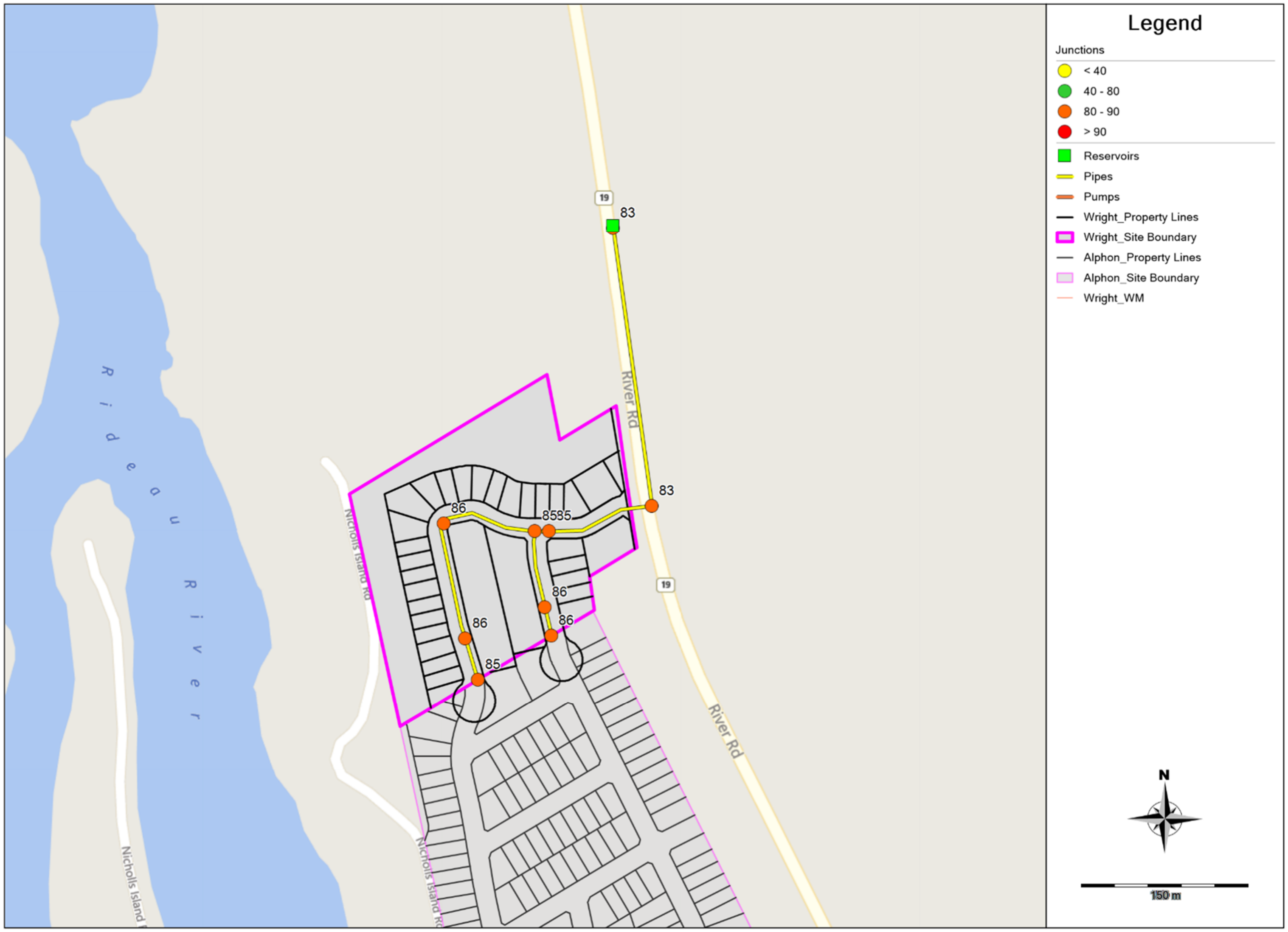


Date: 2020/07/23
M:\2016\116037\DATA\Calculations\Sewer Calcs\Water\Model Schematic_Future.docx

NOVATECH
Engineers, Planners & Landscape Architects

Wright Lands
Job No. 116037
PCSWMM Model Schematic – FUTURE CONDITIONS

Figure 7.3 – Maximum Pressures During BSDY Conditions

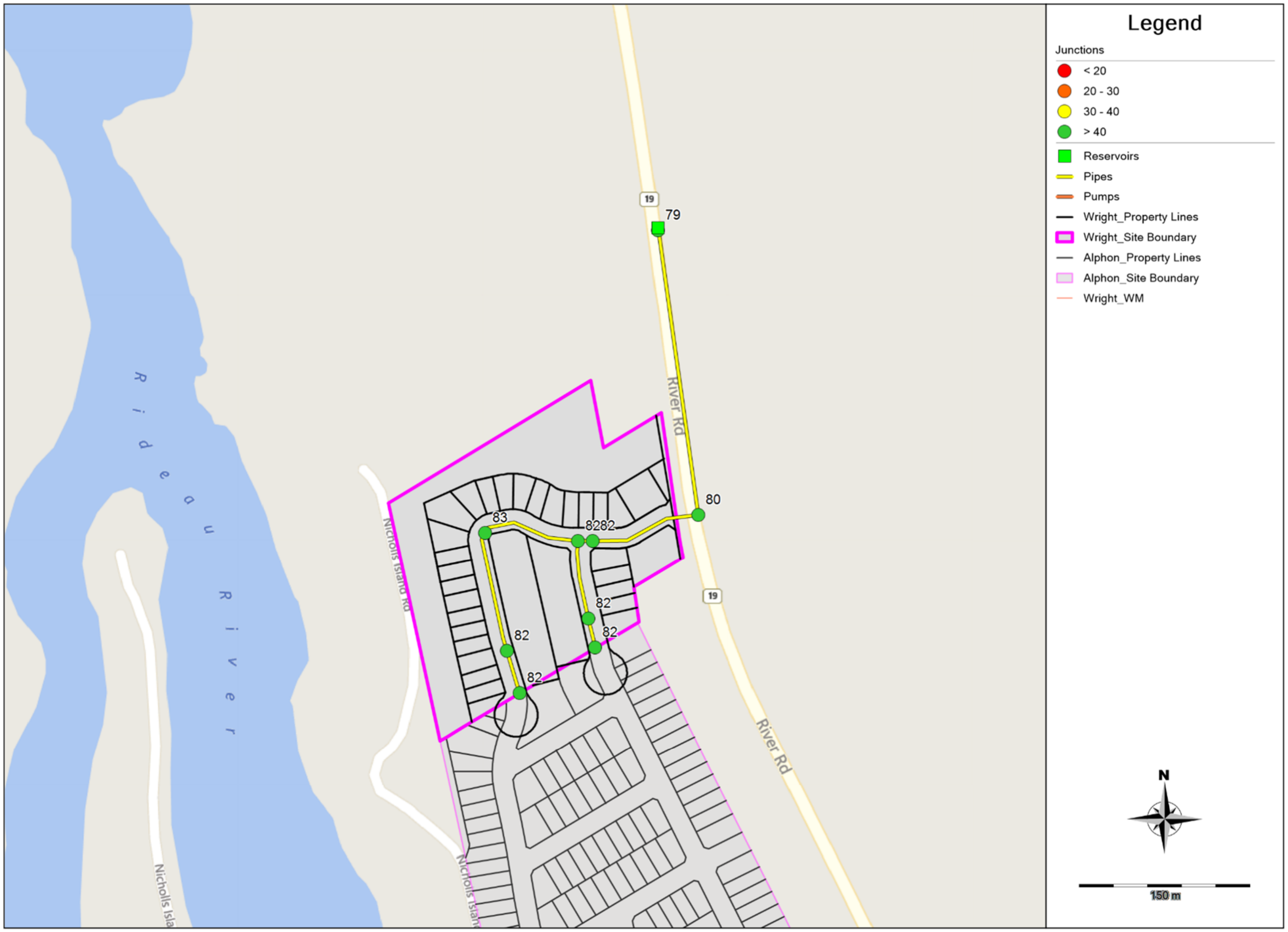


Date: 2020/07/23
M:\2016\116037\DATA\Calculations\Sewer Calcs\Water\Model Schematic_Future.docx

NOVATECH
Engineers, Planners & Landscape Architects

Wright Lands
Job No. 116037
PCSWMM Model Schematic – FUTURE CONDITIONS

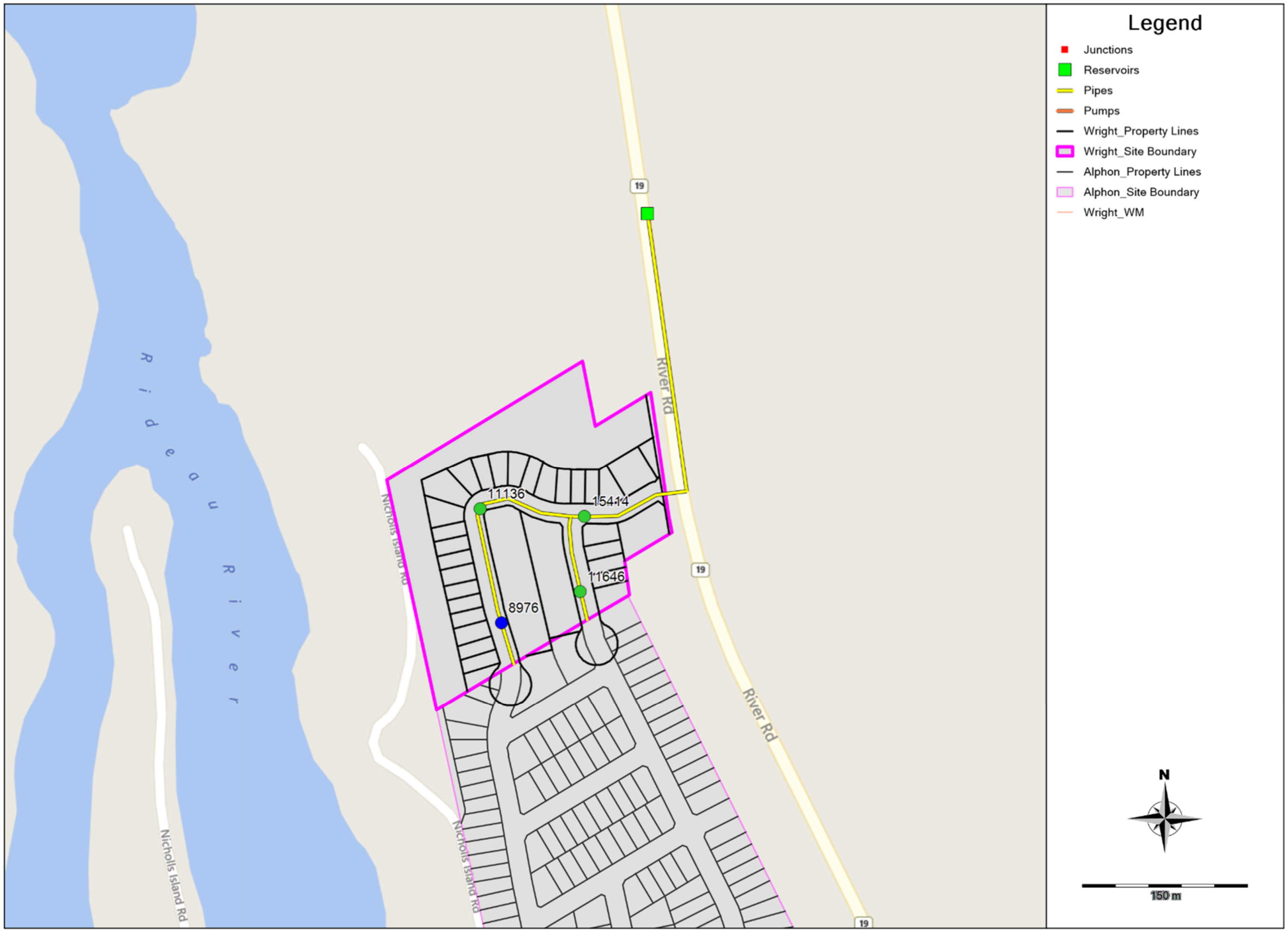
Figure 7.4 – Minimum Pressures During PKHR Conditions



Date: 2020/07/23
M:\2016\116037\DATA\Calculations\Sewer Calcs\Water\Model Schematic_Future.docx

Wright Lands
Job No. 116037
PCSWMM Model Schematic – FUTURE CONDITIONS

Figure 7.5 – Available Flow at 20psi During MXDY+FF Conditions



Date: 2020/07/23
M:\2016\116037\DATA\Calculations\Sewer Calcs\Water\Model Schematic_Future.docx

hydraulic analysis, the required fire flows can be achieved for the proposed structures by utilizing multiple hydrants. An excerpt from ISTB-2018-02 of Appendix I: Guideline on Coordination of Hydrant Placement with Required Fire Flow has been included in **Appendix E**, for reference on the maximum flow that can be considered from a given hydrant. Hydrant locations will be reviewed and confirmed during detailed design.

Figures under existing conditions have also been provided in **Appendix E**.

8.0 UTILITIES

The development will be serviced by Hydro Ottawa, Bell Canada, Rogers Communications, and Enbridge Gas Distribution Inc. Furthermore, streetlighting will be provided within the proposed road allowances, and will be designed in accordance with the City’s lighting policy (2016). The works will be coordinated with local utility companies during detailed design. The cross section of the utility trench and the connection to the existing services will also be confirmed during detailed design.

9.0 EROSION AND SEDIMENT CONTROL AND DEWATERING MEASURES

Temporary erosion and sediment control measures will be implemented during construction in accordance with the “Guidelines on Erosion and Sediment Control for Urban Construction Sites” (Government of Ontario, May 1987). Details will be provided on an Erosion and Sediment Control Plan, prepared during detailed design. Erosion and sediment control measures may include:

- Placement of filter fabric under all catch basin and maintenance hatches;
- Tree protection fence around the trees to be maintained
- Silt fence around the area under construction placed as per OPSS 577 / OPSD 219.110
- Light duty straw bale check dam per OPSD 219.180

The erosion and sediment control measures will need to be installed to the satisfaction of the engineer, the City, the Ontario Ministry of Environment, Conservation and Parks (MECP), and the Rideau Valley Conservation Authority (RVCA), prior to construction and will remain in place during construction until vegetation is established. The erosion and sediment control measure will also be subject to regular inspection to ensure that measures are operational.

Refer to **Figure 3.2** – Macro Grading, Erosion and Sediment Control Plan.

10.0 NEXT STEPS, COORDINATION, AND APPROVALS

The proposed municipal infrastructure may be subject, but not limited to the following next steps, coordination, and approvals:

- ISSU update/amendment for the sanitary lift station and storm servicing deviations per June 2018 City request.
- MECP PTTW. Submitted to: MECP. Proponent: Developer.
- RVCA Approval. Submitted to: RVCA. Proponent: Developer.
- MECP Environmental Certificate of Approval (ECA) for the storm / sanitary sewers through the “Transfer of Review” program. Submitted to: City of Ottawa/ MECP and approved by MECP. Proponent: Developer.
- MECP Pre-authorized watermain alteration and extension program granted as part of City of Ottawa’s Drinking Water Works Permit (F-1 Form). Submitted to: City of Ottawa. Proponent: Developer.
- Tree Cutting Permit. Submitted to City of Ottawa. Proponent: Developer, or its contractor/agent.
- City of Ottawa Commence Work Notice. Submitted to City of Ottawa. Proponent: Developer, or its contractor/agent.
- Road Closure Permit. Submitted to City of Ottawa. Proponent: Developer, or its contractor/agent.
- Road Cut Permit. Submitted to City of Ottawa. Proponent: Developer, or its contractor/agent.
- Separate from this report, the Developer may enter into a Cost Sharing Agreement to provide cost sharing principles and recovery mechanisms for development components that benefit external parties.

11.0 SUMMARY AND CONCLUSIONS

This report demonstrates that the proposed development can be adequately serviced with storm and sanitary sewers and watermain. The report is summarized below:

Stormwater Management:

- The proposed off-site works will require an extension of a 1800mm dia. storm sewer within the River Road road allowance approximately 150m towards the Subject Site.
- The Subject Site will be serviced with approximately 450m of on-site storm sewers ranging from 300mm to 1350mm in diameter. The on-site storm sewers will outlet to the proposed storm sewer on River Road.
- Inlet control devices will be required to control peak flows and HGL elevations.
- Road Right-of-Ways will be used for surface storage (i.e. sawthoothed grading).
- The major system outlet is the pathway block towards the watercourse along the northern and western portion of the Subject Site.
- The Alphon Lands and external area to the east have been accounted for in the storm sewer design.

Sanitary and Wastewater Collection System:

- The proposed off-site works will require an extension of the trunk sanitary sewer within the River Road ROW 115 m to the Subject Site.
- The proposed on-site works will require approximately 500 m of on-site sanitary sewer to collect and direct wastewater flows to a lift station located in the north-east corner of the Subject Site.
- The external flows from Alphon Lands have been accounted for in the proposed off-site and on-site sanitary sewers. The flows are to outlet upstream of MH 23 and 57.
- The external flows from River Road, to the south of the Subject Site, have been accounted for in the proposed off-site sanitary sewers. The flows are to outlet upstream of MH 101.

Water Supply System

- The existing water supply system is currently capped within River Road approximately 255 m north of the Subject Site. As such, an extension of the off-site watermain along River Road will be required from Solarium Avenue to the Subject Site. It is anticipated that the City of Ottawa will complete this work in 2020, in advance of the Subject Site servicing.
- The watermain connection point for the Subject Site will be at the proposed River Road and Street One intersection (Connection 1).
- The proposed on-site works will require approximately 430 m of on-site watermain 200mm in diameter. The location of hydrants will be confirmed during detailed design.

Erosion and Sediment Control and Dewatering Measures

- Temporary erosion and sediment control measures will be implemented both prior to commencement and during construction in accordance with the "Guidelines on Erosion and Sediment Control for Urban Construction Sites" (Government of Ontario, May 1987).

Next Steps, Coordination, and Approvals

- MECP PTTW.
- RVCA Approval.
- MECP Environmental Certificate of Approval (ECA) for the storm / sanitary sewers through the "Transfer of Review" program.
- MECP Pre-authorized watermain alteration and extension program granted as part of City of Ottawa's Drinking Water Works Permit (F-1 Form).
- Tree Cutting Permit.
- City of Ottawa Commence Work Notice.
- Road Closure Permit.
- Road Cut Permit.
- Separate from this report, the Developer may enter into a Cost Sharing Agreement to provide cost sharing principles and recovery mechanisms for development components that benefit external parties.

12.0 CLOSURE

This report is respectfully submitted for review and subsequent approval. Please contact the undersigned should you have questions or require additional information.

NOVATECH

Prepared by:

LICENSED PROFESSIONAL ENGINEER
B. C. SWEET
100206031
Aug 05/20
PROVINCE OF ONTARIO

Ben Sweet, P.Eng.
Project Coordinator I Land Development

LICENSED PROFESSIONAL ENGINEER
Conrad Stang
C. M. STANG
100125708
Aug. 5/20
PROVINCE OF ONTARIO

Conrad Stang, M.A.Sc., P.Eng.
Project Manager I Water Resources

Reviewed by:

LICENSED PROFESSIONAL ENGINEER
B. H. BAHIA
100164647
Aug 05, 2020
PROVINCE OF ONTARIO

Bassam Bahia, M.Eng., P.Eng.
Project Manager | Land Development

Appendix A
Correspondence

From: Sam Bahia
Sent: Thursday, July 23, 2020 11:40 PM
To: Ben Sweet
Subject: Fwd: Riverside South: Wright/Alphon Parcels

Thanks
Sam Bahia, P.Eng., Project Manager | Land Development
NOVATECH
Tel: 613.254.9643 x 285

Begin forwarded message:

From: "Sevigny, John" <John.Sevigny@ottawa.ca>
Date: June 13, 2018 at 1:20:35 PM EDT
To: Sam Bahia <s.bahia@novatech-eng.com>
Cc: John Riddell <J.Riddell@novatech-eng.com>, David Kardish <dkardish@regionalgroup.com>, Steve Cunliffe <scunliffe@regionalgroup.com>, "Bougadis, John" <John.Bougadis@ottawa.ca>, Erin O'Connor <eoconnor@regionalgroup.com>, "Herweyer, Don" <Don.Herweyer@ottawa.ca>
Subject: RE: Riverside South: Wright/Alphon Parcels

Good Afternoon Sam.

I'm just following up with an action item from our meeting last Wednesday June 6.

At the meeting Novatech was proposing a new public sanitary pump/lift station to serve the Wright / Alphon parcels in Riverside South. As noted in the meeting the pump station was not considered as part of the recently updated Infrastructure Servicing Study (ISSU) for Riverside South. Development Review has received a legal opinion that the ISSU should be updated/amended to include the provision for this new pump station. However, as a practical approach, the modifications to the study to reflect the new pump station can be implemented as a draft approval condition for the subdivision. In other words, the update would not be required prior to draft approval.

Please note that prior to submitting your application that a formal pre-consultation would be required.

If you have any further questions then please feel free to contact me at ext. 14388 or via email at john.sevigny@ottawa.ca.

Regards,

John Sevigny, C.E.T.
Project Manager, Infrastructure Approvals
Development Review, Suburban Services | *Examen des projets d'aménagement, Services suburbains*
Planning, Infrastructure and Economic Development Department | Services de la planification, de l'infrastructure et du développement économique

City of Ottawa | Ville d'Ottawa
110 Laurier Avenue West. Ottawa, ON | 110, avenue. Laurier Ouest. Ottawa (Ontario) K1P 1J1
613.580.2424 ext./poste **14388**, fax/téléc:613-580-2576, john.sevigny@ottawa.ca

---

From: Sam Bahia <s.bahia@novatech-eng.com>
Sent: Wednesday, June 06, 2018 12:20 PM
To: Sevigny, John <John.Sevigny@ottawa.ca>; Bougadis, John <John.Bougadis@ottawa.ca>; Erin O'Connor <eoconnor@regionalgroup.com>
Cc: John Riddell <J.Riddell@novatech-eng.com>; David Kardish <dkardish@regionalgroup.com>; Steve Cunliffe <scunliffe@regionalgroup.com>
Subject: RE: Riverside South: Wright/Alphon Parcels

Hi John
As requested, plz find attached servicing/earthworks plans that were provided to you at the meeting.
Regards
Sam Bahia, P.Eng., Project Manager | Land Development
NOVATECH Engineers, Planners & Landscape Architects
240 Michael Cowpland Drive, Suite 200, Ottawa, ON, K2M 1P6 | Tel: 613.254.9643 x 285 | Fax: 613.254.5867

-----Original Appointment-----
From: Sevigny, John [mailto:John.Sevigny@ottawa.ca]
Sent: Wednesday, May 30, 2018 10:55 AM
To: Sevigny, John; Bougadis, John; John Riddell; David Kardish; Steve Cunliffe; Sam Bahia
Subject: Riverside South: Wright/Alphon Parcels
When: Wednesday, June 6, 2018 10:00 AM-11:30 AM (UTC-05:00) Eastern Time (US & Canada).
Where: Laurier 110 - Room 4103E

To discuss the following:

From: Sam Bahia <s.bahia@novatech-eng.com>
Sent: Tuesday, May 29, 2018 3:13 PM
To: Sevigny, John <John.Sevigny@ottawa.ca>
Cc: John Riddell <J.Riddell@novatech-eng.com>; David Kardish <dkardish@regionalgroup.com>; Steve Cunliffe <scunliffe@regionalgroup.com>; Oram, Cody <Cody.Oram@ottawa.ca>
Subject: RE: Riverside South: Wright/Alphon Parcels

Hi John
The ISSU(Section 4.4) contemplated the 450mm San Obv at 87.32m. IBI provided us an Obv elevation of 86.00m (150m north of our site). We based our Gravity vs. PS analysis on the latter elevation.
Regards
Sam Bahia, P.Eng., Project Manager | Land Development
NOVATECH Engineers, Planners & Landscape Architects
240 Michael Cowpland Drive, Suite 200, Ottawa, ON, K2M 1P6 | Tel: 613.254.9643 x 285 | Fax: 613.254.5867

From: Sevigny, John [mailto:John.Sevigny@ottawa.ca]
Sent: Tuesday, May 29, 2018 2:12 PM
To: Sam Bahia <s.bahia@novatech-eng.com>
Cc: John Riddell <J.Riddell@novatech-eng.com>; David Kardish <dkardish@regionalgroup.com>; Steve Cunliffe

<scunliffe@regionalgroup.com>; Oram, Cody <Cody.Oram@ottawa.ca>
Subject: RE: Riverside South: Wright/Alphon Parcels

Hi Sam.
Do you anticipate that the pump station would still be required with the lowering of the sanitary sewer in River Road or is it only required based on the ISSU elevation?

John Sevigny, C.E.T.
Project Manager, Infrastructure Approvals
Development Review, Suburban Services | *Examen des projets d'aménagement, Services suburbains*
Planning, Infrastructure and Economic Development Department | Services de la planification, de l'infrastructure et du développement économique
City of Ottawa | Ville d'Ottawa
110 Laurier Avenue West. Ottawa, ON | 110, avenue. Laurier Ouest. Ottawa (Ontario) K1P 1J1
613.580.2424 ext./poste **14388**, fax/téléc:613-580-2576, john.sevigny@ottawa.ca

From: Sam Bahia <s.bahia@novatech-eng.com>
Sent: Monday, May 28, 2018 1:15 PM
To: Sevigny, John <John.Sevigny@ottawa.ca>; Oram, Cody <Cody.Oram@ottawa.ca>
Cc: John Riddell <J.Riddell@novatech-eng.com>; David Kardish <dkardish@regionalgroup.com>; Steve Cunliffe <scunliffe@regionalgroup.com>
Subject: Riverside South: Wright/Alphon Parcels

Hi John/Cody
As discussed with John S., we are preparing for a draft plan submission for the above noted sites for Regional and would like to discuss a sanitary servicing alternative for development of the above parcels, which will include ~200 residential dwellings. We request a meeting with City Staff, to discuss the above, with the intent that a solution can be agreed upon with the City and incorporated in planning applications in the near future for both parcels.
We are available Thursday (May 31) anytime or early next week. To ensure a productive meeting, below is our rational for proposing an alternative sanitary solution.

ISSU Sanitary Solution
The ISSU/MDP contemplated a significant grade raise (3.5 ~ 5.5m) in order to provide the minimum 2.5m pipe cover for the on-site sanitary sewers per City Guidelines. The governing constraint is the proposed sanitary sewer along River Road, which we understand has been lowered through recent draft plan submissions since the ISSU was finalized in 2017, by others. On the other hand, the proposed storm sewer along River Road tributary to Pond 5 is quite deep and would not govern the design. Attached, you'll find Figure 1- Grade Raise contour/elevations and a preliminary servicing based on the ISSU solution. Unfortunately, the grade raise highly impacts the development and feasibility of the two parcels due to the following:

- grade raise restriction (2.5m) and slope stability setback constraints (15m for high-level planning);
- constructability/functionality issues for lots which tie-in into adjacent parcels whereby retaining walls/terracing would be generally required around the site perimeter; and,
- significant trucking and capital costs (150000 cubic meters of imported material, 75000 cubic meters of engineered fill, and 2.0m high retaining walls) in the magnitude of $5.0M. This doesn't even deal with grade raise restriction of 2.5m and the requirements for light-weight fill.

On behalf of our client, based on all the above factors, we feel that it is appropriate to propose a sanitary solution which is more feasible and economical approach, and can be supported by City Staff in principle.

Alternative Sanitary Solution
The proposed solution outlined below. See attached Figure 2, for an Alternative Grade Raise.

- extension of the 450mm dia River Road sanitary sewer per the ISSU, to facilitate servicing of future lands;

- a small sanitary pump/lift station (peak flow of 12 L/s) to service Alphon and Wright parcels, would be located just north of the Wright Parcel ROW. The PS would be complete with control panel, SCADA, fiber optic communication line, 3-phase power, back-up generator, water service with a non-freeze hydrant, an emergency overflow, paved access, and fencing; and,
- a 30m – 100mm dia forcemain or 250mm dia gravity outlet to the River Road gravity sewer.

The foregoing solution would allow the site's grading to be governed by the storm sewer on River Road, which will:

- meet the grade raise restrictions and slope stability setbacks;
- provide a grading scheme that eliminates the need for retaining walls, and allow grading tie-in to adjacent properties quite manageable (by walkouts/lookouts, if necessary); and,
- eliminate 90% of the imported / engineered / light-weight fill, reducing off-site trucking and costs.

Please call if you have any questions.
Thank you

Sam Bahia, P.Eng., Project Manager | Land Development
NOVATECH Engineers, Planners & Landscape Architects
240 Michael Cowpland Drive, Suite 200, Ottawa, ON, K2M 1P6 | Tel: 613.254.9643 x 285 | Fax: 613.254.5867

'

'

'

'

This e-mail originates from the City of Ottawa e-mail system. Any distribution, use or copying of this e-mail or the information it contains by other than the intended recipient(s) is unauthorized. Thank you.

Le présent courriel a été expédié par le système de courriels de la Ville d'Ottawa. Toute distribution, utilisation ou reproduction du courriel ou des renseignements qui s'y trouvent par une personne autre que son destinataire prévu est interdite. Je vous remercie de votre collaboration.

'

Greg Winters

From: Scaramozzino, Tracey <Tracey.Scaramozzino@ottawa.ca>
Sent: Tuesday, May 21, 2019 2:07 PM
To: John Riddell; 'Taylor Marquis'; Greg Winters; Sam Bahia
Cc: 'Jamie Batchelor'; Giampa, Mike; Sharif, Golam; Sevigny, John; Walker, Burl
Subject: 788 River, Subdivision City Minutes.docx
Attachments: 788 River, Subdivision City Minutes.docx; 788-790 River, Plans and Study list.docx

Good Afternoon;

Please find attached the City's Draft minutes from our meeting last week. If any changes are required, please let me know. I've also attached the list of plans and studies. Please note that some of the requirements (shown with A) are required for the approval phase.

Regards,

Tracey Scaramozzino, MCIP RPP
Planner II
Development Review, South
Planning, Infrastructure and Economic Development Department
City of Ottawa
110 Laurier Avenue West, Ottawa, ON K1P1J1
☎ 613.580.2424 ext 12545, fax: 613-580-2576
tracey.scaramozzino@ottawa.ca
ottawa.ca/planning / ottawa.ca/urbanisme

'

'

788-790 River Road, Subdivision

Meeting Summary Notes
May 15, 2019, Ottawa City Hall

Attendees:

- Steve Cunliffe, Regional Group
- John Riddell, Novatech
- Taylor Marquis, Regional Group
- Paul Smolkin, Golder
- Sam Bahia, Project Manager, Novatech
- Greg Wingers, Novatech
- Jamie Bachelor (RVCA)
- Mike Giampa (Transportation Project Manager, City of Ottawa)
- Sharif Sharif (Project Manager, City of Ottawa)
- John Sevigny Project Manager, City of Ottawa)
- Burl Walker (Parks Planner, City of Ottawa)
- Tracey Scaramozzino (File Lead, Planner, City of Ottawa)

Issue of Discussion:

- 54 unit (27 singles, 27 towns) subdivision on 1 new road proposed off of River Road
- Same product as their eQ Riverwalk development in Manotick, all 1-storey units
- Most of the studies are underway
- Archaeological remains, that are linked to the construction of the canal (buildings and clothing notions), have been found at south-west corner of the site. The location of these objects may require the proposed pathway location to be altered. The Applicant has been working with the Ministry of Tourism, Culture and Sport and will require that the City prepare a standard letter to the Ministry to acknowledge these artifacts and the Cities intent to avoid and protect them – as outlined in a Phase 3 report by the Applicant. This will be req'd in the fall 2019 and will be prompted by the Applicant.
- Proposed Timing: DA in 2019; construction in fall 2020-2021

---

1. **Official Plan:**
    a. Designated "General Urban Area".

2. **Riverside South CDP**:
    a. Medium Density in Sector 2,
    b. Medium density is considered to be predominantly towns but may also include single-detached,
    c. Medium Density is to be 38 units/ha,
    d. Ensure varied streetscape, colours, models,

   e. Well designed units, flush garages, windows and living spaces at front of units, etc.

3. **Zoning Information**
   a. Rezoning will be req'd from R1WW and DR to suitable zone, as yet TBD.

4. **Infrastructure/Servicing (John Sevigny, Golam Sharif):**
   a. If the proposed rear yards are to sheet drain to the existing creek than an MECP ECA would not be required. However, if the rear yards are piped and outlet to the creek than a Direct Submission MECP ECA would be required unless it can be proven that an enhanced level of quality control can be provided then the application would be under the City's Transfer Review program;
   b. The Manotick Watermain Link is to be completed by the City. It is currently in the Design Stage with construction planned to be completed in 2021. Work will need to be completed prior to connecting to the watermain;
   c. The proposed unlooped watermain will need to meet the City's criteria for FUS and Technical Bulletin ISTB-2018-02;
   d. The proposed sanitary lift station will require an update to the Master Servicing Study for Riverside South; this will be a draft plan condition;
   e. Not mentioned in the meeting however there is a special area development charge for the Riverside South Area. The following link for current rates (the area is S-1) https://ottawa.ca/en/city-hall/planning-and-development/information-developers/development-application-review-process/development-application-submission/fees-and-funding-programs/development-charges

Assessment of Adequacy of Public Services:

- The report is to follow the City's Servicing Study guidelines which can be found at the following link: https://ottawa.ca/en/city-hall/planning-and-development/information-developers/development-application-review-process/development-application-submission/guide-preparing-studies-and-plans#servicing-study-guidelines-development-applications
- Prior to submitting the servicing report the consultant should contact John S and request boundary conditions for the watermain design. The consultant will need to provide the type of development, fire flow required, average day demand, maximum day demand and maximum hour demand as well as a location plan showing the points of connection to the public system.
- The storm water management design is to follow the Master Drainage Plan for Riverside South and the Design Brief for Pond 5.
- The report should include a master grading plan and servicing plan.

Geotechnical Study:

- Containing detailed information on geotechnical matters and recommendations (i.e. pavement, foundation, bedding construction etc.). The report is to follow the City’s Geotechnical Reporting Guidelines which can be found at http://www.ottawa.ca/cs/groups/content/@webottawa/documents/pdf/mdaw/mtm4/~edisp/cap137602.pdf

- Sensitive Marine Clay (SMC) is widely found across Ontario – geotechnical reports should include Atterberg Limits, consolidation testing, sensitivity values, and vane shear test results (at a minimum) with a discussion for proposals in areas containing SMC.

Slope Stability Study:

- The report is to follow the City’s slope stability reporting guidelines which can be found at http://documents.ottawa.ca/en/document/slope-stability-guidelines-development-applications

Hydrogeological Assessment:

- Addressing the impacts to existing wells in the vicinity of the development.
- This report shall include at a minimum the following items:
  - Basic hydrogeology for the area
  - Risk to existing wells during construction and from the long term development of the site (e.g. quantity/quality, recharge, water budget)
  - Monitoring program for existing wells.

5. Initial Planning Comments (Tracey Scaramozzino)

a. Discuss the proposal with Councillor Meehan (transportation, affordable housing are key subjects),
b. Ensure compliance with the Riverside South CDP and Building Better, Smarter Suburbs (BBSS),
c. Applicant acknowledges that they do not meet the definition of “medium density” as designated in the CDP and that they likely don’t meet the density target of 38 units/ha for medium density areas. This will likely require an OPA. (City staff will meet internally to discuss)
d. Provide density achieved through this proposal.
e. Consider providing a ped link partway along the street to the pathway.

6. Transportation (Mike Giampa):

a. Road widening has been confirmed to be: 37.5m.
b. Mike has spoken to Jennifer Luong at Novatech and the TIA screening report has been completed. A TIA is not required based on the screening report.
c. Sight-lines will be important

7. Parks (Burl Walker):

a. The parkland dedication requirement for the proposed subdivision application has been calculated to be 0.177 ha based on the rates established for residential development in the Parkland Dedication By-law. In the event that the land use(s) and/or number of proposed dwelling units change, the parkland dedication requirement will also change. The parkland dedication requirement has been calculated as follows:

Proposed Use	Number of Dwelling Units	Parkland Dedication Rate	Parkland Dedication Requirement
Non-apartment dwelling units	54 new dwelling units less 1 existing dwelling units = uplift of 53 dwelling units	1 ha per 300 dwelling units	0.177 ha

b. The CDP and the Riverside South Modified Area Parks Plan do not identify any parks on the subject lands. Therefore, no conveyance of parkland will be required within the limits of the site. A condition similar to the following would be included as a draft plan approval condition for the subdivision application:

“The Owner acknowledges and agrees that where multiple parks are to be developed within a Community Design Plan (CDP) area or draft plan of subdivision with multiple land-owners, the landowners will enter into a cost sharing agreement to cover the cost of the development of the parks as per the direction of OPA 159. Prior to the registration of the Subdivision Agreement, the Owner shall submit to the City proof from the landowners’ trustee that the Owner is party to the cost sharing agreement and has paid its share of any costs pursuant to the Agreement, or the Owner shall submit other suitable documentation from the landowners’ trustee demonstrating that the Owner is participating in the Agreement, to the satisfaction of the General Manager, Recreation, Cultural and Facility Services.”

According to information provided by Riverside South Development Corporation in 2018, Nicolls Island Holdings Inc. and Alphon Group (Canada) Inc. are not participating in the Riverside South Park Cost Sharing Agreement. It is understood that the Owner is proposing an expansion of Jeffrey Armstrong Memorial Park on the Alphon lands to address the parkland dedication and park development requirements for the subdivision. Staff would be supportive of using a park agreement between Nicolls Island Holdings and Alphon Group to implement the expansion of Jeffrey Armstrong Memorial Park. A letter would be required from the trustee for the agreement prior to registration of the Nicolls Island Holdings subdivision agreement.

The Riverside South Modified Area Parks Plan contemplates that Jeffrey Armstrong Memorial Park would be expanded by approximately 1.35 ha from the existing size of 0.28 ha to a total size of 1.63 ha.

The Preliminary Servicing Plan submitted with the pre-consultation application illustrates approximately 143 dwelling units on the Alphon Group lands, which would correspond with a parkland dedication requirement of 0.477 ha. The combined parkland dedication from the Nicolls Island Holdings and Alphon Group developments would total approximately 0.654 ha. The expanded park size would be approximately 0.934 ha. While the total parkland dedication would be less than contemplated in the Modified Area Parks Plan, the proposed park expansion would be acceptable since the owners are not participating in the Riverside South park agreement. The final size and configuration of the lands for the park expansion would be determined through the review of the future subdivision application for the Alphon Group lands.

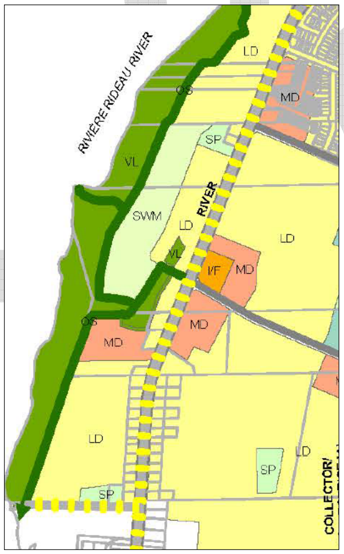
It would be appreciated if the applicant could advise how they plan to address the proposed parkland conveyance and park development for the expansion of Jeffrey Armstrong Memorial Park. One option would be for the park to be developed through the developer-built park development process as outlined in the Park Development Manual. The timing for the parkland conveyance and park development would need to be coordinated with the Alphon Group development. The park development budget would be based on the park development rate for active parks in effect at the time of registration for the subdivision agreement for the Alphon lands (current rate of $536,166 per ha). Another option that could be explored would be to develop the park through the City-built park development process. Park development funding could be provided to the City separately for the Nicolls Island Holdings and the Alphon Group developments at the time of registration of the respective subdivision agreements. The park development rate would be based on the rate in effect at the time of registration of the subdivision agreements. Note that there would be an additional 5% administrative fee for City forces to execute the project as described in standard draft plan approval condition P24. The park development funding from the Nicolls Island Holdings and Alphon Group subdivision agreements would be transferred into a new City park development account for the expansion of Jeffrey Armstrong Memorial Park. The City would then proceed with the design and construction process for the park project following the registration of both subdivision agreements. The latter approach would simplify the park agreement between Nicolls Island Holdings and the Alphon Group as it would only need to address the parkland conveyance for the park expansion.

c. For your reference, an excerpt from the Riverside South Modified Area Parks Plan is attached including a list of the proposed amenities and a preliminary facility fit sketch for the Jeffrey Armstrong Memorial Park expansion.
d. Part of the lands located along the north and west sides of the site are designated as Valley Land on the Land Use Plan in the Riverside South CDP (2016). These lands should be conveyed to the City through the conditions of subdivision approval.

e. A Multi-use Pathway is designated on the Land Use Plan in the Riverside South CDP along the north and west sides of the site. Similarly, the Official Plan designates a Major Pathway through the lands on Schedule “C” (OPA 150 version). A minimum 10 m wide corridor is typically required for a multi-use pathway. The multi-use pathway corridor shall be conveyed to the City through the conditions of subdivision approval. The MUP corridor shall be located outside the applicable minimum development setbacks as described in Section 4.7.3 of the Official Plan. The minimum development setbacks should be described on a plan of survey or other appropriate drawing and included with the application submission. The Owner would be required to design and construct the pathway and associated landscaping and benches through the conditions of approval.

f. A sharp corner is shown for the pathway corridor in the northwest corner of the site. If the final configuration for the pathway corridor includes any sharp corners, consider providing a corner triangle to improve sight lines and to provide a gentler pathway curve at the corner.

g. Note that the draft Riverside South Secondary Plan - Land Use Plan contemplates a multi-use pathway alignment with a crossing of the ravine along the north side of the site. See excerpt below.



h. Consider incorporating a mid-block walkway block between the street and the multi-use pathway block to provide a more direct and convenient access between the proposed dwellings and the multi-use pathway.

i. Consider providing a single-loaded street adjacent to the Valley Lands. Guideline 54 of the Greenspaces section of the Urban Design Guidelines for Greenfield Neighbourhoods states: “Design stormwater management areas, and other greenspaces with majority of their frontage onto public roads to make a visible contribution to the neighbourhood.” For example, could the potential to develop a single-loaded street with an integrated multi-use pathway be reviewed similar to the treatment of the proponent’s Greystone Village development adjacent to the Rideau River?

j. Interpretive signage for the archaeological site could be introduced along the multi-use pathway corridor.

k. City Staff to confirm the type and width of the proposed pathway extending off of River Road, along the rear of the dwellings near the Top of Bank. The Applicant is showing 6m wide pathway corridor with a 2m wide stonedust pathway to keep with the natural setting, while Burl noted that a MUP is designated in the Official Plan (Major Pathway on Schedule “C” - OPA 150 version), which would require a 3m wide asphalt MUP within a typical 10m wide corridor to be more accessible. (City staff will discuss with Emily Davies and Sam Roberts).

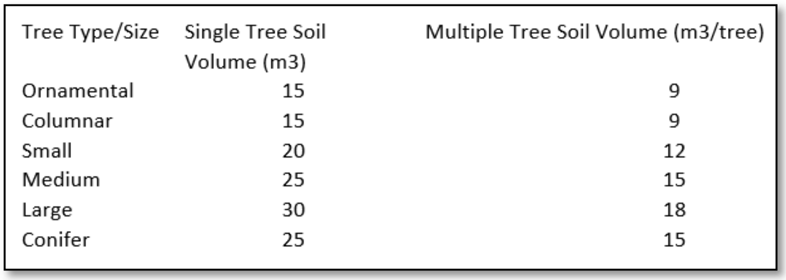
8. Trees/Environment (Mark Richardson/Matthew Hayley):

a. TCR and EIS are required and can be combined into one report. Address features along norther property line and potential species at risk.

b. Tree Permit is required prior to any tree removal.

c. TCR requirements:

1. a Tree Conservation Report (TCR) must be supplied for review along with the various other plans/reports required by the City; an approved TCR is a requirement for Site Plan approval
2. any removal of privately-owned trees 10cm or larger in diameter requires a tree permit issued under the Urban Tree Conservation Bylaw; the permit is based on the approved TCR
3. the removal of City-owned trees will require the permission of Forestry Services who will also review the submitted TCR
4. in this case, the TCR may be combined with the Landscape Plan, or the EIS if one is required
5. the TCR must list all trees on site by species, diameter and health condition; similar groupings (stands) of trees can combined using averages by species, diameter class
6. the TCR must address all trees with a critical root zone that extends into the developable area – all trees that could be impacted by the construction that are outside the developable area need to be addressed.
7. Trees with a trunk that crosses/touches a property line are considered co-owned by both property owners; permission from the adjoining property owner must be obtained prior to the removal of co-owned trees
8. If trees are to be removed, the TCR must clearly show where they are, and document the reason they can not be retained – please provide a plan showing retained and removed treed areas
9. All retained trees must be shown and all retained trees within the area impacted by the development process must be protected as per City guidelines listed on Ottawa.ca
10. Please ensure newly planted trees have an adequate soil volume for their size at maturity. The following is a table of recommended minimum soil volumes:



Tree Type/Size	Single Tree Soil Volume (m3)	Multiple Tree Soil Volume (m3/tree)
Ornamental	15	9
Columnar	15	9
Small	20	12
Medium	25	15
Large	30	18
Conifer	25	15

11. The City requests that all efforts are made to retain trees – trees should be healthy, and of a size and species that can grow into the site and contribute to Ottawa’s urban forest canopy
12. For more information on the TCR process or help with tree retention options, contact Mark Richardson mark.richardson@ottawa.ca

9. Conservation Authority (Jamie Bachelor)

a. A 30 metre setback from bankfull is required from both tributaries.
b. A geotechnical report/slope stability analysis is required to determine the limit of hazard lands. The report must take into account sensitive marine soils. It is strongly recommended that a work plan be forwarded to the RVCA prior to the undertaken of the study to ensure that the appropriate methodology is being used.
c. All lots and proposed pathways must be outside the 30 metre setback and the limit of hazard lands. Any consideration for a pathway within the access erosion allowance will be dependent on the outcome of the study and provided the pathways are still meeting the required 30 metre setback.
d. A Headwater Drainage Features Assessment is required for any watercourse where there is a proposed alteration/elimination. The outcome of an accepted report will determine whether the watercourses can be altered or filled in.
e. The outcome of an accepted Headwater Drainage Features Assessment will determine hydration requirements. Any proposed methods to maintain hydration to the downstream watercourses must take into account the erosion thresholds established through the geomorphological study that was completed by Matrix Solutions Inc Environment & Engineering. Any consideration for hydration must also take into account flows which are currently being directed to the watercourses or proposed by neighboring development (ie: River Road re-construction and the Richcraft Subdivision) when considering the erosion thresholds. Any water being discharged to the watercourses must achieve 80 TT removal prior to entering the watercourse.
f. There are two areas where it would appear works are proposed to cut off a portion of the slope. The first being near lots 1 to 3, the second being at lots 6 and 7. Further detail on how the proposed alterations would tie into the existing slope would be required. It should be noted that the RVCA typically does not support the alteration of slopes to accommodate new development.

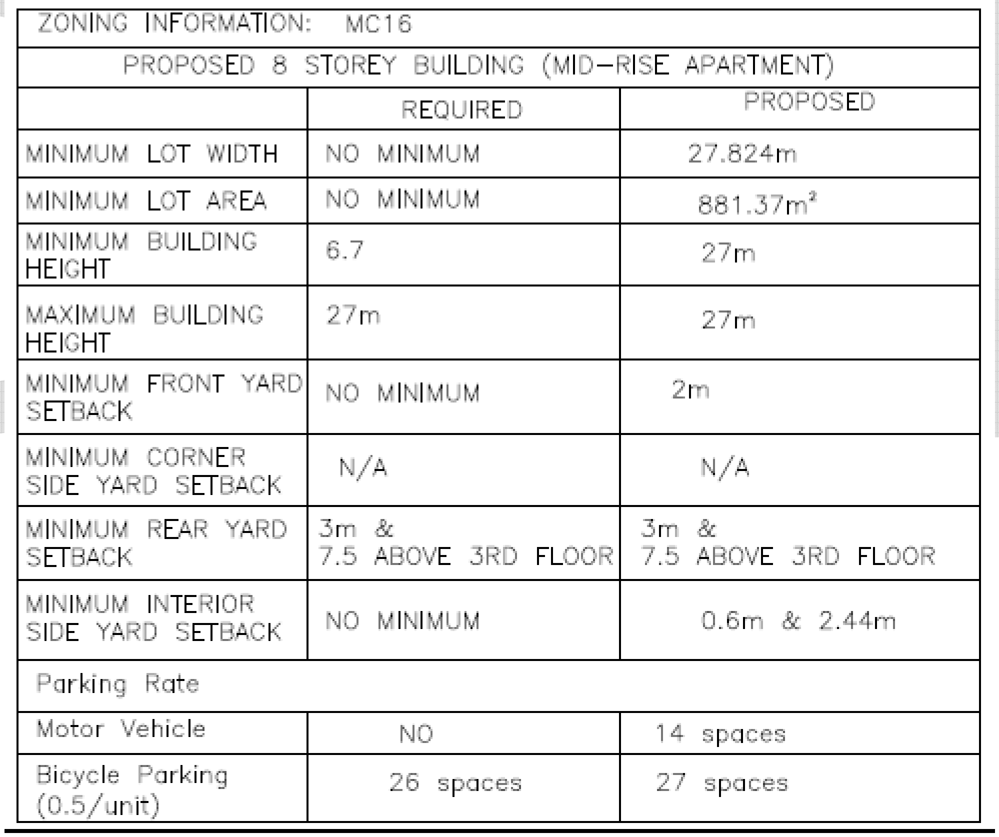
Therefore the proposed layout should not rely on cut offs of the slope. Discussion around the second proposed cut off will be dependent on the outcome of an accepted Headwater Drainage Features Assessment.

10. Process/Required Applications

a. Draft Plan of Subdivision
b. Rezoning
c. OPA – to revise the CDP – medium density – unit type and also the density target.

11. General Information

a. Please ensure the zoning table on the plan is in the following format. Ensure that <u>all</u> zoning provisions and rates are shown and differentiate those that require a re-zoning.



ZONING INFORMATION: MC16		
PROPOSED 8 STOREY BUILDING (MID-RISE APARTMENT)		
	REQUIRED	PROPOSED
MINIMUM LOT WIDTH	NO MINIMUM	27.824m
MINIMUM LOT AREA	NO MINIMUM	881.37m²
MINIMUM BUILDING HEIGHT	6.7	27m
MAXIMUM BUILDING HEIGHT	27m	27m
MINIMUM FRONT YARD SETBACK	NO MINIMUM	2m
MINIMUM CORNER SIDE YARD SETBACK	N/A	N/A
MINIMUM REAR YARD SETBACK	3m & 7.5 ABOVE 3RD FLOOR	3m & 7.5 ABOVE 3RD FLOOR
MINIMUM INTERIOR SIDE YARD SETBACK	NO MINIMUM	0.6m & 2.44m
Parking Rate		
Motor Vehicle	NO	14 spaces
Bicycle Parking (0.5/unit)	26 spaces	27 spaces

b. Ensure that all plans and studies are prepared as per City guidelines – as available online…
https://ottawa.ca/en/city-hall/planning-and-development/information-developers/development-application-review-process/development-application-submission/guide-preparing-studies-and-plans

Ottawa

PLANNING AND GROWTH MANAGEMENT
URBANISME ET GESTION DE LA CROISSANCE

APPLICANT'S STUDY AND PLAN IDENTIFICATION LIST

Legend: **S** indicates that the study or plan is required with application submission.
A indicates that the study or plan may be required to satisfy a condition of approval/draft approval.

For information and guidance on preparing required studies and plans refer to:

http://ottawa.ca/en/development-application-review-process-0/guide-preparing-studies-and-plans

S/A	Number of copies	ENGINEERING		S/A	Number of copies
S	1	1. Site Servicing Plan – High Level	2. Assessment of Adequacy of Public Services Brief	S	1
S	1	3. Grade Control and Drainage Plan – High Level	4. Geotechnical Study / Slope Stability Study (update to existing is acceptable)	S	1
A	1	5. Composite Utility Plan	6. Groundwater Impact Study		
A	1	7. Servicing Options Report	8. Wellhead Protection Study		
		9. Transportation Impact Brief	10.Erosion and Sediment Control Plan / Brief	A	1
A	1	11.Storm water Management Report / Brief	12.Hydro geological and Terrain Analysis		
S	1	13.Hydraulic Water main Analysis	14.Noise Study for residential units close to Arterial Road.	S	1
		15.Roadway Modification Design Plan	16.Confederation Line Proximity Study		

S/A	Number of copies	PLANNING / DESIGN / SURVEY		S/A	Number of copies
S	2	17.Draft Plan of Subdivision	18.Plan Showing Layout of Parking Garage		
		19.Draft Plan of Condominium	20.Planning Rationale	S	1
		21.Site Plan	22.Minimum Distance Separation (MDS)		
		23.Concept Plan Showing Proposed Land Uses and Landscaping	24.Agrology and Soil Capability Study		
		25.Concept Plan Showing Ultimate Use of Land	26.Cultural Heritage Impact Statement – not req'd as the devt is more than 30m from the river/canal		
A	2	27.Landscape Plan	28.Archaeological Resource Assessment Requirements: **S** (site plan) **A** (subdivision, condo)	S	1
S	1	29.Survey Plan	30.Shadow Analysis		
A	2	31.Architectural Building Elevation Drawings (dimensioned)	32.Design Brief – compliance with CDP, BBSS	S	1
		33.Wind Analysis			

S/A	Number of copies	ENVIRONMENTAL		S/A	Number of copies
S	1	34.Phase 1 Environmental Site Assessment	35.Impact Assessment of Adjacent Waste Disposal/Former Landfill Site		
	3	36.Phase 2 Environmental Site Assessment (depends on the outcome of Phase 1)	37.Assessment of Landform Features		
		38.Record of Site Condition	39.Mineral Resource Impact Assessment		
S	2	Tree Conservation Report combined with Environmental Impact Statement *address features along the northern property line which appears to be a ravine and forest (identified in the CDP) and potential species at risk, e.g., butternut, etc. There is a watercourse, which will need to be addressed as per the RVCA requirements.			
		40.Mine Hazard Study / Abandoned Pit or Quarry Study	41. Integrated Environmental Review		

S/A	Number of copies	ADDITIONAL REQUIREMENTS		S/A	Number of copies
S	1	42.Electronic Copy of All reports/drawings	43. Pedestrian Plan – showing all ped connections within the development and extending to outside of the development	**S**	1

Minimal bindings and minimal plastic pages on reports please. Staples are preferred when possible to reduce plastic use and waste

Meeting Date: May 15 2019

Application Type: *Plan of Subdivision*

File Lead: Tracey Scaramozzino
City Architect: Christopher Moise
Environmental/Trees: Matthew Hayley, Mark Richardson

Infrastructure Approvals Project Manager: John Sevigny/Golam Sharif
Transportation Project Manager: Mike Giampa

Site Address (Municipal Address): 788-790 River Rd

*Preliminary Assessment: 1☐ 2☐ 3☐ 4☐ 5☐

*One (1) indicates that considerable major revisions are required before a planning application is submitted, while five (5) suggests that proposal appears to meet the City's key land use policies and guidelines. **This assessment is purely advisory and does not consider technical aspects of the proposal or in any way guarantee application approval.**

It is important to note that the need for additional studies and plans may result during application review. If following the submission of your application, it is determined that material that is not identified in this checklist is required to achieve complete application status, in accordance with the Planning Act and Official Plan requirements, the Planning and Growth Management Department will notify you of outstanding material required within the required 30 *day period. Mandatory pre-application consultation will not shorten the City's standard processing timelines, or guarantee that an application will be approved. It is intended to help educate and inform the applicant about submission requirements as well as municipal processes, policies, and key issues in advance of submitting a formal development application. This list is valid for one year following the meeting date. If the application is not submitted within this timeframe the applicant must again pre-consult with the Planning and Growth Management Department.*

Ben Sweet

From: Scaramozzino, Tracey <Tracey.Scaramozzino@ottawa.ca>
Sent: Tuesday, February 18, 2020 10:45 AM
To: Robert Tran
Subject: RE: 788-790 River Road - Submission Requirements

Thanks Robert for checking in. We are trying to reduce the amount of paper copies – but since I haven't been able to double-check with staff – please submit your standard of 3 copies.

Tks,

Regards,

Tracey Scaramozzino, MCIP RPP
Planner II
Development Review, South
Planning, Infrastructure and Economic Development Department
City of Ottawa
110 Laurier Avenue West, Ottawa, ON K1P1J1
☎ 613.580.2424 ext 12545, fax: 613-580-2576
tracey.scaramozzino@ottawa.ca
ottawa.ca/planning / ottawa.ca/urbanisme

From: Robert Tran <r.tran@novatech-eng.com>
Sent: February 18, 2020 9:28 AM
To: Scaramozzino, Tracey <Tracey.Scaramozzino@ottawa.ca>
Subject: 788-790 River Road - Submission Requirements

Hello Tracey,

Following up on the below, can you please confirm the number of submission requirements are correct? Thanks.

Robert Tran, M.PL., Planner
NOVATECH Engineers, Planners & Landscape Architects
240 Michael Cowpland Drive, Suite 200, Ottawa, ON, K2M 1P6 | Tel: 613.254.9643 Ext. 272 | Fax: 613.254.5867

From: Robert Tran
Sent: Thursday, February 13, 2020 9:36 AM
To: 'Tracey.Scaramozzino@ottawa.ca' <Tracey.Scaramozzino@ottawa.ca>
Subject: 788-790 River Road - Submission Requirements

Hi Tracey,

Can you please confirm that you would like (1) copy of the required reports and plans listed in the attached document? We normally submit (3) or more copies of the required reports and plans to the City on other applications esp. for Plan of Subdivision applications. Thanks.

Robert Tran, M.PL., Planner
NOVATECH Engineers, Planners & Landscape Architects
240 Michael Cowpland Drive, Suite 200, Ottawa, ON, K2M 1P6 | Tel: 613.254.9643 Ext. 272 | Fax: 613.254.5867

'

'

Appendix B
Servicing Report Checklist

Development Servicing Study Checklist

Project Name: Wright Lands
Project Number: 116037
Date: July 23, 2020

4.1 General Content	Addressed (Y/N/NA)	Section	Comments
Executive Summary (for larger reports only).	NA		
Date and revision number of the report.	Y	Cover	
Location map and plan showing municipal address, boundary, and layout of proposed development.	Y	Fig 1.1, 1.2, 1.3	
Plan showing the site and location of all existing services.	Y	Fig 1.2, 3.1	
Development statistics, land use, density, adherence to zoning and official plan, and reference to applicable subwatershed and watershed plans that provide context to which individual developments must adhere.	NA		
Summary of Pre-consultation Meetings with City and other approval agencies.	Y	1	
Reference and confirm conformance to higher level studies and reports (Master Servicing Studies, Environmental Assessments, Community Design Plans), or in the case where it is not in conformance, the proponent must provide justification and develop a defendable design criteria.	Y	1, 2	
Statement of objectives and servicing criteria.	Y	1	
Identification of existing and proposed infrastructure available in the immediate area.	Y	4,5,6,7	
Identification of Environmentally Significant Areas, watercourses and Municipal Drains potentially impacted by the proposed development (Reference can be made to the Natural Heritage Studies, if available).	NA		
Concept level master grading plan to confirm existing and proposed grades in the development. This is required to confirm the feasibility of proposed stormwater management and drainage, soil removal and fill constraints, and potential impacts to neighboring properties. This is also required to confirm that the proposed grading will not impede existing major system flow paths.	Y	Fig 3.2	

Development Servicing Study Checklist

Project Name: Wright Lands
Project Number: 116037
Date: July 23, 2020

4.1 General Content	**Addressed (Y/N/NA)**	**Section**	**Comments**
Identification of potential impacts of proposed piped services on private services (such as wells and septic fields on adjacent lands) and mitigation required to address potential impacts.	NA		
Proposed phasing of the development, if applicable.	NA		
Reference to geotechnical studies and recommendations concerning servicing.	Y	2.2	
All preliminary and formal site plan submissions should have the following information:			
Metric scale	NA		
North arrow (including construction North)	NA		
Key plan	NA		
Name and contact information of applicant and property owner	NA		
Property limits including bearings and dimensions	NA		
Existing and proposed structures and parking areas	NA		
Easements, road widening and rights-of-way	NA		
Adjacent street names	NA		

Development Servicing Study Checklist

Project Name: Wright Lands
Project Number: 116037
Date: July 23, 2020

4.2 Water	**Addressed (Y/N/NA)**	**Section**	**Comments**
Confirm consistency with Master Servicing Study, if available.	Y	7	
Availability of public infrastructure to service proposed development.	Y	7	
Identification of system constraints.	Y	7	
Identify boundary conditions.	Y	7	
Confirmation of adequate domestic supply and pressure.	Y	7	
Confirmation of adequate fire flow protection and confirmation that fire flow is calculated as per the Fire Underwriter's Survey. Output should show available fire flow at locations throughout the development.	Y	7	
Provide a check of high pressures. If pressure is found to be high, an assessment is required to confirm the application of pressure reducing valves.	Y	7	
Definition of phasing constraints. Hydraulic modeling is required to confirm servicing for all defined phases of the project including the ultimate design.	Y	7	
Address reliability requirements such as appropriate location of shut-off valves.	Y	Fig 3.1	
Check on the necessity of a pressure zone boundary modification.	NA		
Reference to water supply analysis to show that major infrastructure is capable of delivering sufficient water for the proposed land use. This includes data that shows that the expected demands under average day, peak hour and fire flow conditions provide water within the required pressure range.	Y	7	
Description of the proposed water distribution network, including locations of proposed connections to the existing system, provisions for necessary looping, and appurtenances (valves, pressure reducing valves, valve chambers, and fire hydrants) including special metering provisions.	Y	7, Fig 3.1	
Description of off-site required feedermains, booster pumping stations, and other water infrastructure that will be ultimately required to service proposed development, including financing, interim facilities, and timing of implementation.	Y	7	
Confirmation that water demands are calculated based on the City of Ottawa Design Guidelines.	Y	7	
Provision of a model schematic showing the boundary conditions locations, streets, parcels, and building locations for reference.	Y	Fig 7.1	

4.3 Wastewater	Addressed (Y/N/NA)	Section	Comments
Summary of proposed design criteria (Note: Wet-weather flow criteria should not deviate from the City of Ottawa Sewer Design Guidelines. Monitored flow data from relatively new infrastructure cannot be used to justify capacity requirements for proposed infrastructure).	Y	5	
Confirm consistency with Master Servicing Study and/or justifications for deviations.	Y	5	
Consideration of local conditions that may contribute to extraneous flows that are higher than the recommended flows in the guidelines. This includes groundwater and soil conditions, and age and condition of sewers.	NA		
Description of existing sanitary sewer available for discharge of wastewater from proposed development.	Y	5	
Verify available capacity in downstream sanitary sewer and/or identification of upgrades necessary to service the proposed development. (Reference can be made to previously completed Master Servicing Study if applicable)	Y	5	
Calculations related to dry-weather and wet-weather flow rates from the development in standard MOE sanitary sewer design table (Appendix ‘C’) format.	N		
Description of proposed sewer network including sewers, pumping stations, and forcemains.	Y	5	
Discussion of previously identified environmental constraints and impact on servicing (environmental constraints are related to limitations imposed on the development in order to preserve the physical condition of watercourses, vegetation, soil cover, as well as protecting against water quantity and quality).	NA		
Pumping stations: impacts of proposed development on existing pumping stations or requirements for new pumping station to service development.	NA		
Forcemain capacity in terms of operational redundancy, surge pressure and maximum flow velocity.	NA		
Identification and implementation of the emergency overflow from sanitary pumping stations in relation to the hydraulic grade line to protect against basement flooding.	Y	6	
Special considerations such as contamination, corrosive environment etc.	NA		

Development Servicing Study Checklist

4.4 Stormwater	**Addressed (Y/N/NA)**	**Section**	**Comments**
Description of drainage outlets and downstream constraints including legality of outlet (i.e. municipal drain, right-of-way, watercourse, or private property).	Y	4	
Analysis of the available capacity in existing public infrastructure.	Y	4	
A drawing showing the subject lands, its surroundings, the receiving watercourse, existing drainage patterns and proposed drainage patterns.	Y	Fig 4.1	
Water quantity control objective (e.g. controlling post-development peak flows to pre-development level for storm events ranging from the 2 or 5 year event (dependent on the receiving sewer design) to 100 year return period); if other objectives are being applied, a rationale must be included with reference to hydrologic analyses of the potentially affected subwatersheds, taking into account long-term cumulative effects.	Y	4	
Water Quality control objective (basic, normal or enhanced level of protection based on the sensitivities of the receiving watercourse) and storage requirements.	Y	4	
Description of stormwater management concept with facility locations and descriptions with references and supporting information.	Y	4	
Set-back from private sewage disposal systems.	NA		
Watercourse and hazard lands setbacks.	NA		
Record of pre-consultation with the Ontario Ministry of Environment and the Conservation Authority that has jurisdiction on the affected watershed.	NA		
Confirm consistency with sub-watershed and Master Servicing Study, if applicable study exists.	Y	4	
Storage requirements (complete with calcs) and conveyance capacity for 5 yr and 100 yr events.	Y	4	
Identification of watercourse within the proposed development and how watercourses will be protected, or, if necessary, altered by the proposed development with applicable approvals.	Y	4	
Calculate pre and post development peak flow rates including a description of existing site conditions and proposed impervious areas and drainage catchments in comparison to existing conditions.	Y	4	
Any proposed diversion of drainage catchment areas from one outlet to another.	NA		
Proposed minor and major systems including locations and sizes of stormwater trunk sewers, and SWM facilities.	Y	4	
If quantity control is not proposed, demonstration that downstream system has adequate capacity for the post-development flows up to and including the 100-year return period storm event.	Y	4	

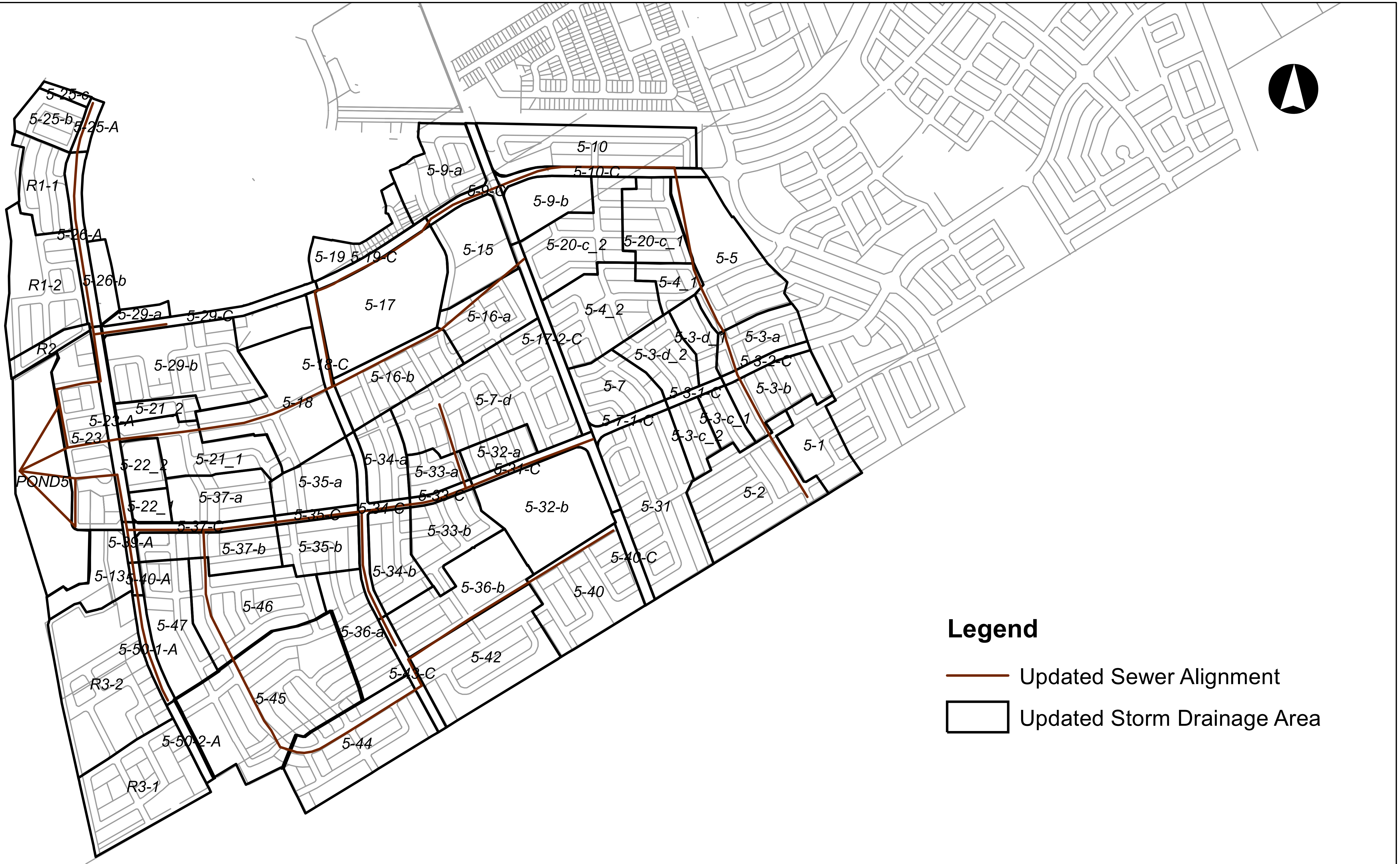
4.4 Stormwater	**Addressed (Y/N/NA)**	**Section**	**Comments**
Identification of municipal drains and related approval requirements.	Y	4	
Description of how the conveyance and storage capacity will be achieved for the development.	Y	4	
100 year flood levels and major flow routing to protect proposed development from flooding for establishing minimum building elevations (MBE) and overall grading.	Y	4	
Inclusion of hydraulic analysis including HGL elevations.	Y	4	
Description of approach to erosion and sediment control during construction for the protection of receiving watercourse or drainage corridors.	Y	9	
Identification of floodplains – proponent to obtain relevant floodplain information from the appropriate Conservation Authority. The proponent may be required to delineate floodplain elevations to the satisfaction of the Conservation Authority if such information is not available or if information does not match current conditions.	Y	4	
Identification of fill constrains related to floodplain and geotechnical investigation.	Y	2, Fig 1.3	

Development Servicing Study Checklist

4.5 Approval and Permit Requirements	**Addressed (Y/N/NA)**	**Section**	**Comments**
Conservation Authority as the designated approval agency for modification of floodplain, potential impact on fish habitat, proposed works in or adjacent to a watercourse, cut/fill permits and Approval under Lakes and Rivers Improvement Act. The Conservation Authority is not the approval authority for the Lakes and Rivers Improvement Act. Where there are Conservation Authority regulations in place, approval under the Lakes and Rivers Improvement Act is not required, except in cases of dams as defined in the Act.	Y	10	
Application for Certificate of Approval (CofA) under the Ontario Water Resources Act.	Y	10	
Changes to Municipal Drains.	NA		
Other permits (National Capital Commission, Parks Canada, Public Works and Government Services Canada, Ministry of Transportation etc.)	Y	10	

4.6 Conclusion	**Addressed (Y/N/NA)**	**Section**	**Comments**
Clearly stated conclusions and recommendations.	Y	11	
Comments received from review agencies including the City of Ottawa and information on how the comments were addressed. Final sign-off from the responsible reviewing agency.	NA		
All draft and final reports shall be signed and stamped by a professional Engineer registered in Ontario.	Y	12	

Appendix C
Storm Sewer Design Sheets and Stormwater Management Calculations



Scale

1:10000

Project Title

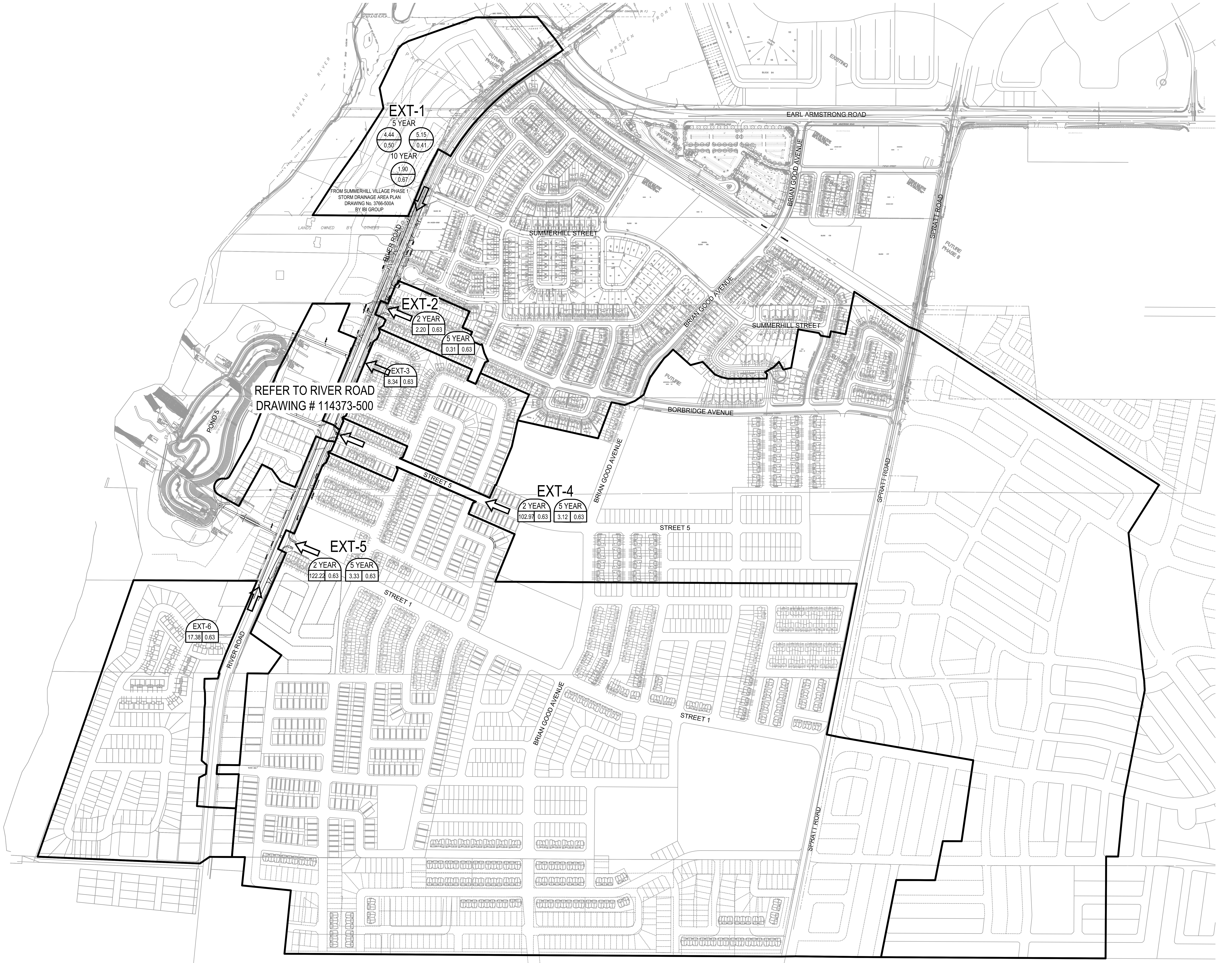
Riverside South
Febryary 27, 2018 Memorandum

Drawing Title

Updated PCSWMM Drainage Area

Sheet No.

Figure 1



NOTES:

1. ALL CULVERTS TO BE GALVANIZED CSP 68x13 CORR. x2.8mm THICK CLASS "B" BEDDING. ALL JOINTS TO BE WRAPPED WITH NON-WOVEN GEOTEXTILE, MINIMUM 1.0m WIDTH.

No.	REVISIONS	By	Date
14			
13			
12			
11			
10			
9			
8			
7			
6			
5	REVISED AS PER CITY COMMENTS	LE	20-08-18
4	PRELIM. ISSUED TO CONTRACTOR	LE	16-08-18
3	ISSUED FOR TENDER	LE	06-07-18
2	REVISED AS PER CITY COMMENTS	LE	29-06-18
1	ISSUED FOR CITY REVIEW	LE	27-04-18

IBI GROUP
400 – 333 Preston Street
Ottawa ON K1S 5N4 Canada
tel 613 225 1311 fax 613 225 9868
ibigroup.com

Project Title
RIVER ROAD
RECONSTRUCTION

LICENSED PROFESSIONAL ENGINEER
E. M. ERION
13379508
20/08/18
PROVINCE OF ONTARIO

N

Drawing Title
EXTERNAL STORM
DRAINAGE AREA PLAN

Scale
1:4000

Design
LE

Date
APR 2018

Drawn
CC

Checked
TB

Project No.
114373

Drawing No.
501

NOTES:

1. ALL CULVERTS TO BE GALVANIZED CSP 68x13 CORR. x2.8mm THICK CLASS "B" BEDDING. ALL JOINTS TO BE WRAPPED WITH NON-WOVEN GEOTEXTILE, MINIMUM 1.0m WIDTH.

No.	REVISIONS	By	Date
14			
13			
12			
11			
10			
9			
8			
7			
6			
5	REVISED AS PER CITY COMMENTS	LE	20-08-18
4	PRELIM. ISSUED TO CONTRACTOR	LE	16-08-18
3	ISSUED FOR TENDER	LE	06-07-18
2	REVISED AS PER CITY COMMENTS	LE	29-06-18
1	ISSUED FOR CITY REVIEW	LE	27-04-18

IBI GROUP
400 – 333 Preston Street
Ottawa ON K1S 5N4 Canada
tel 613 225 1311 fax 613 225 9868
ibigroup.com

Project Title

RIVER ROAD
RECONSTRUCTION

L. M. ERION
13379508
20/08/18

N

Drawing Title

STORM DRAINAGE
AREA PLAN

Scale	1:1000
Design LE	Date APR 2018
Drawn CC	Checked TB
Project No. 114373	Drawing No. 500

D07

J:\114373_RiverRoad\5.9 Drawings\59civil\layouts\500 – Storm Drainage Area Plan.dwg Layout Name: STORM DRAINAGE AREA PLAN Plot Style: AIA STANDARD-FULL.CTB Plot Scale: 1:50.8 Plotted At: 8/20/2018 4:07 PM Last Saved By: CHRIS.CORMIER Last Saved At: Aug. 20, 18

IBI GROUP
400-333 Preston Street
Ottawa, Ontario K1S 5N4 Canada
tel 613 225 1311 fax 613 225 9868
ibigroup.com

STORM SEWER DESIGN SHEET

River Road
City of Ottawa
Riverside South Development Corporation

LOCATION				AREA (Ha)						RATIONAL DESIGN FLOW																	SEWER DATA						
STREET	AREA ID	FROM	TO	Existing	Single Family		Townhouse		Walden	2 Year		5 Year		10 Year		INLET (min)	TIME IN PIPE	TOTAL (min)	i (2) (mm/hr)	i (5) (mm/hr)	i (10) (mm/hr)	2yr PEAK FLOW (L/s)	5yr PEAK FLOW (L/s)	10yr PEAK FLOW (L/s)	FIXED FLOW (L/s)	DESIGN FLOW (L/s)	CAPACITY (L/s)	LENGTH (m)	PE SIZE (m DIA	SLOPE (%)	VELOCITY (m/s)	AVAIL CAP	
				C= 0.25	C= 0.41	C= 0.50	C= 0.63	C= 0.63	C= 0.67	IND 2.78AC	CUM 2.78AC	IND 2.78AC	CUM 2.78AC	IND 2.78AC	CUM 2.78AC																	(L/s)	(%)
North Outlet																																	
River Road	EXT-1		EXMH160		5.15	4.44			1.90	0.00	0.00	12.04	12.04	3.54	3.54	12.78			67.56	91.50	107.20	0.00	1,101.80	379.36		1,481.16							
River Road	160A&B	EXMH160	MH2					0.97		0.00	0.00	1.70	13.74	0.00	3.54	12.78	1.45	14.23	67.56	91.50	107.20	0.00	1,257.24	379.36		1,636.60	3,006.86	118.40	1650	0.10	1.362	1370.26	45.57%
River Road		MH2	MH3							0.00	0.00	0.00	13.74	0.00	3.54	14.23	1.15	15.37	63.66	86.14	100.89	0.00	1,183.64	357.06		1,540.70	3,006.86	93.83	1650	0.10	1.362	1466.16	48.76%
Borbridge Avenue	EXT-2	CAP	MH3				1.86	0.60		3.26	3.26	1.05	1.05	0.00	0.00	12.56	0.21	12.77	68.21	92.39	108.24	222.21	97.08	0.00		319.29	572.93	25.02	600	0.80	1.963	253.64	44.27%
River Road		MH3	MH4							0.00	3.26	0.00	14.79	0.00	3.54	15.37	1.49	16.87	60.90	82.37	96.45	198.38	1,218.32	341.34		1,758.04	3,792.13	129.25	1800	0.10	1.444	2034.09	53.64%
Capricorn Circle	EXT-3, 83	CAP	MH4				8.34	0.32		14.61	14.61	0.56	0.56	0.00	0.00	16.67	0.22	16.89	58.09	78.53	91.94	848.57	44.01	0.00		892.58	1,117.30	22.89	900	0.35	1.701	224.72	20.11%
Street No. 3 West		MH4	MH154				0.28	0.28		0.49	18.35	0.49	15.84	0.00	3.54	16.87	0.26	17.12	57.69	77.98	91.29	1,058.82	1,235.29	323.06		2,617.18	3,792.13	22.11	1800	0.10	1.444	1174.95	30.98%
Street No. 3 West	154	MH154	CAP				2.05			3.59	21.95	0.00	15.84	0.00	3.54	17.12	1.36	18.48	57.17	77.28	90.47	1,254.71	1,224.20	320.15		2,799.06	3,792.13	117.91	1800	0.10	1.444	993.07	26.19%
Atrium Ridge	EXT-4	CAP	MH11				103.76	2.60		181.73	181.73	4.55	4.55	0.00	0.00	33.75	0.08	33.83	36.97	49.75	58.15	6,718.47	226.56	0.00		6,945.03	14,807.43	9.29	3000	0.10	2.029	7862.40	53.10%
Street No. 1 West	11	MH11	CAP				1.22			2.14	183.86	0.00	4.55	0.00	0.00	33.83	1.33	33.75	36.91	49.68	58.06	6,786.97	226.21	0.00		7,013.18	14,807.43	162.00	3000	0.10	2.029	7794.25	52.64%
South Outlet																																	
River Road	EXT-6		MH28				17.38			30.44	30.44	0.00	0.00	0.00	0.00	16.67			58.09	78.53	91.94	1,768.36	0.00	0.00		1,768.36							
River Road		MH28	MH29							0.00	30.44	0.00	0.00	0.00	0.00	16.67	1.05	17.72	58.09	78.53	91.94	1,768.36	0.00	0.00		1,768.36	4,486.91	107.73	1800	0.14	1.708	2718.55	60.59%
Solarium Avenue	EXT-5	CAP	MH29				122.85	2.77		215.16	245.60	4.85	4.85	0.00	0.00	23.33	0.27	23.60	47.22	63.69	74.51	11,597.38	309.00	0.00		11,906.38	14,807.43	33.00	3000	0.10	2.029	2901.05	19.59%
River Road		MH30	MH29							0.00	0.00	0.00	0.00	0.00	0.00	10.00	1.65	11.65	76.81	104.19	122.14	0.00	0.00	0.00		0.00	129.34	112.57	375	0.50	1.134	129.34	100.00%
		MH29	CAP							0.00	276.04	0.00	4.85	0.00	0.00	23.60	1.17	24.78	46.87	63.22	73.95	12,938.66	306.70	0.00		13,245.36	14,807.43	142.90	3000	0.10	2.029	1562.08	10.55%
Roadside Ditch Conveyance																																	
Culvert STA 1+280	S1B, S2B*	MHA	Outlet																						190*	325.00	2,178.02	28.32	900	1.33	3.317	1853.02	85.08%
Culvert STA 1+680	S3B, XS4B*	DICB3	DICB4																						137*	150.00	162.91	23.00	450	0.30	0.992	12.91	7.93%
	S3A, XS4A*	DICB4	MHB																						116*	311.00	350.85	70.37	600	0.30	1.202	39.85	11.36%
		MHB	MHC																							311.00	350.85	41.32	600	0.30	1.202	39.85	11.36%
		MHC	HW42																							311.00	350.85	22.06	600	0.30	1.202	39.85	11.36%

Definitions:
Q = 2.78CiA, where:
Q = Peak Flow in Litres per Second (L/s)
A = Area in Hectares (Ha)
i = Rainfall intensity in millimeters per hour (mm/hr)
[i = 732.951 / (TC+6.199)^0.810] 2 YEAR
[i = 998.071 / (TC+6.053)^0.814] 5 YEAR
[i = 1174.184 / (TC+6.014)^0.816] 10 YEAR

Notes:
1. Mannings coefficient (n) = 0.013

* Drainage Areas per Figure 4.3 and 100 year flows from Table 4.2 of the Design Brief

Designed: LME

Checked:

Dwg. Reference: 114373-500

No.	Revision	Date
1.	City submission No. 1	27-04-2018
2.	City submission No. 2	03-07-2018
3.	City submission No. 3	20-08-2018

File Reference:	Date:	Sheet No:
114373.5.7.1	8/20/2018	1 of 1

Inlet Time

External Draiinage Area	Length of Pipe Upstream (m)	Velocity (m/s)	Travel Time (min)	Inlet Time (min)
EXT-1	250	1.50	2.78	12.78
EXT-2	230	1.50	2.56	12.56
EXT-3	600	1.50	6.67	16.67
EXT-4	2,850	2.00	23.75	33.75
EXT-5	1,600	2.00	13.33	23.33
EXT-6	600	1.50	6.67	16.67

STORM SEWER DESIGN SHEET

NOVATECH
Engineers, Planners & Landscape Architects

Novatech Project #: 116037
Project Name: Wright Lands
Date Prepared: 7/23/2020
Date Revised:
Input By: Ben Sweet
Reviewed By: Sam Bahia
Drawing Reference: FIG 3.1, FIG 4.1

Legend:
PROJECT SPECIFIC INFO
USER DESIGN INPUT
CUMILATIVE CELL
CALCULATED DESIGN CELL OUTPUT
USER AS-BUILT INPUT

LOCATION			DEMAND																	CAPACITY								
			AREA								FLOW									PROPOSED SEWER PIPE SIZING / DESIGN								
STREET	FROM MH	TO MH	AREA ID	FUTURE	EXTERNAL	FRONT YARD / ROAD	REAR YARD	PARK	TOTAL AREA	WEIGHTED RUNOFF COEFFICIENT	INDIVI 2.78 AR	ACCUM 2.78 AR	TIME OF CONC	RAIN INTENSITY (mm/hr)			PEAK FLOW	TOTAL UNCONTROLLED PEAK FLOW (QDesign)	TOTAL RESTRICTED PEAK FLOW (Q)	PIPE PROPERTIES					CAPACITY	FULL FLOW VELOCITY	TIME OF FLOW	QPEAK DESIGN / QFULL
														2yr	5yr	100yr				LENGTH	SIZE / MATERIAL	ID ACTUAL	ROUGHNESS	DESIGN GRADE				
				0.63	0.45	0.70	0.45	0.25	(ha)				(min.)				(L/s)	(L/s)	(L/s)	(m)	(mm / type)	(m)		(%)	(L/s)	(m/s)	(min.)	(%)
ONSITE SEWERS TO PROPOSED MH100																												
ALPHON LANDS FUTURE DEVELOPMENT [1]	CAP	18	B-01	7.52					7.52 0.00 0.00	0.63	13.17 0.00 0.00	13.17 0.00 0.00	17.50 17.50 17.50	56.43			743.27 0.00 0.00	743.3		SEWERS BY OTHERS								
STREET 1	18	16	A-01			0.33			0.33 0.00 0.00	0.70	0.64 0.00 0.00	13.81 0.00 0.00	17.50 17.50 17.50	56.43			779.51 0.00 0.00	779.5		50.1	1200 CONC	1.2192	0.013	0.20	1819.0	1.56	0.54	42.9%
	16	14	-						0.00 0.00 0.00		0.00 0.00 0.00	13.81 0.00 0.00	18.04 18.04 18.04	55.42			765.52 0.00 0.00	765.5		92.7	1200 CONC	1.2192	0.013	0.20	1819.0	1.56	0.99	42.1%
	14	12	A-02, A-03			0.41	0.46		0.87 0.00 0.00	0.57	1.37 0.00 0.00	15.19 0.00 0.00	19.03 19.03 19.03	53.65			814.73 0.00 0.00	814.7		14.4	1200 CONC	1.2192	0.013	0.20	1819.0	1.56	0.15	44.8%
	12	10	-						0.00 0.00 0.00		0.00 0.00 0.00	15.19 0.00 0.00	19.18 19.18 19.18	53.39			810.72 0.00 0.00	810.7		27.1	1200 CONC	1.2192	0.013	0.20	1819.0	1.56	0.29	44.6%
	10	8	A-04				0.50		0.50 0.00 0.00	0.45	0.63 0.00 0.00	15.81 0.00 0.00	19.47 19.47 19.47	52.90			836.39 0.00 0.00	836.4		32.1	1200 CONC	1.2192	0.013	0.20	1819.0	1.56	0.34	46.0%
	8	6	A-05, A-06			0.19	0.32		0.51 0.00 0.00	0.54	0.77 0.00 0.00	16.58 0.00 0.00	19.81 19.81 19.81	52.33			867.73 0.00 0.00	867.7		30.9	1200 CONC	1.2192	0.013	0.20	1819.0	1.56	0.33	47.7%
ALPHON LANDS FUTURE DEVELOPMENT [1]	CAP	76	B-02, B-04, EXT-01	2.54	1.83				4.37 0.00 0.00	0.55	6.74 0.00 0.00	6.74 0.00 0.00	15.00 15.00 15.00	61.77			416.18 0.00 0.00	416.2		SEWERS BY OTHERS								
STREET 1	76	78	A-07			0.21			0.21 0.00 0.00	0.70	0.41 0.00 0.00	7.15 0.00 0.00	15.00 15.00 15.00	61.77			441.42 0.00 0.00	441.4		59.6	750 CONC	0.762	0.013	0.20	519.4	1.14	0.87	85.0%
	78	6	A-08			0.17			0.17 0.00 0.00	0.70	0.33 0.00 0.00	7.48 0.00 0.00	15.87 15.87 15.87	59.78			447.02 0.00 0.00	447.0		37.7	825 CONC	0.8382	0.013	0.20	669.7	1.21	0.52	66.7%
STREET 1	6	4	A-09, A-10, EXT-02		0.15	0.11	0.24		0.50 0.00 0.00	0.51	0.70 0.00 0.00	24.76 0.00 0.00	20.15 20.15 20.15	51.80			1282.58 0.00 0.00	1282.6		36.5	1350 CONC	1.3716	0.013	0.20	2490.2	1.69	0.36	51.5%
	4	2	A-11			0.21			0.21 0.00 0.00	0.70	0.41 0.00 0.00	25.17 0.00 0.00	20.51 20.51 20.51	51.23			1289.45 0.00 0.00	1289.5		41.9	1350 CONC	1.3716	0.013	0.20	2490.2	1.69	0.41	51.8%
	2	100	-						0.00 0.00 0.00		0.00 0.00 0.00	25.17 0.00 0.00	20.92 20.92 20.92	50.60			1273.47 0.00 0.00	1273.5		22.7	1350 CONC	1.3716	0.013	0.20	2490.2	1.69	0.22	51.1%
OFFSITE SEWERS TO EXISTING MH28																												
RIVER ROAD [2]	CAP	100	-						0.00 0.00 0.00		0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00				0.00 0.00 0.00	0.0		SEWERS BY OTHERS								
RIVER ROAD [2]	100	EX MH28	-		3.22		3.22		6.44 0.00 0.00	0.45	8.06 0.00 0.00	33.23 0.00 0.00	21.15 21.15 21.15	50.26			1669.91 0.00 0.00	1669.9		150.0	1800 CONC	1.8034	0.013	0.10	3653.3	1.43	1.75	45.7%

DEMAND EQUATION
Q = 2.78 AIR

Where : Q = Peak flow in litres per second (L/s)
A = Area in hectares (ha)
R = Weighted runoff coefficient (increased by 25% for 100-year)
I = Rainfall intensity in millimeters per hour (mm/hr)
Rainfall Intensity (I) is based on City of Ottawa IDF data presented in the City of Ottawa Sewer Design Guidelines (Oct. 2012)

CAPACITY EQUATION
Q full= (1/n) A R^(2/3)So^(1/2)

Where : Q full = Capacity (L/s)
n = Manning coefficient of roughness (0.013)
A = Flow area (m²)
R = Wetter perimenter (m)
So = Pipe Slope/gradient

NOTE(S)
[1] EXTERNAL FLOWS FROM ALPHON LANDS (FUTURE DEVELOPMENT) TO BE CONFIRMED AS PART OF DETAILED DESIGN.
[2] EXTERNAL FLOWS FROM RIVER ROAD STORM DRAINAGE AREA TO REMAIN WITHIN THE ROADSIDE DITCH PER DESIGN BRIEF - RIVER ROAD RECONSTRUCTION SUMMERHILL STREET TO SOUTH OF SOLARIUM AVENUE (IBI, AUGUST 2018).

788-790 River Road - Wright Lands (116037)
Post-Development Model Parameters

NOVATECH
Engineers, Planners & Landscape Architects

Area ID	Catchment Area (ha)	Runoff Coefficient (C)	Percent Impervious (%)	No Depression (%)	Flow Path Length (m)	Equivalent Width (m)	Average Slope (%)
Controlled to River Road Storm Sewer							
A-01	0.33	0.70	71%	30%	20	165	0.5%
A-02	0.46	0.45	36%	100%	20	230	0.5%
A-03	0.41	0.70	71%	30%	20	205	0.5%
A-04	0.50	0.45	36%	100%	125	40	0.5%
A-05	0.32	0.45	36%	100%	20	160	0.5%
A-06	0.19	0.70	71%	25%	15	127	0.5%
A-07	0.21	0.70	71%	30%	20	105	0.5%
A-08	0.17	0.70	71%	25%	25	68	0.5%
A-09	0.24	0.45	36%	100%	20	120	0.5%
A-10	0.11	0.70	71%	25%	15	73	0.5%
A-11	0.21	0.70	71%	20%	25	84	0.5%
B-01	7.52	0.63	61%	40%	415	181	0.5%
B-02	0.18	0.45	36%	100%	45	40	0.5%
B-04	2.54	0.63	61%	40%	350	73	0.5%
EXT-01	1.65	0.45	36%	100%	30	550	0.5%
EXT-02	0.15	0.45	36%	100%	50	30	0.5%
Subtotal	*15.19*	*0.60*	*57%*	-	-	-	-
Uncontrolled Areas to Rideau River/Ravine							
U-01	0.06	0.20	0%	0%	10	60	0.5%
U-02	0.72	0.20	0%	0%	30	240	0.5%
U-03	0.93	0.20	0%	0%	70	133	0.5%
U-04	0.04	0.70	71%	0%	35	11	0.5%
Subtotal	*1.75*	*0.21*	*2%*	-	-	-	-
TOTAL:	**16.94**	**0.56**	**51%**	**-**	**-**	**-**	**-**

788-790 River Road - Wright Lands (116037)
Conceptual PCSWMM Model - Orifice Sizing

NOVATECH
Engineers, Planners & Landscape Architects

Equivalent Orifice Sizing

Name	Inlet / Outlet Node	Area ID	Drainage Area (ha)	Static Ponding Depth (m)	2-year Flow Rate[1] (L/s)	Artificial Orific Dia.[2] (m)
Orifices (CB's In-Sag)						
O-CB02	MH78	A-07, A-09	0.45	0.13	42.9	0.131
O-CB03	MH76	A-08 & A-10	0.28	0.30	50.7	0.142
O-CB04	MH10	A-04, A-05 & A-06	1.01	0.17	98.6	0.198
O-CB05	MH14	A-03	0.41	0.20	62.8	0.158
O-CB06	MH18	A-01 & A-02	0.79	0.20	86.0	0.185
Outlets (CB's On-Grade)						
O-CB01	MH04	A-11	0.21	-	32.1	-
TOTAL			**3.15**	**-**	**373.1**	**-**

[1] *Flow rate = 2-year Flow Rate in PCSWMM to CB*

[2] *Equivalent orifice diameter corresponding to 2-year flow rate; based on 1.40m of head (CB T/G - CB Inv.)*

Date: 7/21/2020
\\novatech2018\nova2\2016\116037\DATA\Calculations\Sewer Calcs\SWM\116037-Orifice Sizing.xlsx

788-790 River Road - Wright Lands (116037)
Conceptual PCSWMM Model - Outlet Curve Sizing

Engineers, Planners & Landscape Architects

Conceptual Release Rates for Alphon Site

Name	Inlet / Outlet Node	Area ID	Drainage Area (ha)	Static Ponding Depth (m)	2-year Flow Rate[1] (L/s)	Assumed Number of Inlets[2]	Inlet Flow Rate (L/s/inlet)
O-CB07	MH18	B-01	7.52	0.30	623.5	30	20.8
O-CB08	MH76	B-02 & B-04	2.72	0.30	241.9	11	22.0
TOTAL			**10.24**	**-**	**865.4**	**41**	**21.4**

[1] *Flow rate = 2-year Flow Rate in PCSWMM to CB*

[2] *Assume 4 inlets per hectare for Alphon Site*

Conceptual Outlet Curves for Alphon Site

For Single Inlet		For O-CB07 (30 Inlets)		For O-CB08 (11 Inlets)	
Head (m)	**Release Rate (L/s)**	**Head (m)**	**Release Rate (L/s)**	**Head (m)**	**Release Rate (L/s)**
0.00	0.0	0.00	0.0	0.00	0.0
0.50	12.4	0.50	372.0	0.50	136.4
1.00	17.9	1.00	537.0	1.00	196.9
1.40	21.4	1.40	642.0	1.40	235.4
1.70	23.6	1.70	708.0	1.70	259.6
2.40	23.6	2.40	708.0	2.40	259.6

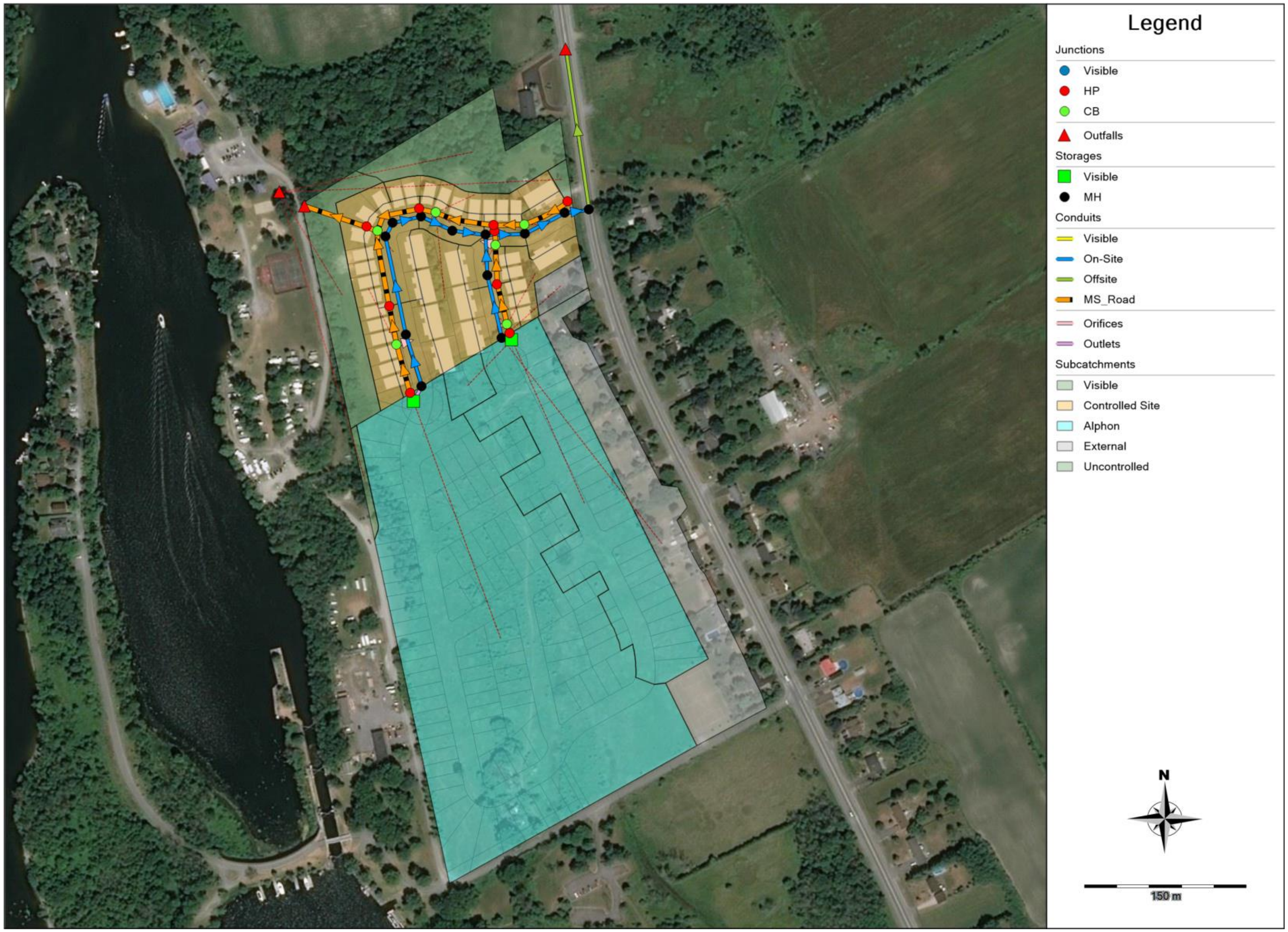
Date: 7/21/2020
\\novatech2018\nova2\2016\116037\DATA\Calculations\Sewer Calcs\SWM\116037-Orifice Sizing.xlsx

788-790 River Road - Wright Lands (116037)
100-year HGL Elevations

MH ID	Pipe / MH / USF Information				HGL Information[1]		Surcharge Depth Above Pipe Obvert		Clearance from T/G		Minimum USF Elevation
	D/S Pipe Size	D/S Pipe Invert Elev.	D/S Pipe Obvert Elev.	MH T/G Elev.	100-year	100-year (+20%)	100-year	100-year (+20%)	100-year	100-year (+20%)	
	(mm)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
MH02	1350	83.56	84.91	89.22	85.57	85.76	0.66	0.85	3.65	3.46	85.87
MH04	1350	83.67	85.02	88.87	85.63	85.83	0.61	0.81	3.24	3.04	85.93
MH06	1350	83.77	85.12	89.06	85.69	85.90	0.57	0.78	3.37	3.16	85.99
MH08	1200	83.99	85.19	88.81	85.71	85.92	0.52	0.73	3.10	2.89	86.01
MH10	1200	84.08	85.28	88.93	85.74	85.95	0.46	0.67	3.19	2.98	86.04
MH12	1200	84.16	85.36	88.76	85.76	85.97	0.40	0.61	3.00	2.79	86.06
MH14	1200	84.22	85.42	88.73	85.78	85.99	0.36	0.57	2.95	2.74	86.08
MH16	1200	84.44	85.64	88.85	85.83	86.05	0.19	0.41	3.02	2.80	86.13
MH18	1200	84.57	85.77	89.04	85.85	86.07	0.08	0.30	3.19	2.97	86.15
MH76	750	85.03	85.78	88.90	86.31	86.74	0.53	0.96	2.59	2.16	86.61
MH78	825	84.80	85.63	89.09	85.99	86.30	0.36	0.67	3.10	2.79	86.29
MH100	1800	83.00	84.80	89.50	85.46	85.63	0.66	0.83	4.04	3.87	85.76

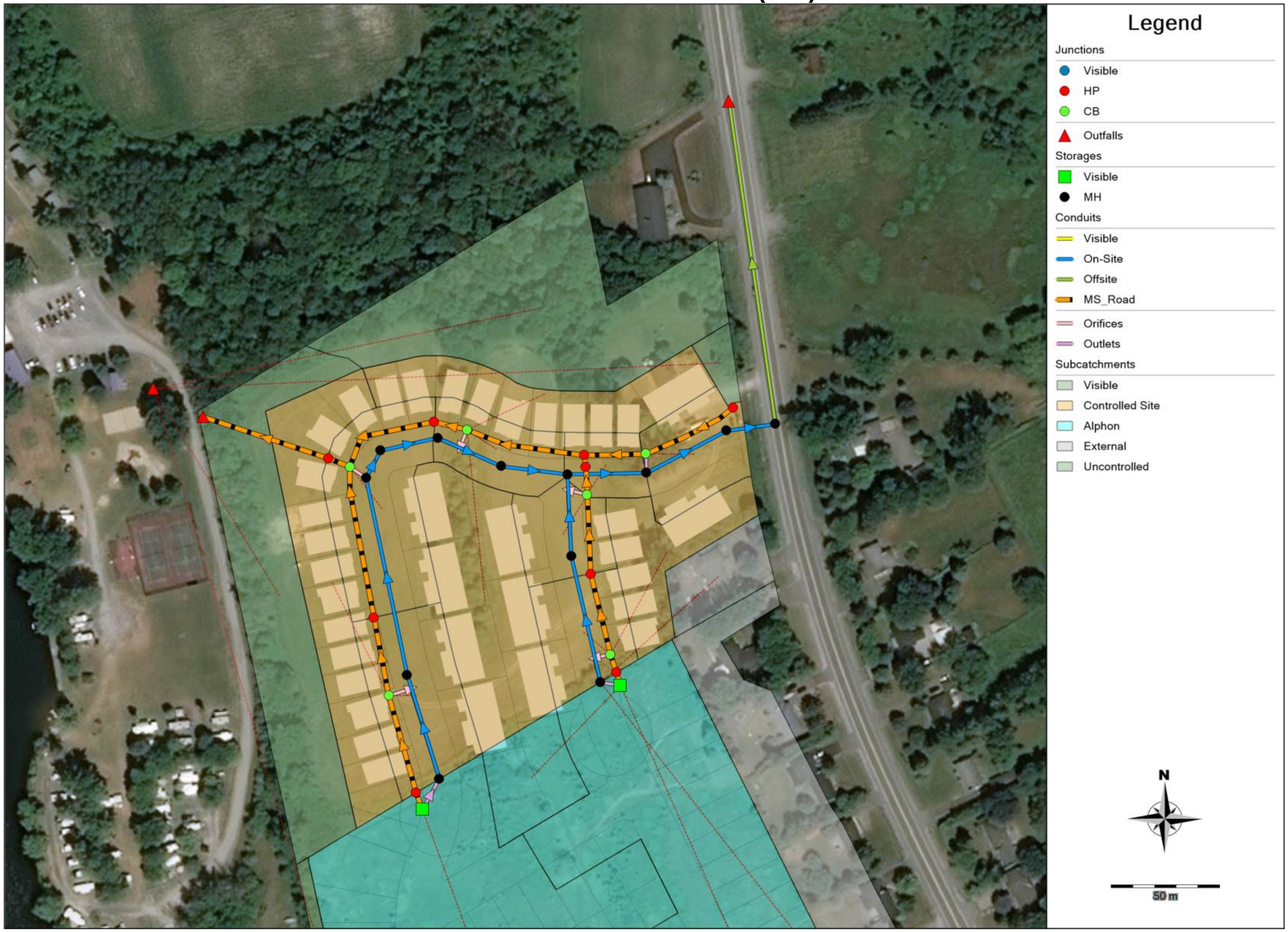
(1) *HGL information is for a 3-hour Chicago Storm Distribution; based on a fixed outfall elevation of 85.40m and 85.56m for the 100-year and 100-year (+20%), respectively*

Overall Model Schematic



Date: 2020-07-21
M:\2016\116037\DATA\Calculations\Sewer Calcs\SWM\PCSWMM\116037-PCSWMM Model Schematics.docx

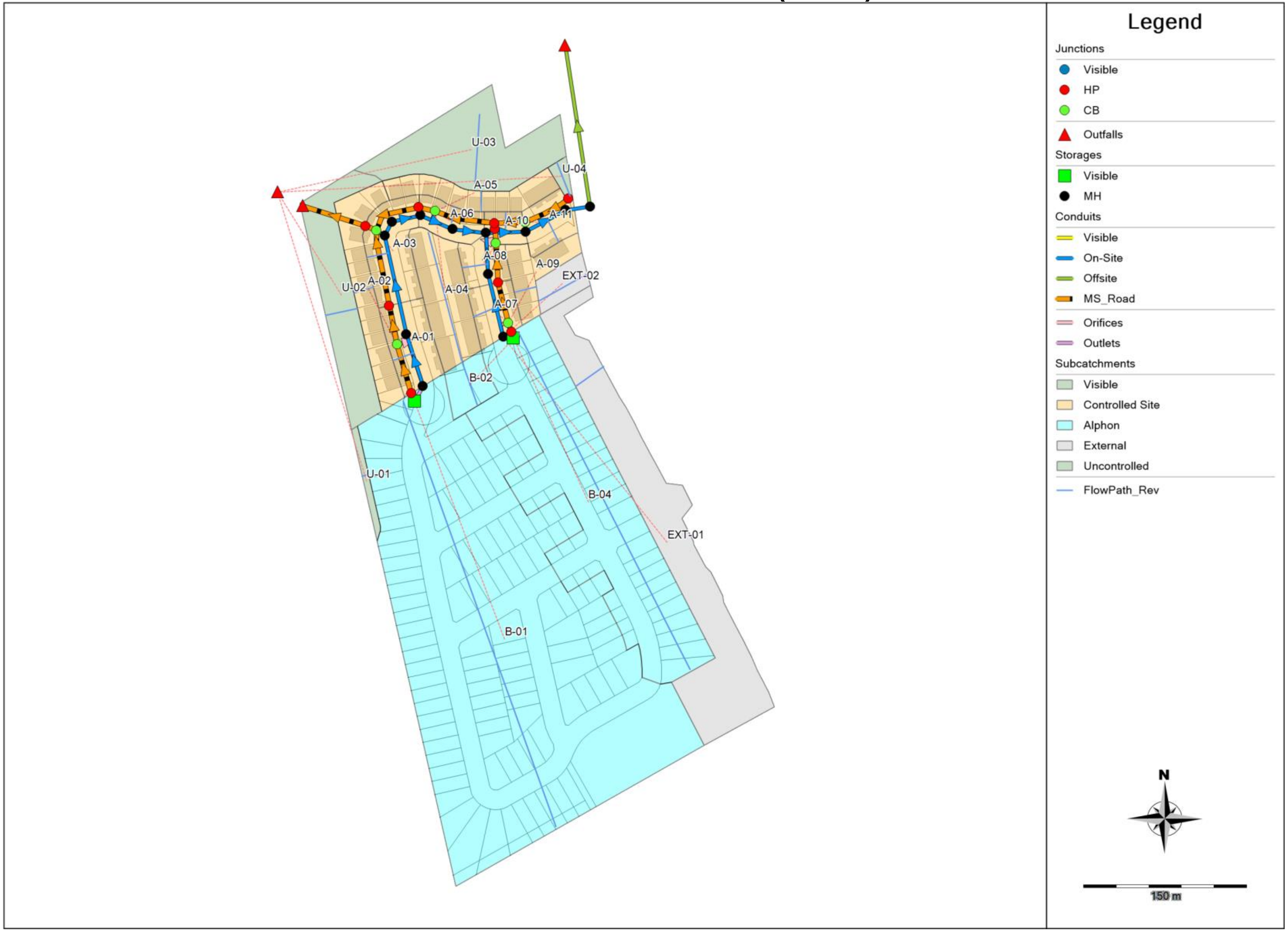
Overall Model Schematic (Site)



788-790 River Road - Wright Lands (116037)
PCSWMM Model Schematics

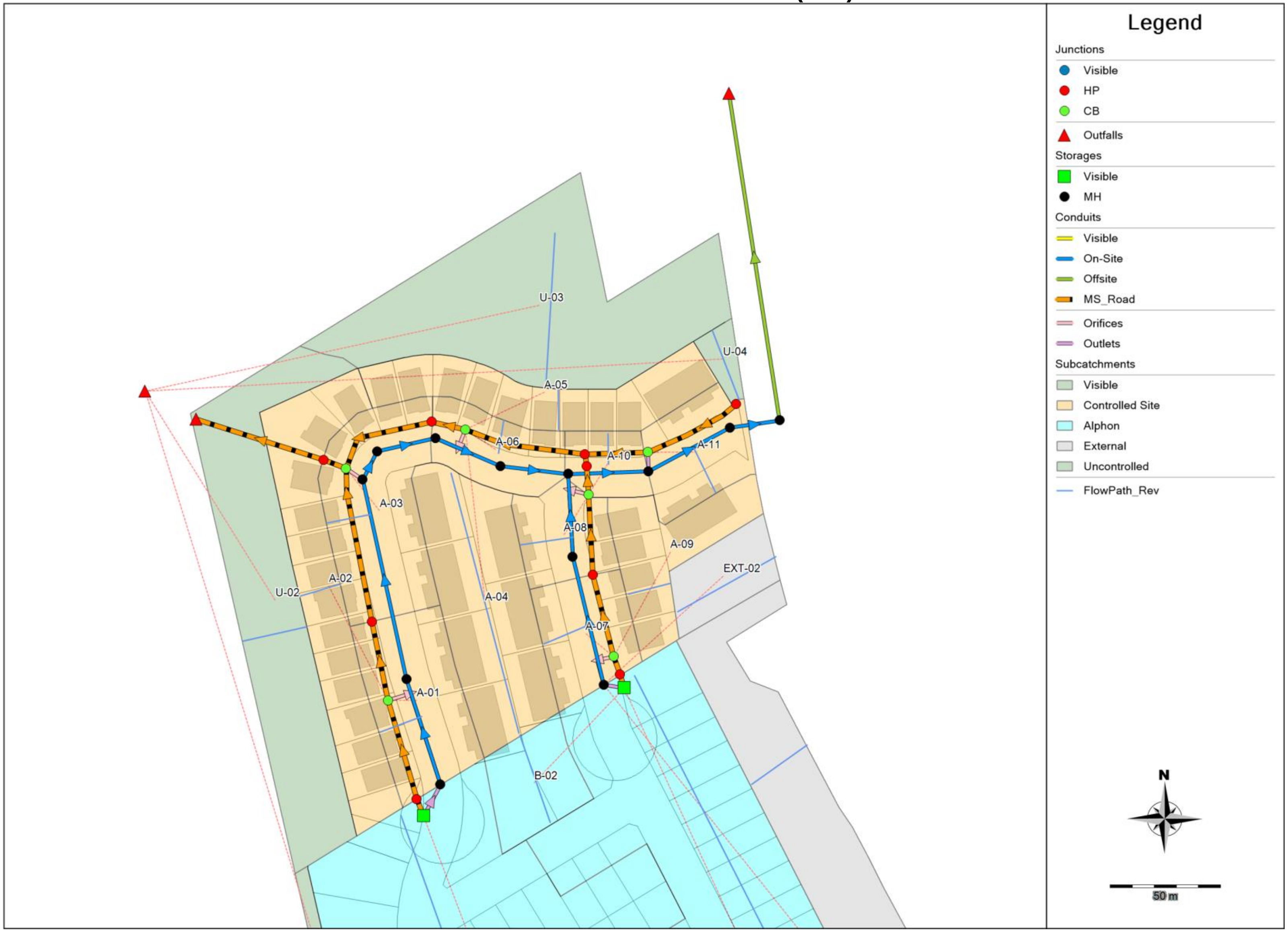
NOVATECH
Engineers, Planners & Landscape Architects

Subcatchments and Flow Paths (Overall)



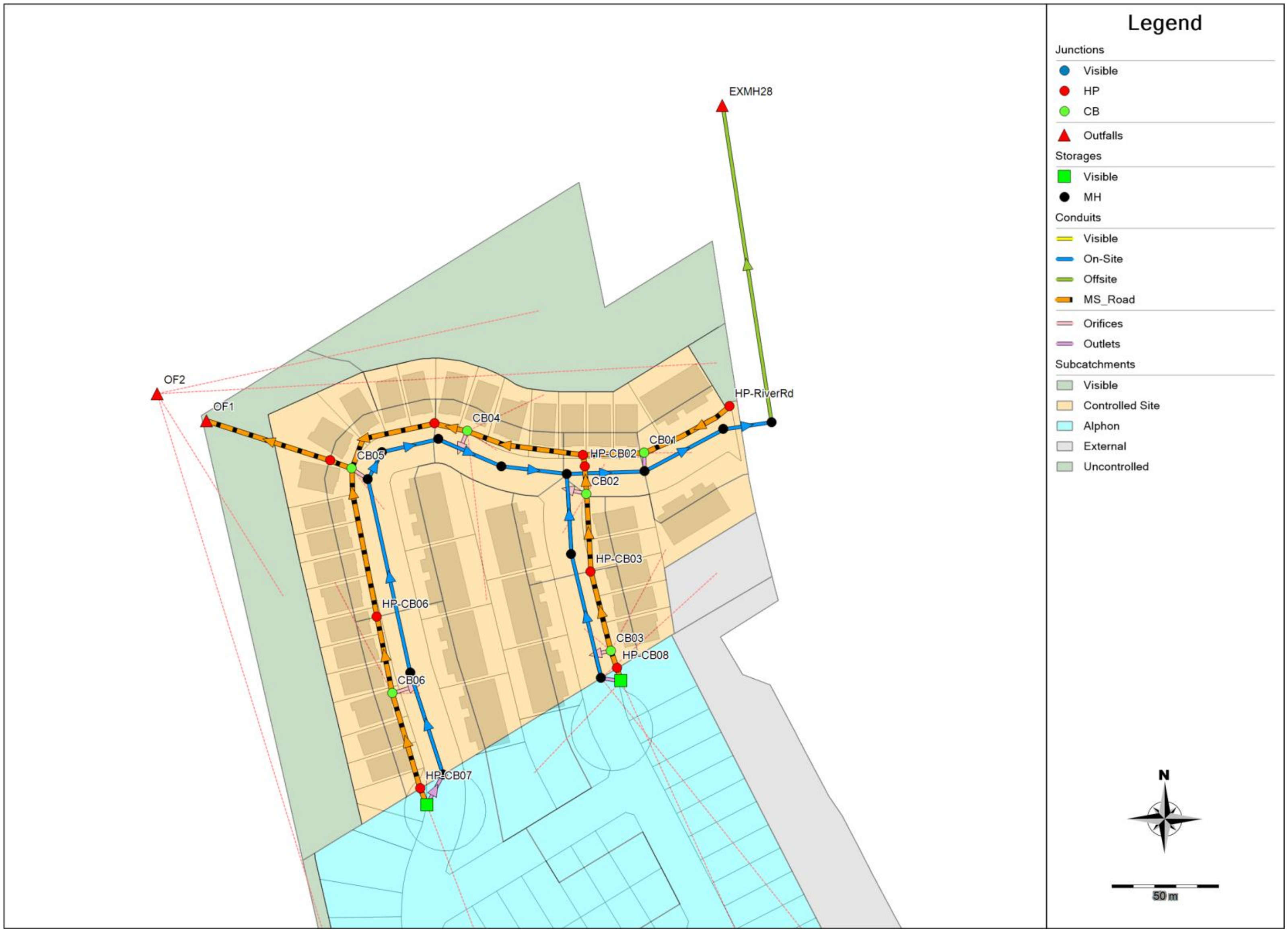
Date: 2020-07-21
M:\2016\116037\DATA\Calculations\Sewer Calcs\SWM\PCSWMM\116037-PCSWMM Model Schematics.docx

Subcatchments and Flow Paths (Site)



788-790 River Road - Wright Lands (116037)
PCSWMM Model Schematics

Junctions and Outfalls

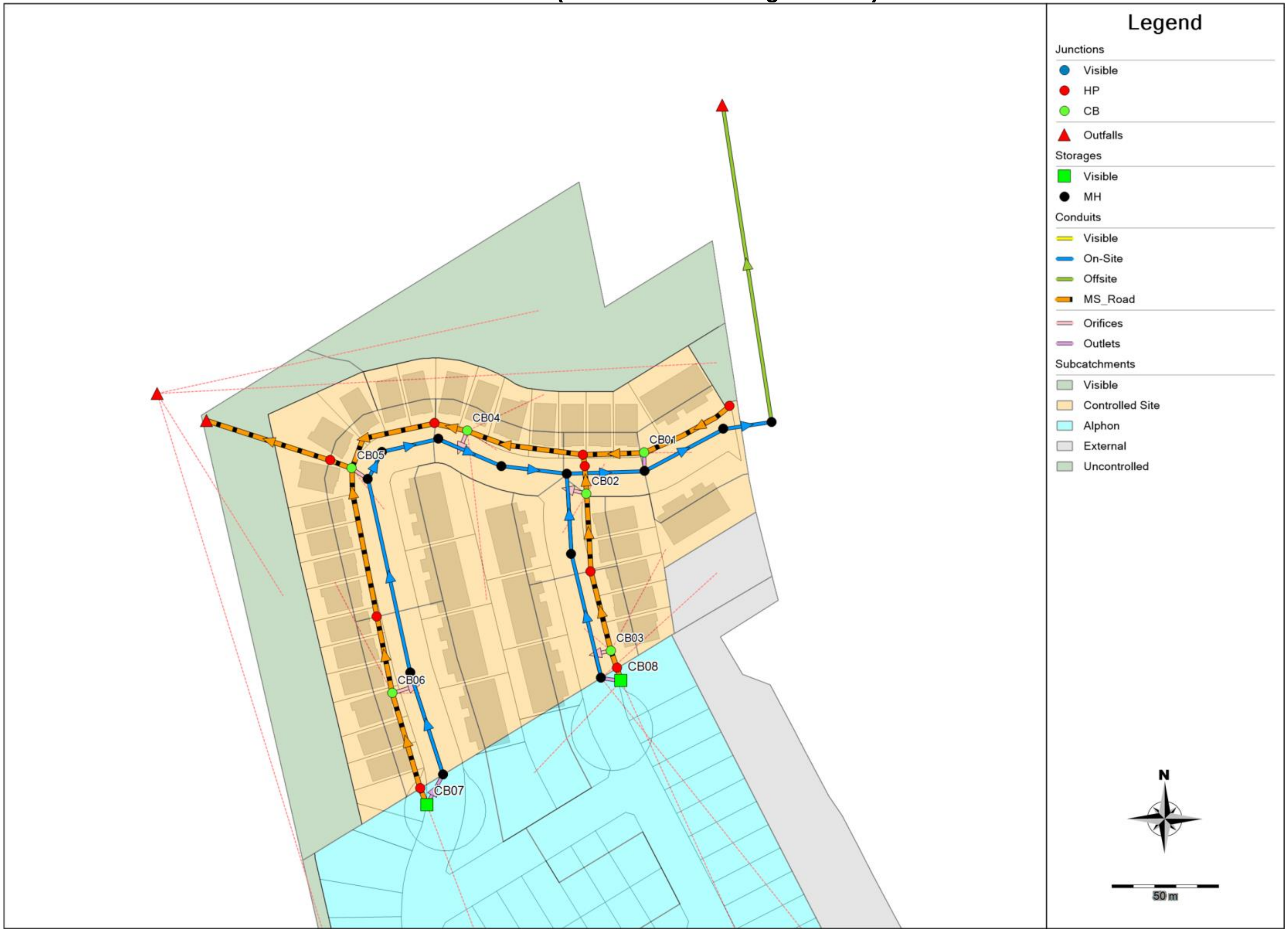


Date: 2020-07-21
M:\2016\116037\DATA\Calculations\Sewer Calcs\SWM\PCSWMM\116037-PCSWMM Model Schematics.docx

788-790 River Road - Wright Lands (116037)
PCSWMM Model Schematics

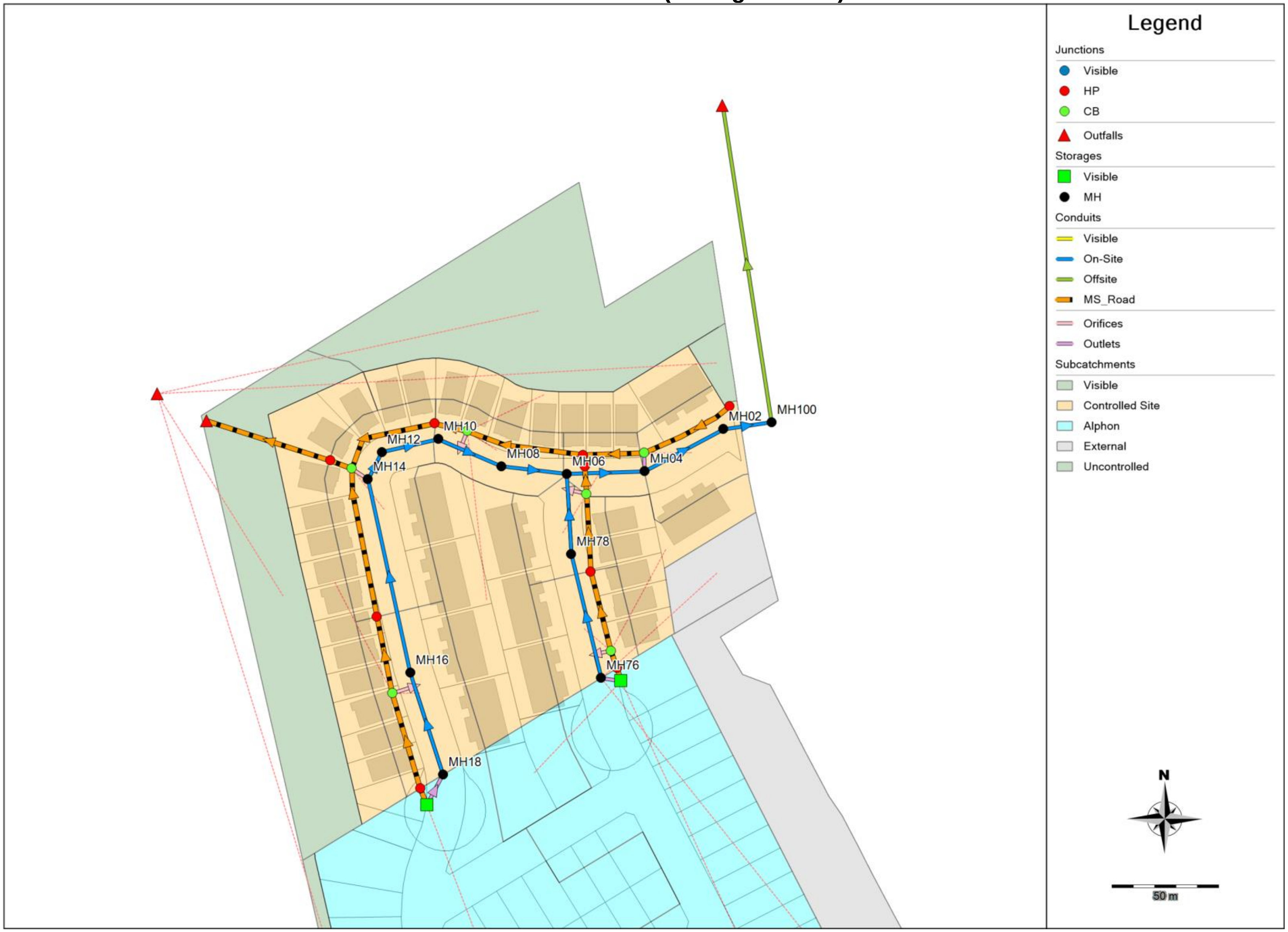
NOVATECH
Engineers, Planners & Landscape Architects

Catchbasins (Junctions & Storage Nodes)



Date: 2020-07-21
M:\2016\116037\DATA\Calculations\Sewer Calcs\SWM\PCSWMM\116037-PCSWMM Model Schematics.docx

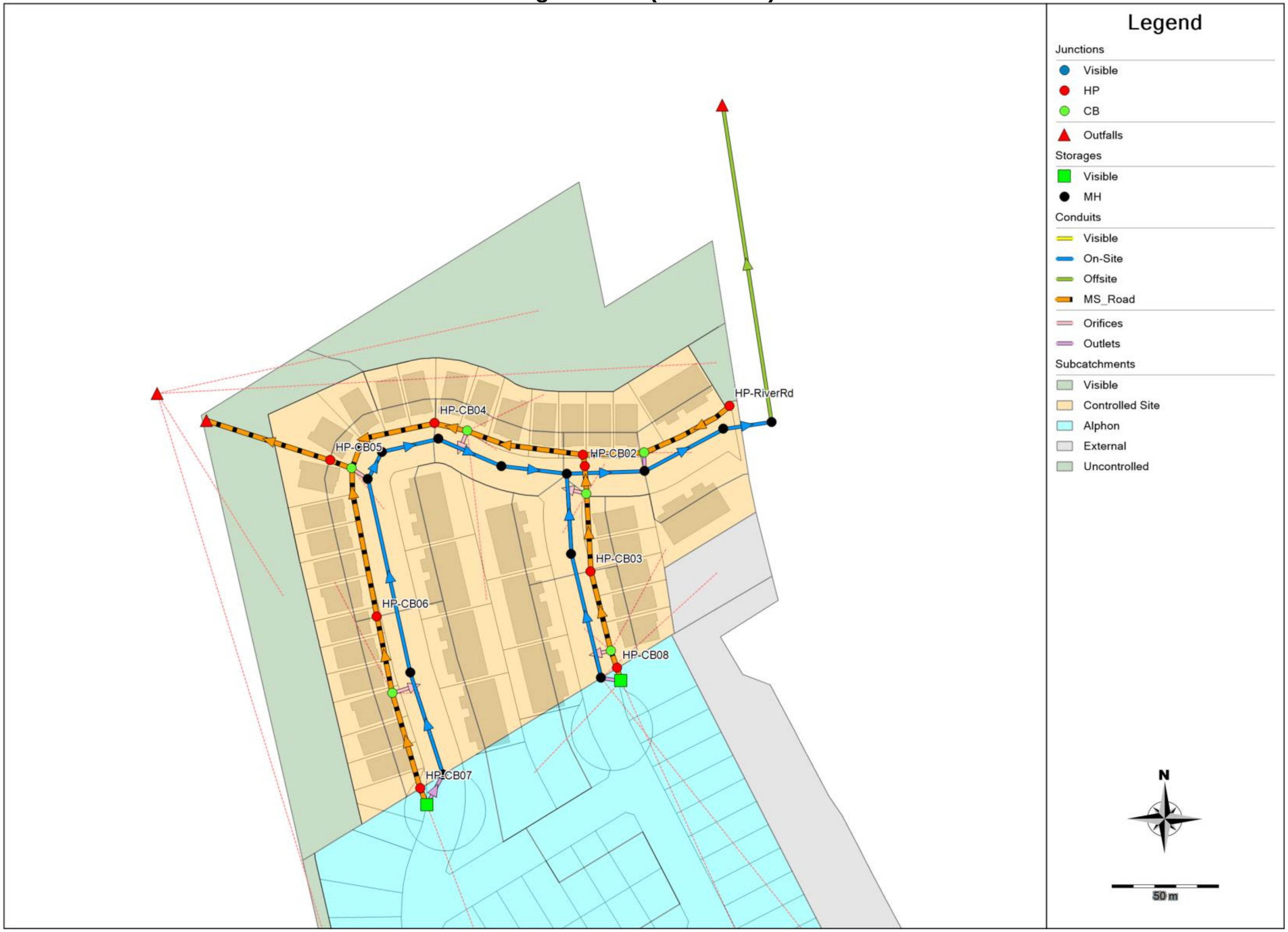
Maintenance Holes (Storage Nodes)



788-790 River Road - Wright Lands (116037)
PCSWMM Model Schematics

NOVATECH
Engineers, Planners & Landscape Architects

High Points (Junctions)



Date: 2020-07-21
M:\2016\116037\DATA\Calculations\Sewer Calcs\SWM\PCSWMM\116037-PCSWMM Model Schematics.docx

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)
--------------------------------------------------------------

Boundary condition
100-year = 85.40
100-year +20% = 85.56

WARNING 02: maximum depth increased for Node CB03
WARNING 02: maximum depth increased for Node CB04
WARNING 02: maximum depth increased for Node CB05

*************
Element Count
*************
Number of rain gages ...... 1
Number of subcatchments ... 20
Number of nodes ........... 32
Number of links ........... 37
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Raingage Summary
****************
                                                    Data       Recording
Name                 Data Source                    Type       Interval
------------------------------------------------------------------------
RG1                  C3hr-2yr                       INTENSITY   10 min.


********************
Subcatchment Summary
********************
Name                       Area     Width   %Imperv    %Slope Rain Gage            Outlet
-----------------------------------------------------------------------------------------------------------
A-01                       0.33    165.00     71.40    0.5000 RG1                  CB06
A-02                       0.46    230.00     35.70    0.5000 RG1                  CB06
A-03                       0.41    205.00     71.40    0.5000 RG1                  CB05
A-04                       0.50     40.00     35.70    0.5000 RG1                  CB04
A-05                       0.32    160.00     35.70    0.5000 RG1                  CB04
A-06                       0.19    126.67     71.40    0.5000 RG1                  CB04
A-07                       0.21    105.00     71.40    0.5000 RG1                  CB03
A-08                       0.17     68.00     71.40    0.5000 RG1                  CB02
A-09                       0.24    120.00     35.70    0.5000 RG1                  CB03
```

```
A-10                       0.11     73.33     71.40    0.5000 RG1                  CB02
A-11                       0.21     84.00     71.40    0.5000 RG1                  CB01
B-01                       7.52    181.21     61.40    0.5000 RG1                  CB07
B-02                       0.18     40.00     35.70    0.5000 RG1                  CB08
B-04                       2.54     72.57     61.40    0.5000 RG1                  CB08
EXT-01                     1.65    550.00     35.70    0.5000 RG1                  MH76
EXT-02                     0.15     30.00     35.70    0.5000 RG1                  MH76
U-01                       0.06     60.00      0.00    0.5000 RG1                  OF2
U-02                       0.72    240.00      0.00    0.5000 RG1                  OF2
U-03                       0.93    132.86      0.00    0.5000 RG1                  OF2
U-04                       0.04     11.43     71.40    0.5000 RG1                  OF2

************
Node Summary
************
                                         Invert      Max.    Ponded    External
Name                 Type                 Elev.     Depth      Area    Inflow
-------------------------------------------------------------------------------
CB01                 JUNCTION             87.96      1.00       0.0
CB02                 JUNCTION             86.34      2.40       0.0
CB03                 JUNCTION             86.22      2.40       0.0
CB04                 JUNCTION             86.02      2.40       0.0
CB05                 JUNCTION             86.02      2.40       0.0
CB06                 JUNCTION             86.17      2.40       0.0
HP-CB01              JUNCTION             87.74      1.00       0.0
HP-CB02              JUNCTION             87.87      1.00       0.0
HP-CB03              JUNCTION             87.92      1.00       0.0
HP-CB04              JUNCTION             87.59      1.00       0.0
HP-CB05              JUNCTION             87.62      1.00       0.0
HP-CB06              JUNCTION             87.77      1.00       0.0
HP-CB07              JUNCTION             88.17      1.00       0.0
HP-CB08              JUNCTION             88.17      1.00       0.0
HP-RiverRd           JUNCTION             89.18      1.00       0.0
EXMH28               OUTFALL              82.85      1.80       0.0
OF1                  OUTFALL              85.50      1.00       0.0
OF2                  OUTFALL              85.50      0.00       0.0
CB07                 STORAGE              86.47      2.40       0.0
CB08                 STORAGE              86.47      2.40       0.0
MH02                 STORAGE              83.56      5.66       0.0
MH04                 STORAGE              83.67      5.20       0.0
MH06                 STORAGE              83.77      5.29       0.0
MH08                 STORAGE              83.99      4.82       0.0
MH10                 STORAGE              84.08      4.85       0.0
MH100                STORAGE              83.00      6.50       0.0
MH12                 STORAGE              84.16      4.60       0.0
```

```
MH14             STORAGE          84.22      4.51       0.0
MH16             STORAGE          84.44      4.41       0.0
MH18             STORAGE          84.57      4.47       0.0
MH76             STORAGE          85.03      3.87       0.0
MH78             STORAGE          84.80      4.29       0.0


************
Link Summary
************
Name             From Node        To Node          Type            Length    %Slope Roughness
---------------------------------------------------------------------------------------------
MH02-MH100       MH02             MH100            CONDUIT           22.7    0.2199    0.0130
MH04-MH02        MH04             MH02             CONDUIT           41.9    0.1912    0.0130
MH06-MH04        MH06             MH04             CONDUIT           36.5    0.1920    0.0130
MH08-MH06        MH08             MH06             CONDUIT           30.9    0.1942    0.0130
Mh10-MH08        MH10             MH08             CONDUIT           32.1    0.1867    0.0130
MH12-MH10        MH12             MH10             CONDUIT           27.1    0.1846    0.0130
MH14-MH12        MH14             MH12             CONDUIT           14.4    0.2088    0.0130
MH16-MH14        MH16             MH14             CONDUIT           92.7    0.2051    0.0130
Mh18-MH16        MH18             MH16             CONDUIT           50.0    0.1998    0.0130
MH76-MH78        MH76             MH78             CONDUIT           59.6    0.2014    0.0130
MH78-MH06        MH78             MH06             CONDUIT           37.7    0.1857    0.0130
MS01             HP-CB05          OF1              CONDUIT           40.0    5.3075    0.0150
MS02             CB05             HP-CB05          CONDUIT           25.0   -0.8000    0.0150
MS03             HP-CB06          CB05             CONDUIT           66.0    0.5303    0.0150
MS04             CB06             HP-CB06          CONDUIT           40.0   -0.5000    0.0150
MS05             HP-CB07          CB06             CONDUIT           60.0    1.0001    0.0150
MS06             CB07             HP-CB07          CONDUIT           40.0   -0.7500    0.0150
MS07             HP-CB04          CB05             CONDUIT           35.0    0.4857    0.0150
MS08             CB04             HP-CB04          CONDUIT           20.0   -0.8500    0.0150
MS09             HP-CB01          CB04             CONDUIT           44.0    0.7273    0.0150
MS10             CB01             HP-CB01          CONDUIT           31.0    0.7097    0.0150
MS11             HP-CB02          HP-CB01          CONDUIT            4.3    3.0603    0.0150
MS12             CB02             HP-CB02          CONDUIT            4.3   -3.0603    0.0150
MS13             HP-CB03          CB02             CONDUIT           40.0    0.4500    0.0150
MS14             CB03             HP-CB03          CONDUIT           40.0   -0.7500    0.0150
MS15             HP-CB08          CB03             CONDUIT           54.0    1.0186    0.0150
MS16             CB08             HP-CB08          CONDUIT           40.0   -0.7500    0.0150
MS17             HP-RiverRd       CB01             CONDUIT           60.0    2.0338    0.0150
STM-OFFSITE-2-4_(STM-OFFSITE) MH100            EXMH28           CONDUIT          150.0    0.1000    0.0130
O-CB02           CB02             MH78             ORIFICE
O-CB03           CB03             MH76             ORIFICE
O-CB04           CB04             MH10             ORIFICE
O-CB05           CB05             MH14             ORIFICE
O-CB06           CB06             MH18             ORIFICE
```

```
O-CB01           CB01             MH04             OUTLET
O-CB07           CB07             MH18             OUTLET
O-CB08           CB08             MH76             OUTLET


*********************
Cross Section Summary
*********************
                                        Full     Full     Hyd.     Max.   No. of     Full
Conduit          Shape                 Depth     Area     Rad.    Width  Barrels     Flow
---------------------------------------------------------------------------------------
MH02-MH100       CIRCULAR               1.35     1.43     0.34     1.35        1  2502.92
MH04-MH02        CIRCULAR               1.35     1.43     0.34     1.35        1  2333.75
MH06-MH04        CIRCULAR               1.35     1.43     0.34     1.35        1  2338.82
MH08-MH06        CIRCULAR               1.20     1.13     0.30     1.20        1  1718.09
Mh10-MH08        CIRCULAR               1.20     1.13     0.30     1.20        1  1684.62
MH12-MH10        CIRCULAR               1.20     1.13     0.30     1.20        1  1675.37
MH14-MH12        CIRCULAR               1.20     1.13     0.30     1.20        1  1781.48
MH16-MH14        CIRCULAR               1.20     1.13     0.30     1.20        1  1765.55
Mh18-MH16        CIRCULAR               1.20     1.13     0.30     1.20        1  1742.80
MH76-MH78        CIRCULAR               0.75     0.44     0.19     0.75        1   499.65
MH78-MH06        CIRCULAR               0.82     0.53     0.21     0.82        1   618.57
MS01             RECT_OPEN              1.00     3.00     0.60     3.00        1 32779.35
MS02             RECT_OPEN              1.00     3.00     0.60     3.00        1 12726.50
MS03             18.0mROW               1.00    15.07     0.37    18.00        1 37645.24
MS04             18.0mROW               1.00    15.07     0.37    18.00        1 36553.81
MS05             18.0mROW               1.00    15.07     0.37    18.00        1 51695.86
MS06             18.0mROW               1.00    15.07     0.37    18.00        1 44769.44
MS07             18.0mROW               1.00    15.07     0.37    18.00        1 36027.82
MS08             18.0mROW               1.00    15.07     0.37    18.00        1 47660.90
MS09             18.0mROW               1.00    15.07     0.37    18.00        1 44085.86
MS10             18.0mROW               1.00    15.07     0.37    18.00        1 43549.27
MS11             18.0mROW               1.00    15.07     0.37    18.00        1 90432.34
MS12             18.0mROW               1.00    15.07     0.37    18.00        1 90432.34
MS13             18.0mROW               1.00    15.07     0.37    18.00        1 34677.95
MS14             18.0mROW               1.00    15.07     0.37    18.00        1 44769.44
MS15             18.0mROW               1.00    15.07     0.37    18.00        1 52172.38
MS16             18.0mROW               1.00    15.07     0.37    18.00        1 44769.44
MS17             18.0mROW               1.00    15.07     0.37    18.00        1 73721.49
STM-OFFSITE-2-4_(STM-OFFSITE) CIRCULAR             1.80     2.54     0.45     1.80        1  3635.06


****************
Transect Summary
****************
```

```
Transect 18.0mROW
Area:
            0.0009     0.0035     0.0078     0.0139     0.0217
            0.0313     0.0424     0.0539     0.0664     0.0802
            0.0953     0.1117     0.1292     0.1481     0.1682
            0.1895     0.2121     0.2359     0.2597     0.2836
            0.3075     0.3313     0.3552     0.3791     0.4029
            0.4268     0.4507     0.4746     0.4984     0.5223
            0.5462     0.5701     0.5939     0.6178     0.6417
            0.6656     0.6895     0.7133     0.7372     0.7611
            0.7850     0.8089     0.8328     0.8567     0.8805
            0.9044     0.9283     0.9522     0.9761     1.0000
Hrad:
            0.0262     0.0524     0.0787     0.1049     0.1311
            0.1573     0.1962     0.2469     0.2908     0.3274
            0.3577     0.3829     0.4038     0.4212     0.4357
            0.4478     0.4579     0.4670     0.4779     0.4901
            0.5034     0.5175     0.5323     0.5476     0.5632
            0.5793     0.5956     0.6121     0.6289     0.6458
            0.6629     0.6801     0.6974     0.7148     0.7323
            0.7498     0.7674     0.7851     0.8029     0.8206
            0.8384     0.8563     0.8742     0.8921     0.9100
            0.9280     0.9460     0.9640     0.9820     1.0000
Width:
            0.0728     0.1456     0.2184     0.2912     0.3640
            0.4368     0.4733     0.4996     0.5522     0.6047
            0.6573     0.7098     0.7624     0.8149     0.8675
            0.9201     0.9726     0.9989     0.9989     0.9990
            0.9990     0.9990     0.9991     0.9991     0.9991
            0.9992     0.9992     0.9992     0.9993     0.9993
            0.9994     0.9994     0.9994     0.9995     0.9995
            0.9995     0.9996     0.9996     0.9996     0.9997
            0.9997     0.9997     0.9998     0.9998     0.9998
            0.9999     0.9999     0.9999     1.0000     1.0000


*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
```

```
Flow Units ............... LPS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 05/01/2020 00:00:00
Ending Date .............. 05/02/2020 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00
Routing Time Step ........ 2.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 4
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         0.540        31.857
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.265        15.644
Surface Runoff ...........         0.269        15.865
Final Storage ............         0.007         0.434
Continuity Error (%) .....        -0.270


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.269         2.688
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         0.269         2.688
Flooding Loss ............         0.000         0.000
```

```
  Evaporation Loss .........         0.000         0.000
  Exfiltration Loss ........         0.000         0.000
  Initial Stored Volume ....         0.000         0.000
  Final Stored Volume ......         0.000         0.000
  Continuity Error (%) .....        -0.024


  ***************************
  Time-Step Critical Elements
  ***************************
  None


  ********************************
  Highest Flow Instability Indexes
  ********************************
  All links are stable.


  *************************
  Routing Time Step Summary
  *************************
  Minimum Time Step           :     1.50 sec
  Average Time Step           :     2.00 sec
  Maximum Time Step           :     2.00 sec
  Percent in Steady State     :     0.00
  Average Iterations per Step :     2.00
  Percent Not Converging      :     0.00


  ***************************
  Subcatchment Runoff Summary
  ***************************

  ------------------------------------------------------------------------------------------------------------------------------
                            Total      Total      Total      Total     Imperv       Perv      Total       Total     Peak  Runoff
                           Precip      Runon       Evap      Infil     Runoff     Runoff     Runoff      Runoff   Runoff   Coeff
  Subcatchment                 mm         mm         mm         mm         mm         mm         mm    10^6 ltr      LPS
  ------------------------------------------------------------------------------------------------------------------------------
  A-01                        31.86       0.00       0.00       9.10      22.12       0.03      22.15        0.07    50.54   0.695
  A-02                        31.86       0.00       0.00      20.47      11.41       0.03      11.44        0.05    35.45   0.359
  A-03                        31.86       0.00       0.00       9.10      22.12       0.03      22.15        0.09    62.79   0.695
  A-04                        31.86       0.00       0.00      20.48      11.46       0.00      11.47        0.06    37.12   0.360
  A-05                        31.86       0.00       0.00      20.47      11.41       0.03      11.44        0.04    24.66   0.359
  A-06                        31.86       0.00       0.00       9.09      22.04       0.04      22.08        0.04    29.17   0.693
  A-07                        31.86       0.00       0.00       9.10      22.12       0.03      22.15        0.05    32.16   0.695



  A-08                        31.86       0.00       0.00       9.10      22.08       0.02      22.10        0.04    25.98   0.694
  A-09                        31.86       0.00       0.00      20.47      11.41       0.03      11.44        0.03    18.50   0.359
  A-10                        31.86       0.00       0.00       9.09      22.04       0.04      22.08        0.02    16.89   0.693
  A-11                        31.86       0.00       0.00       9.10      22.03       0.02      22.05        0.05    32.09   0.692
  B-01                        31.86       0.00       0.00      12.30      19.05       0.00      19.05        1.43   621.21   0.598
  B-02                        31.86       0.00       0.00      20.48      11.45       0.01      11.46        0.02    13.77   0.360
  B-04                        31.86       0.00       0.00      12.30      19.07       0.00      19.07        0.48   226.88   0.599
  EXT-01                      31.86       0.00       0.00      20.47      11.43       0.02      11.45        0.19   126.66   0.359
  EXT-02                      31.86       0.00       0.00      20.48      11.45       0.01      11.47        0.02    11.46   0.360
  U-01                        31.86       0.00       0.00      31.83       0.00       0.06       0.06        0.00     0.11   0.002
  U-02                        31.86       0.00       0.00      31.85       0.00       0.02       0.02        0.00     0.44   0.001
  U-03                        31.86       0.00       0.00      31.85       0.00       0.01       0.01        0.00     0.24   0.000
  U-04                        31.86       0.00       0.00       9.10      21.82       0.02      21.84        0.01     6.08   0.686


  ******************
  Node Depth Summary
  ******************

  ---------------------------------------------------------------------------------
                                 Average  Maximum  Maximum  Time of Max    Reported
                                   Depth    Depth      HGL   Occurrence   Max Depth
  Node                 Type       Meters   Meters   Meters  days hr:min      Meters
  ---------------------------------------------------------------------------------
  CB01                 JUNCTION     0.00     0.03    87.99     0  01:10        0.03
  CB02                 JUNCTION     0.02     1.40    87.74     0  01:10        1.40
  CB03                 JUNCTION     0.02     1.40    87.62     0  01:10        1.40
  CB04                 JUNCTION     0.02     1.40    87.42     0  01:10        1.40
  CB05                 JUNCTION     0.02     1.40    87.42     0  01:10        1.40
  CB06                 JUNCTION     0.02     1.40    87.57     0  01:10        1.40
  HP-CB01              JUNCTION     0.00     0.03    87.77     0  01:11        0.03
  HP-CB02              JUNCTION     0.00     0.00    87.87     0  00:00        0.00
  HP-CB03              JUNCTION     0.00     0.00    87.92     0  00:00        0.00
  HP-CB04              JUNCTION     0.00     0.00    87.59     0  00:00        0.00
  HP-CB05              JUNCTION     0.00     0.00    87.62     0  00:00        0.00
  HP-CB06              JUNCTION     0.00     0.00    87.77     0  00:00        0.00
  HP-CB07              JUNCTION     0.00     0.00    88.17     0  00:00        0.00
  HP-CB08              JUNCTION     0.00     0.00    88.17     0  00:00        0.00
  HP-RiverRd           JUNCTION     0.00     0.00    89.18     0  00:00        0.00
  EXMH28               OUTFALL      0.05     0.73    83.58     0  01:13        0.73
  OF1                  OUTFALL      0.00     0.00    85.50     0  00:00        0.00
  OF2                  OUTFALL      0.00     0.00    85.50     0  00:00        0.00
  CB07                 STORAGE      0.03     1.33    87.80     0  01:10        1.32
  CB08                 STORAGE      0.03     1.40    87.87     0  01:10        1.40
  MH02                 STORAGE      0.06     0.87    84.43     0  01:12        0.86
  MH04                 STORAGE      0.05     0.81    84.48     0  01:12        0.81
```

```
  MH06                 STORAGE      0.05      0.78     84.55     0  01:11          0.78
  MH08                 STORAGE      0.04      0.62     84.61     0  01:11          0.62
  MH10                 STORAGE      0.04      0.62     84.70     0  01:11          0.62
  MH100                STORAGE      0.05      0.73     83.73     0  01:12          0.73
  MH12                 STORAGE      0.04      0.63     84.79     0  01:11          0.62
  MH14                 STORAGE      0.04      0.63     84.85     0  01:11          0.63
  MH16                 STORAGE      0.04      0.57     85.01     0  01:10          0.57
  MH18                 STORAGE      0.04      0.53     85.10     0  01:10          0.53
  MH76                 STORAGE      0.03      0.52     85.55     0  01:10          0.52
  MH78                 STORAGE      0.04      0.61     85.41     0  01:10          0.61


  *******************
  Node Inflow Summary
  *******************

  -------------------------------------------------------------------------------------------------
                                  Maximum  Maximum                  Lateral       Total        Flow
                                  Lateral    Total  Time of Max      Inflow      Inflow     Balance
                                   Inflow   Inflow   Occurrence      Volume      Volume       Error
  Node                 Type           LPS      LPS  days hr:min    10^6 ltr    10^6 ltr     Percent
  -------------------------------------------------------------------------------------------------
  CB01                 JUNCTION     32.09    32.09     0  01:10      0.0463      0.0463      -0.075
  CB02                 JUNCTION     42.86    42.86     0  01:10      0.0619      0.0619      -0.011
  CB03                 JUNCTION     50.66    50.66     0  01:10       0.074       0.074      -0.030
  CB04                 JUNCTION     90.95    98.47     0  01:10       0.136       0.145      -0.006
  CB05                 JUNCTION     62.79    62.79     0  01:10      0.0908      0.0908      -0.041
  CB06                 JUNCTION     85.99    85.99     0  01:10       0.126       0.126      -0.015
  HP-CB01              JUNCTION      0.00     8.92     0  01:10           0     0.00943       0.932
  HP-CB02              JUNCTION      0.00     0.00     0  00:00           0           0       0.000 ltr
  HP-CB03              JUNCTION      0.00     0.00     0  00:00           0           0       0.000 ltr
  HP-CB04              JUNCTION      0.00     0.00     0  00:00           0           0       0.000 ltr
  HP-CB05              JUNCTION      0.00     0.00     0  00:00           0           0       0.000 ltr
  HP-CB06              JUNCTION      0.00     0.00     0  00:00           0           0       0.000 ltr
  HP-CB07              JUNCTION      0.00     0.00     0  00:00           0           0       0.000 ltr
  HP-CB08              JUNCTION      0.00     0.00     0  00:00           0           0       0.000 ltr
  HP-RiverRd           JUNCTION      0.00     0.00     0  00:00           0           0       0.000 ltr
  EXMH28               OUTFALL       0.00  1265.30     0  01:13           0        2.68       0.000
  OF1                  OUTFALL       0.00     0.00     0  00:00           0           0       0.000 ltr
  OF2                  OUTFALL       6.87     6.87     0  01:10     0.00899     0.00899       0.000
  CB07                 STORAGE     621.21   621.21     0  01:10        1.43        1.43       0.001
  CB08                 STORAGE     240.65   240.65     0  01:10       0.505       0.505       0.003
  MH02                 STORAGE       0.00  1278.11     0  01:12           0        2.68      -0.014
  MH04                 STORAGE       0.00  1285.04     0  01:11           0        2.68      -0.062
  MH06                 STORAGE       0.00  1270.28     0  01:11           0        2.64       0.036
  MH08                 STORAGE       0.00   828.47     0  01:11           0        1.79      -0.144
```

```
  MH10                 STORAGE       0.00   829.46     0  01:11           0         1.8       0.136
  MH100                STORAGE       0.00  1274.83     0  01:12           0        2.68      -0.003
  MH12                 STORAGE       0.00   744.18     0  01:11           0        1.65      -0.026
  MH14                 STORAGE       0.00   754.12     0  01:11           0        1.65      -0.017
  MH16                 STORAGE       0.00   703.60     0  01:10           0        1.56      -0.238
  MH18                 STORAGE       0.00   704.06     0  01:10           0        1.56       0.221
  MH76                 STORAGE     138.12   422.07     0  01:10       0.206       0.785       0.193
  MH78                 STORAGE       0.00   462.60     0  01:10           0       0.845       0.041


  **********************
  Node Surcharge Summary
  **********************

  No nodes were surcharged.


  *********************
  Node Flooding Summary
  *********************

  No nodes were flooded.


  **********************
  Storage Volume Summary
  **********************

  --------------------------------------------------------------------------------------------------
                           Average     Avg  Evap Exfil       Maximum     Max    Time of Max    Maximum
                            Volume    Pcnt  Pcnt  Pcnt        Volume    Pcnt     Occurrence    Outflow
  Storage Unit             1000 m3    Full  Loss  Loss       1000 m3    Full    days hr:min        LPS
  --------------------------------------------------------------------------------------------------
  CB07                       0.000       0     0     0         0.000       0       0  00:00     619.96
  CB08                       0.000       0     0     0         0.000       0       0  01:10     234.78
  MH02                       0.000       1     0     0         0.001      15       0  01:12    1274.83
  MH04                       0.000       1     0     0         0.001      16       0  01:12    1278.11
  MH06                       0.000       1     0     0         0.001      15       0  01:11    1265.07
  MH08                       0.000       1     0     0         0.001      13       0  01:11     829.08
  MH10                       0.000       1     0     0         0.001      13       0  01:11     828.47
  MH100                      0.000       1     0     0         0.001      11       0  01:12    1265.30
  MH12                       0.000       1     0     0         0.001      14       0  01:11     743.46
  MH14                       0.000       1     0     0         0.001      14       0  01:11     744.18
  MH16                       0.000       1     0     0         0.001      13       0  01:10     693.19
  MH18                       0.000       1     0     0         0.001      12       0  01:10     703.60
  MH76                       0.000       1     0     0         0.001      14       0  01:10     420.50
```

```
  MH78                     0.000       1     0     0         0.001      14       0  01:10     459.65


  ***********************
  Outfall Loading Summary
  ***********************

  -----------------------------------------------------------
                       Flow       Avg       Max       Total
                       Freq      Flow      Flow      Volume
  Outfall Node         Pcnt       LPS       LPS    10^6 ltr
  -----------------------------------------------------------
  EXMH28              98.57     31.46   1265.30       2.679
  OF1                  0.00      0.00      0.00       0.000
  OF2                 12.06      0.86      6.87       0.009
  -----------------------------------------------------------
  System              36.88     32.31   1265.25       2.688


  ********************
  Link Flow Summary
  ********************

  -----------------------------------------------------------------------------
                                 Maximum  Time of Max   Maximum    Max/    Max/
                                  |Flow|   Occurrence   |Veloc|    Full    Full
  Link                 Type          LPS  days hr:min     m/sec    Flow   Depth
  -----------------------------------------------------------------------------
  MH02-MH100           CONDUIT   1274.83     0  01:12      1.62    0.51    0.54
  MH04-MH02            CONDUIT   1278.11     0  01:12      1.41    0.55    0.61
  MH06-MH04            CONDUIT   1265.07     0  01:11      1.49    0.54    0.58
  MH08-MH06            CONDUIT    829.08     0  01:12      1.50    0.48    0.52
  Mh10-MH08            CONDUIT    828.47     0  01:11      1.45    0.49    0.50
  MH12-MH10            CONDUIT    743.46     0  01:11      1.30    0.44    0.51
  MH14-MH12            CONDUIT    744.18     0  01:11      1.28    0.42    0.51
  MH16-MH14            CONDUIT    693.19     0  01:11      1.28    0.39    0.49
  Mh18-MH16            CONDUIT    703.60     0  01:10      1.45    0.40    0.44
  MH76-MH78            CONDUIT    420.50     0  01:10      1.32    0.84    0.68
  MH78-MH06            CONDUIT    459.65     0  01:10      1.33    0.74    0.62
  MS01                 CONDUIT      0.00     0  00:00      0.00    0.00    0.00
  MS02                 CONDUIT      0.00     0  00:00      0.00    0.00    0.00
  MS03                 CHANNEL      0.00     0  00:00      0.00    0.00    0.00
  MS04                 CHANNEL      0.00     0  00:00      0.00    0.00    0.00
  MS05                 CHANNEL      0.00     0  00:00      0.00    0.00    0.00
  MS06                 CHANNEL      0.00     0  00:00      0.00    0.00    0.00
  MS07                 CHANNEL      0.00     0  00:00      0.00    0.00    0.00
```

```
  MS08                 CHANNEL      0.00     0  00:00      0.00    0.00    0.00
  MS09                 CHANNEL      8.00     0  01:11      0.33    0.00    0.03
  MS10                 CHANNEL      8.92     0  01:10      0.40    0.00    0.03
  MS11                 CHANNEL      0.00     0  00:00      0.00    0.00    0.01
  MS12                 CHANNEL      0.00     0  00:00      0.00    0.00    0.00
  MS13                 CHANNEL      0.00     0  00:00      0.00    0.00    0.00
  MS14                 CHANNEL      0.00     0  00:00      0.00    0.00    0.00
  MS15                 CHANNEL      0.00     0  00:00      0.00    0.00    0.00
  MS16                 CHANNEL      0.00     0  00:00      0.00    0.00    0.00
  MS17                 CHANNEL      0.00     0  00:00      0.00    0.00    0.01
  STM-OFFSITE-2-4_(STM-OFFSITE) CONDUIT   1265.30     0  01:13      1.30    0.35    0.41
  O-CB02               ORIFICE     42.11     0  01:10                      1.00
  O-CB03               ORIFICE     49.40     0  01:10                      1.00
  O-CB04               ORIFICE     96.93     0  01:10                      1.00
  O-CB05               ORIFICE     60.96     0  01:10                      1.00
  O-CB06               ORIFICE     84.10     0  01:10                      1.00
  O-CB01               DUMMY       23.09     0  01:10
  O-CB07               DUMMY      619.96     0  01:10
  O-CB08               DUMMY      234.78     0  01:10


  ***************************
  Flow Classification Summary
  ***************************

  -------------------------------------------------------------------------------------
                      Adjusted    ---------- Fraction of Time in Flow Class ----------
                       /Actual         Up    Down   Sub   Sup    Up    Down  Norm  Inlet
  Conduit               Length    Dry  Dry    Dry   Crit  Crit  Crit  Crit  Ltd   Ctrl
  -------------------------------------------------------------------------------------
  MH02-MH100              1.00   0.01  0.00  0.00  0.00  0.00  0.00  0.99  0.00  0.00
  MH04-MH02               1.00   0.01  0.00  0.00  0.13  0.00  0.00  0.86  0.00  0.00
  MH06-MH04               1.00   0.01  0.00  0.00  0.10  0.00  0.00  0.89  0.00  0.00
  MH08-MH06               1.00   0.01  0.00  0.00  0.01  0.00  0.00  0.98  0.00  0.00
  Mh10-MH08               1.00   0.01  0.00  0.00  0.03  0.00  0.00  0.96  0.00  0.00
  MH12-MH10               1.00   0.01  0.00  0.00  0.11  0.00  0.00  0.88  0.00  0.00
  MH14-MH12               1.00   0.01  0.00  0.00  0.09  0.00  0.00  0.90  0.00  0.00
  MH16-MH14               1.00   0.01  0.00  0.00  0.08  0.00  0.00  0.91  0.00  0.00
  Mh18-MH16               1.00   0.01  0.00  0.00  0.11  0.00  0.00  0.88  0.00  0.00
  MH76-MH78               1.00   0.01  0.00  0.00  0.01  0.00  0.00  0.98  0.00  0.00
  MH78-MH06               1.00   0.01  0.00  0.00  0.00  0.00  0.00  0.99  0.00  0.00
  MS01                    1.00   1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
  MS02                    1.00   1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
  MS03                    1.00   1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
  MS04                    1.00   1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
  MS05                    1.00   1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
```

```
MS06                    1.00   1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
MS07                    1.00   1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
MS08                    1.00   1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
MS09                    1.00   0.03  0.00  0.00  0.00  0.00  0.00  0.97  0.00  0.00
MS10                    1.00   0.01  0.71  0.00  0.26  0.03  0.00  0.00  0.95  0.00
MS11                    1.00   0.03  0.97  0.00  0.00  0.00  0.00  0.00  0.00  0.00
MS12                    1.00   1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
MS13                    1.00   1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
MS14                    1.00   1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
MS15                    1.00   1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
MS16                    1.00   1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
MS17                    1.00   0.71  0.29  0.00  0.00  0.00  0.00  0.00  0.00  0.00
STM-OFFSITE-2-4_(STM-OFFSITE)    1.00   0.01  0.00  0.00  0.99  0.00  0.00  0.00  0.87  0.00


*************************
Conduit Surcharge Summary
*************************

No conduits were surcharged.


Analysis begun on:  Tue Jul 21 17:55:01 2020
Analysis ended on:  Tue Jul 21 17:55:04 2020
Total elapsed time: 00:00:03
```

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)
--------------------------------------------------------------

Boundary condition
100-year = 85.40
100-year +20% = 85.56

WARNING 02: maximum depth increased for Node CB03
WARNING 02: maximum depth increased for Node CB04
WARNING 02: maximum depth increased for Node CB05

*************
Element Count
*************
Number of rain gages ...... 1
Number of subcatchments ... 20
Number of nodes ........... 32
Number of links ........... 37
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Raingage Summary
****************
                                                    Data       Recording
Name                 Data Source                    Type       Interval 
------------------------------------------------------------------------
RG1                  C3hr-100yr                     INTENSITY   10 min.


********************
Subcatchment Summary
********************
Name                       Area     Width   %Imperv    %Slope Rain Gage            Outlet
-----------------------------------------------------------------------------------------------------------
A-01                       0.33    165.00     71.40    0.5000 RG1                  CB06
A-02                       0.46    230.00     35.70    0.5000 RG1                  CB06
A-03                       0.41    205.00     71.40    0.5000 RG1                  CB05
A-04                       0.50     40.00     35.70    0.5000 RG1                  CB04
A-05                       0.32    160.00     35.70    0.5000 RG1                  CB04
A-06                       0.19    126.67     71.40    0.5000 RG1                  CB04
A-07                       0.21    105.00     71.40    0.5000 RG1                  CB03
A-08                       0.17     68.00     71.40    0.5000 RG1                  CB02
A-09                       0.24    120.00     35.70    0.5000 RG1                  CB03
A-10                       0.11     73.33     71.40    0.5000 RG1                  CB02
A-11                       0.21     84.00     71.40    0.5000 RG1                  CB01
B-01                       7.52    181.21     61.40    0.5000 RG1                  CB07
B-02                       0.18     40.00     35.70    0.5000 RG1                  CB08
B-04                       2.54     72.57     61.40    0.5000 RG1                  CB08
EXT-01                     1.65    550.00     35.70    0.5000 RG1                  MH76
EXT-02                     0.15     30.00     35.70    0.5000 RG1                  MH76
U-01                       0.06     60.00      0.00    0.5000 RG1                  OF2
U-02                       0.72    240.00      0.00    0.5000 RG1                  OF2
U-03                       0.93    132.86      0.00    0.5000 RG1                  OF2
U-04                       0.04     11.43     71.40    0.5000 RG1                  OF2


************
Node Summary
************
                                         Invert      Max.    Ponded    External
Name                 Type                 Elev.     Depth      Area    Inflow  
-------------------------------------------------------------------------------
CB01                 JUNCTION             87.96      1.00       0.0
CB02                 JUNCTION             86.34      2.40       0.0
CB03                 JUNCTION             86.22      2.40       0.0
CB04                 JUNCTION             86.02      2.40       0.0
CB05                 JUNCTION             86.02      2.40       0.0
CB06                 JUNCTION             86.17      2.40       0.0
HP-CB01              JUNCTION             87.74      1.00       0.0
HP-CB02              JUNCTION             87.87      1.00       0.0
HP-CB03              JUNCTION             87.92      1.00       0.0
HP-CB04              JUNCTION             87.59      1.00       0.0
HP-CB05              JUNCTION             87.62      1.00       0.0
HP-CB06              JUNCTION             87.77      1.00       0.0
HP-CB07              JUNCTION             88.17      1.00       0.0
HP-CB08              JUNCTION             88.17      1.00       0.0
HP-RiverRd           JUNCTION             89.18      1.00       0.0
EXMH28               OUTFALL              82.85      1.80       0.0
OF1                  OUTFALL              85.50      1.00       0.0
OF2                  OUTFALL              85.50      0.00       0.0
CB07                 STORAGE              86.47      2.40       0.0
CB08                 STORAGE              86.47      2.40       0.0
MH02                 STORAGE              83.56      5.66       0.0
MH04                 STORAGE              83.67      5.20       0.0
MH06                 STORAGE              83.77      5.29       0.0
MH08                 STORAGE              83.99      4.82       0.0
MH10                 STORAGE              84.08      4.85       0.0
MH100                STORAGE              83.00      6.50       0.0
MH12                 STORAGE              84.16      4.60       0.0
```

```
MH14                 STORAGE               84.22      4.51       0.0
MH16                 STORAGE               84.44      4.41       0.0
MH18                 STORAGE               84.57      4.47       0.0
MH76                 STORAGE               85.03      3.87       0.0
MH78                 STORAGE               84.80      4.29       0.0


************
Link Summary
************
Name             From Node        To Node          Type            Length    %Slope Roughness
----------------------------------------------------------------------------------------------
MH02-MH100       MH02             MH100            CONDUIT           22.7    0.2199    0.0130
MH04-MH02        MH04             MH02             CONDUIT           41.9    0.1912    0.0130
MH06-MH04        MH06             MH04             CONDUIT           36.5    0.1920    0.0130
MH08-MH06        MH08             MH06             CONDUIT           30.9    0.1942    0.0130
Mh10-MH08        MH10             MH08             CONDUIT           32.1    0.1867    0.0130
MH12-MH10        MH12             MH10             CONDUIT           27.1    0.1846    0.0130
MH14-MH12        MH14             MH12             CONDUIT           14.4    0.2088    0.0130
MH16-MH14        MH16             MH14             CONDUIT           92.7    0.2051    0.0130
Mh18-MH16        MH18             MH16             CONDUIT           50.0    0.1998    0.0130
MH76-MH78        MH76             MH78             CONDUIT           59.6    0.2014    0.0130
MH78-MH06        MH78             MH06             CONDUIT           37.7    0.1857    0.0130
MS01             HP-CB05          OF1              CONDUIT           40.0    5.3075    0.0150
MS02             CB05             HP-CB05          CONDUIT           25.0   -0.8000    0.0150
MS03             HP-CB06          CB05             CONDUIT           66.0    0.5303    0.0150
MS04             CB06             HP-CB06          CONDUIT           40.0   -0.5000    0.0150
MS05             HP-CB07          CB06             CONDUIT           60.0    1.0001    0.0150
MS06             CB07             HP-CB07          CONDUIT           40.0   -0.7500    0.0150
MS07             HP-CB04          CB05             CONDUIT           35.0    0.4857    0.0150
MS08             CB04             HP-CB04          CONDUIT           20.0   -0.8500    0.0150
MS09             HP-CB01          CB04             CONDUIT           44.0    0.7273    0.0150
MS10             CB01             HP-CB01          CONDUIT           31.0    0.7097    0.0150
MS11             HP-CB02          HP-CB01          CONDUIT            4.3    3.0603    0.0150
MS12             CB02             HP-CB02          CONDUIT            4.3   -3.0603    0.0150
MS13             HP-CB03          CB02             CONDUIT           40.0    0.4500    0.0150
MS14             CB03             HP-CB03          CONDUIT           40.0   -0.7500    0.0150
MS15             HP-CB08          CB03             CONDUIT           54.0    1.0186    0.0150
MS16             CB08             HP-CB08          CONDUIT           40.0   -0.7500    0.0150
MS17             HP-RiverRd       CB01             CONDUIT           60.0    2.0338    0.0150
STM-OFFSITE-2-4_(STM-OFFSITE) MH100            EXMH28           CONDUIT          150.0    0.1000    0.0130
O-CB02           CB02             MH78             ORIFICE
O-CB03           CB03             MH76             ORIFICE
O-CB04           CB04             MH10             ORIFICE
O-CB05           CB05             MH14             ORIFICE
O-CB06           CB06             MH18             ORIFICE
```

```
O-CB01           CB01             MH04             OUTLET
O-CB07           CB07             MH18             OUTLET
O-CB08           CB08             MH76             OUTLET


*********************
Cross Section Summary
*********************
                                       Full     Full     Hyd.     Max.   No. of     Full
Conduit          Shape                Depth     Area     Rad.    Width  Barrels     Flow
----------------------------------------------------------------------------------------
MH02-MH100       CIRCULAR              1.35     1.43     0.34     1.35        1  2502.92
MH04-MH02        CIRCULAR              1.35     1.43     0.34     1.35        1  2333.75
MH06-MH04        CIRCULAR              1.35     1.43     0.34     1.35        1  2338.82
MH08-MH06        CIRCULAR              1.20     1.13     0.30     1.20        1  1718.09
Mh10-MH08        CIRCULAR              1.20     1.13     0.30     1.20        1  1684.62
MH12-MH10        CIRCULAR              1.20     1.13     0.30     1.20        1  1675.37
MH14-MH12        CIRCULAR              1.20     1.13     0.30     1.20        1  1781.48
MH16-MH14        CIRCULAR              1.20     1.13     0.30     1.20        1  1765.55
Mh18-MH16        CIRCULAR              1.20     1.13     0.30     1.20        1  1742.80
MH76-MH78        CIRCULAR              0.75     0.44     0.19     0.75        1   499.65
MH78-MH06        CIRCULAR              0.82     0.53     0.21     0.82        1   618.57
MS01             RECT_OPEN             1.00     3.00     0.60     3.00        1 32779.35
MS02             RECT_OPEN             1.00     3.00     0.60     3.00        1 12726.50
MS03             18.0mROW              1.00    15.07     0.37    18.00        1 37645.24
MS04             18.0mROW              1.00    15.07     0.37    18.00        1 36553.81
MS05             18.0mROW              1.00    15.07     0.37    18.00        1 51695.86
MS06             18.0mROW              1.00    15.07     0.37    18.00        1 44769.44
MS07             18.0mROW              1.00    15.07     0.37    18.00        1 36027.82
MS08             18.0mROW              1.00    15.07     0.37    18.00        1 47660.90
MS09             18.0mROW              1.00    15.07     0.37    18.00        1 44085.86
MS10             18.0mROW              1.00    15.07     0.37    18.00        1 43549.27
MS11             18.0mROW              1.00    15.07     0.37    18.00        1 90432.34
MS12             18.0mROW              1.00    15.07     0.37    18.00        1 90432.34
MS13             18.0mROW              1.00    15.07     0.37    18.00        1 34677.95
MS14             18.0mROW              1.00    15.07     0.37    18.00        1 44769.44
MS15             18.0mROW              1.00    15.07     0.37    18.00        1 52172.38
MS16             18.0mROW              1.00    15.07     0.37    18.00        1 44769.44
MS17             18.0mROW              1.00    15.07     0.37    18.00        1 73721.49
STM-OFFSITE-2-4_(STM-OFFSITE) CIRCULAR              1.80     2.54     0.45     1.80        1  3635.06


****************
Transect Summary
****************
```

```
Transect 18.0mROW
Area:
            0.0009     0.0035     0.0078     0.0139     0.0217
            0.0313     0.0424     0.0539     0.0664     0.0802
            0.0953     0.1117     0.1292     0.1481     0.1682
            0.1895     0.2121     0.2359     0.2597     0.2836
            0.3075     0.3313     0.3552     0.3791     0.4029
            0.4268     0.4507     0.4746     0.4984     0.5223
            0.5462     0.5701     0.5939     0.6178     0.6417
            0.6656     0.6895     0.7133     0.7372     0.7611
            0.7850     0.8089     0.8328     0.8567     0.8805
            0.9044     0.9283     0.9522     0.9761     1.0000
Hrad:
            0.0262     0.0524     0.0787     0.1049     0.1311
            0.1573     0.1962     0.2469     0.2908     0.3274
            0.3577     0.3829     0.4038     0.4212     0.4357
            0.4478     0.4579     0.4670     0.4779     0.4901
            0.5034     0.5175     0.5323     0.5476     0.5632
            0.5793     0.5956     0.6121     0.6289     0.6458
            0.6629     0.6801     0.6974     0.7148     0.7323
            0.7498     0.7674     0.7851     0.8029     0.8206
            0.8384     0.8563     0.8742     0.8921     0.9100
            0.9280     0.9460     0.9640     0.9820     1.0000
Width:
            0.0728     0.1456     0.2184     0.2912     0.3640
            0.4368     0.4733     0.4996     0.5522     0.6047
            0.6573     0.7098     0.7624     0.8149     0.8675
            0.9201     0.9726     0.9989     0.9989     0.9990
            0.9990     0.9990     0.9991     0.9991     0.9991
            0.9992     0.9992     0.9992     0.9993     0.9993
            0.9994     0.9994     0.9994     0.9995     0.9995
            0.9995     0.9996     0.9996     0.9996     0.9997
            0.9997     0.9997     0.9998     0.9998     0.9998
            0.9999     0.9999     0.9999     1.0000     1.0000


*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
```

```
Flow Units ............... LPS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 05/01/2020 00:00:00
Ending Date .............. 05/02/2020 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00
Routing Time Step ........ 2.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 4
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         1.214        71.667
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.437        25.808
Surface Runoff ...........         0.776        45.790
Final Storage ............         0.007         0.434
Continuity Error (%) .....        -0.509


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.776         7.757
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.004         0.044
External Outflow .........         0.780         7.802
Flooding Loss ............         0.000         0.000
```

```
  Evaporation Loss .........         0.000         0.000
  Exfiltration Loss ........         0.000         0.000
  Initial Stored Volume ....         0.084         0.836
  Final Stored Volume ......         0.084         0.835
  Continuity Error (%) .....         0.002


  *************************
  Highest Continuity Errors
  *************************
  Node HP-CB01 (-1.46%)


  ***************************
  Time-Step Critical Elements
  ***************************
  Link MH14-MH12 (3.83%)


  ********************************
  Highest Flow Instability Indexes
  ********************************
  All links are stable.


  *************************
  Routing Time Step Summary
  *************************
  Minimum Time Step           :     0.43 sec
  Average Time Step           :     1.96 sec
  Maximum Time Step           :     2.00 sec
  Percent in Steady State     :    -0.00
  Average Iterations per Step :     2.00
  Percent Not Converging      :     0.01


  ***************************
  Subcatchment Runoff Summary
  ***************************

  ------------------------------------------------------------------------------------------------------------------------------
                            Total      Total      Total      Total     Imperv       Perv      Total       Total     Peak  Runoff
                           Precip     Runon       Evap      Infil     Runoff     Runoff     Runoff      Runoff   Runoff   Coeff
  Subcatchment                 mm         mm         mm         mm         mm         mm         mm    10^6 ltr      LPS
  ------------------------------------------------------------------------------------------------------------------------------
  A-01                      71.67       0.00       0.00      12.82      50.61       8.08      58.69        0.19   147.74   0.819
```

```
  A-02                      71.67       0.00       0.00      29.63      25.63      16.95      42.59        0.20   145.86   0.594
  A-03                      71.67       0.00       0.00      12.82      50.61       8.08      58.69        0.24   183.56   0.819
  A-04                      71.67       0.00       0.00      34.18      25.80      12.00      37.80        0.19   103.96   0.527
  A-05                      71.67       0.00       0.00      29.63      25.63      16.95      42.59        0.14   101.47   0.594
  A-06                      71.67       0.00       0.00      12.74      50.49       8.25      58.74        0.11    86.80   0.820
  A-07                      71.67       0.00       0.00      12.82      50.61       8.08      58.69        0.12    94.02   0.819
  A-08                      71.67       0.00       0.00      12.89      50.60       7.95      58.55        0.10    74.72   0.817
  A-09                      71.67       0.00       0.00      29.63      25.63      16.95      42.59        0.10    76.10   0.594
  A-10                      71.67       0.00       0.00      12.74      50.49       8.25      58.74        0.06    50.25   0.820
  A-11                      71.67       0.00       0.00      12.89      50.55       7.95      58.49        0.12    92.30   0.816
  B-01                      71.67       0.00       0.00      22.16      43.68       5.54      49.22        3.70  1884.16   0.687
  B-02                      71.67       0.00       0.00      31.11      25.71      15.22      40.93        0.07    45.88   0.571
  B-04                      71.67       0.00       0.00      21.73      43.70       5.97      49.67        1.26   671.98   0.693
  EXT-01                    71.67       0.00       0.00      30.27      25.66      16.17      41.83        0.69   467.59   0.584
  EXT-02                    71.67       0.00       0.00      31.36      25.72      14.95      40.67        0.06    37.27   0.567
  U-01                      71.67       0.00       0.00      45.59       0.00      27.01      27.01        0.02    15.16   0.377
  U-02                      71.67       0.00       0.00      48.52       0.00      23.53      23.53        0.17    84.64   0.328
  U-03                      71.67       0.00       0.00      52.39       0.00      19.45      19.45        0.18    60.91   0.271
  U-04                      71.67       0.00       0.00      13.04      50.40       7.73      58.12        0.02    17.05   0.811


  ******************
  Node Depth Summary
  ******************

  ---------------------------------------------------------------------------------
                                 Average  Maximum  Maximum  Time of Max    Reported
                                   Depth    Depth      HGL   Occurrence   Max Depth
  Node                 Type       Meters   Meters   Meters  days hr:min      Meters
  ---------------------------------------------------------------------------------
  CB01                 JUNCTION     0.00     0.06    88.02     0  01:10        0.06
  CB02                 JUNCTION     0.04     1.58    87.92     0  01:10        1.58
  CB03                 JUNCTION     0.07     1.64    87.86     0  01:21        1.64
  CB04                 JUNCTION     0.06     1.68    87.70     0  01:12        1.68
  CB05                 JUNCTION     0.07     1.68    87.70     0  01:14        1.68
  CB06                 JUNCTION     0.07     1.66    87.83     0  01:14        1.66
  HP-CB01              JUNCTION     0.00     0.08    87.82     0  01:11        0.08
  HP-CB02              JUNCTION     0.00     0.05    87.92     0  01:10        0.05
  HP-CB03              JUNCTION     0.00     0.01    87.93     0  01:11        0.01
  HP-CB04              JUNCTION     0.00     0.11    87.70     0  01:14        0.11
  HP-CB05              JUNCTION     0.00     0.04    87.66     0  01:14        0.04
  HP-CB06              JUNCTION     0.00     0.06    87.83     0  01:14        0.06
  HP-CB07              JUNCTION     0.00     0.00    88.17     0  01:27        0.00
  HP-CB08              JUNCTION     0.00     0.00    88.17     0  00:00        0.00
  HP-RiverRd           JUNCTION     0.00     0.00    89.18     0  00:00        0.00
  EXMH28               OUTFALL      2.55     2.55    85.40     0  00:00        2.55
```

```
OF1                  OUTFALL      0.00     0.04    85.54     0  01:14        0.04
OF2                  OUTFALL      0.00     0.00    85.50     0  00:00        0.00
CB07                 STORAGE      0.10     1.70    88.17     0  01:27        1.70
CB08                 STORAGE      0.10     1.69    88.16     0  01:26        1.69
MH02                 STORAGE      1.85     2.01    85.57     0  01:10        2.01
MH04                 STORAGE      1.74     1.96    85.63     0  01:10        1.96
MH06                 STORAGE      1.64     1.92    85.69     0  01:10        1.92
MH08                 STORAGE      1.42     1.72    85.71     0  01:10        1.72
MH10                 STORAGE      1.33     1.66    85.74     0  01:10        1.66
MH100                STORAGE      2.40     2.46    85.46     0  01:02        2.46
MH12                 STORAGE      1.25     1.60    85.76     0  01:11        1.60
MH14                 STORAGE      1.19     1.56    85.78     0  01:11        1.56
MH16                 STORAGE      0.97     1.39    85.83     0  01:11        1.39
MH18                 STORAGE      0.85     1.28    85.85     0  01:11        1.28
MH76                 STORAGE      0.39     1.28    86.31     0  01:10        1.27
MH78                 STORAGE      0.61     1.19    85.99     0  01:10        1.18


*******************
Node Inflow Summary
*******************

-------------------------------------------------------------------------------------------------
                                Maximum  Maximum                  Lateral       Total        Flow
                                Lateral    Total  Time of Max      Inflow      Inflow     Balance
                                 Inflow   Inflow   Occurrence      Volume      Volume       Error
Node                 Type           LPS      LPS  days hr:min    10^6 ltr    10^6 ltr     Percent
-------------------------------------------------------------------------------------------------
CB01                 JUNCTION     92.30    92.30     0  01:10       0.123       0.123      -0.194
CB02                 JUNCTION    124.97   124.97     0  01:10       0.164       0.164      -0.208
CB03                 JUNCTION    170.12   170.13     0  01:10       0.225       0.226      -0.220
CB04                 JUNCTION    292.22   405.17     0  01:10       0.437       0.516       0.192
CB05                 JUNCTION    183.56   398.98     0  01:12       0.241       0.395      -0.075
CB06                 JUNCTION    293.60   293.60     0  01:10        0.39       0.393      -0.161
HP-CB01              JUNCTION      0.00   127.56     0  01:10           0       0.074      -1.441
HP-CB02              JUNCTION      0.00    69.67     0  01:10           0      0.0282       0.030
HP-CB03              JUNCTION      0.00     8.54     0  01:10           0     0.00077      52.186
HP-CB04              JUNCTION      0.00   237.00     0  01:11           0       0.119      -0.861
HP-CB05              JUNCTION      0.00   203.54     0  01:14           0       0.134       0.016
HP-CB06              JUNCTION      0.00    89.70     0  01:10           0      0.0422       3.383
HP-CB07              JUNCTION      0.00     3.40     0  01:26           0     0.00029     315.659
HP-CB08              JUNCTION      0.00     0.00     0  00:00           0           0       0.000 ltr
HP-RiverRd           JUNCTION      0.00     0.00     0  00:00           0           0       0.000 ltr
EXMH28               OUTFALL       0.00  1817.46     0  01:11           0        7.32       0.000
OF1                  OUTFALL       0.00   203.17     0  01:14           0       0.134       0.000
OF2                  OUTFALL     169.18   169.18     0  01:10        0.39        0.39       0.000
```

```
CB07                 STORAGE    1884.16  1884.16     0  01:10         3.7         3.7       0.017
CB08                 STORAGE     717.86   717.86     0  01:10        1.34        1.34      -0.011
MH02                 STORAGE       0.00  1806.46     0  01:11           0        7.31       0.000
MH04                 STORAGE       0.00  1804.20     0  01:10           0        7.31       0.000
MH06                 STORAGE       0.00  1770.26     0  01:10           0        7.23      -0.000
MH08                 STORAGE       0.00   988.86     0  01:15           0        4.76       0.000
MH10                 STORAGE       0.00   984.89     0  01:15           0        4.75       0.000
MH100                STORAGE       0.00  1808.81     0  01:11           0        7.32       0.000
MH12                 STORAGE       0.00   875.42     0  01:15           0        4.35      -0.000
MH14                 STORAGE       0.00   869.78     0  01:43           0        4.35      -0.009
MH16                 STORAGE       0.00   798.31     0  01:25           0        4.07       0.000
MH18                 STORAGE       0.00   797.14     0  01:26           0        4.05       0.005
MH76                 STORAGE     504.86   807.60     0  01:10       0.751        2.32       0.005
MH78                 STORAGE       0.00   846.97     0  01:10           0        2.46      -0.003


**********************
Node Surcharge Summary
**********************

No nodes were surcharged.


*********************
Node Flooding Summary
*********************

No nodes were flooded.


**********************
Storage Volume Summary
**********************

--------------------------------------------------------------------------------------------------
                       Average     Avg  Evap Exfil       Maximum     Max    Time of Max    Maximum
                        Volume    Pcnt  Pcnt  Pcnt        Volume    Pcnt     Occurrence    Outflow
Storage Unit           1000 m3    Full  Loss  Loss       1000 m3    Full    days hr:min        LPS
--------------------------------------------------------------------------------------------------
CB07                     0.022       3     0     0         0.755      97       0  01:27     709.35
CB08                     0.007       3     0     0         0.263      93       0  01:26     258.37
MH02                     0.002      33     0     0         0.002      36       0  01:10    1808.81
MH04                     0.002      33     0     0         0.002      38       0  01:10    1806.46
MH06                     0.002      31     0     0         0.002      36       0  01:10    1772.10
MH08                     0.002      29     0     0         0.002      36       0  01:10     993.05
MH10                     0.002      27     0     0         0.002      34       0  01:10     988.86
```

```
MH100                    0.003      37      0     0         0.003      38       0  01:02    1817.46
MH12                     0.001      27      0     0         0.002      35       0  01:11     878.36
MH14                     0.001      26      0     0         0.002      35       0  01:11     875.42
MH16                     0.001      22      0     0         0.002      32       0  01:11     806.02
MH18                     0.001      19      0     0         0.001      29       0  01:11     798.31
MH76                     0.000      10      0     0         0.001      33       0  01:10     802.09
MH78                     0.001      14      0     0         0.001      28       0  01:10     844.54


***********************
Outfall Loading Summary
***********************

-----------------------------------------------------------
                       Flow       Avg       Max       Total
                       Freq      Flow      Flow      Volume
Outfall Node           Pcnt       LPS       LPS    10^6 ltr
-----------------------------------------------------------
EXMH28                98.85     89.24   1817.46       7.323
OF1                    2.10     73.88    203.17       0.134
OF2                   14.77     31.28    169.18       0.390
-----------------------------------------------------------
System                38.57    194.40   1817.38       7.846


********************
Link Flow Summary
********************

-----------------------------------------------------------------------------
                                 Maximum  Time of Max   Maximum    Max/    Max/
                                  |Flow|   Occurrence   |Veloc|    Full    Full
Link                     Type        LPS  days hr:min     m/sec    Flow   Depth
-----------------------------------------------------------------------------
MH02-MH100               CONDUIT   1808.81     0  01:11      1.26    0.72    1.00
MH04-MH02                CONDUIT   1806.46     0  01:11      1.26    0.77    1.00
MH06-MH04                CONDUIT   1772.10     0  01:10      1.24    0.76    1.00
MH08-MH06                CONDUIT    993.05     0  01:15      0.88    0.58    1.00
Mh10-MH08                CONDUIT    988.86     0  01:15      0.87    0.59    1.00
MH12-MH10                CONDUIT    878.36     0  01:15      0.78    0.52    1.00
MH14-MH12                CONDUIT    875.42     0  01:15      0.77    0.49    1.00
MH16-MH14                CONDUIT    806.02     0  01:43      0.71    0.46    1.00
Mh18-MH16                CONDUIT    798.31     0  01:25      0.71    0.46    1.00
MH76-MH78                CONDUIT    802.09     0  01:10      1.82    1.61    1.00
MH78-MH06                CONDUIT    844.54     0  01:10      1.58    1.37    1.00
MS01                     CONDUIT    203.17     0  01:14      1.74    0.01    0.04
```

```
MS02                     CONDUIT    203.54     0  01:14      0.43    0.02    0.16
MS03                     CHANNEL     51.24     0  01:14      0.16    0.00    0.17
MS04                     CHANNEL     89.70     0  01:10      0.16    0.00    0.16
MS05                     CHANNEL      0.00     0  01:27      0.00    0.00    0.13
MS06                     CHANNEL      3.40     0  01:26      0.00    0.00    0.15
MS07                     CHANNEL    232.01     0  01:12      0.24    0.01    0.19
MS08                     CHANNEL    237.00     0  01:11      0.21    0.00    0.19
MS09                     CHANNEL    120.87     0  01:11      0.29    0.00    0.18
MS10                     CHANNEL     57.92     0  01:10      0.54    0.00    0.07
MS11                     CHANNEL     69.64     0  01:10      0.59    0.00    0.06
MS12                     CHANNEL     69.67     0  01:10      0.16    0.00    0.12
MS13                     CHANNEL      8.54     0  01:10      0.08    0.00    0.09
MS14                     CHANNEL      0.09     0  01:11      0.08    0.00    0.12
MS15                     CHANNEL      0.00     0  00:00      0.00    0.00    0.12
MS16                     CHANNEL      0.00     0  00:00      0.00    0.00    0.15
MS17                     CHANNEL      0.00     0  00:00      0.00    0.00    0.03
STM-OFFSITE-2-4_(STM-OFFSITE) CONDUIT   1817.46     0  01:11      0.71    0.50    1.00
O-CB02                   ORIFICE     44.88     0  01:10                      1.00
O-CB03                   ORIFICE     53.67     0  01:21                      1.00
O-CB04                   ORIFICE    106.89     0  01:12                      1.00
O-CB05                   ORIFICE     67.06     0  01:14                      1.00
O-CB06                   ORIFICE     91.92     0  01:14                      1.00
O-CB01                   DUMMY       32.10     0  01:03
O-CB07                   DUMMY      705.96     0  01:27
O-CB08                   DUMMY      258.37     0  01:26


***************************
Flow Classification Summary
***************************

-------------------------------------------------------------------------------------
                      Adjusted    ---------- Fraction of Time in Flow Class ----------
                       /Actual         Up    Down  Sub   Sup   Up    Down  Norm  Inlet
Conduit                 Length    Dry  Dry   Dry   Crit  Crit  Crit  Crit  Ltd   Ctrl
-------------------------------------------------------------------------------------
MH02-MH100                1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
MH04-MH02                 1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
MH06-MH04                 1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
MH08-MH06                 1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
Mh10-MH08                 1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
MH12-MH10                 1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
MH14-MH12                 1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
MH16-MH14                 1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
Mh18-MH16                 1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
MH76-MH78                 1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
```

```
MH78-MH06               1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
MS01                    1.00   0.95  0.00  0.00  0.02  0.03  0.00  0.00  0.02  0.00
MS02                    1.00   0.95  0.01  0.00  0.03  0.00  0.00  0.02  0.01  0.00
MS03                    1.00   0.04  0.00  0.00  0.03  0.00  0.00  0.92  0.03  0.00
MS04                    1.00   0.04  0.00  0.00  0.03  0.00  0.00  0.92  0.01  0.00
MS05                    1.00   0.04  0.02  0.00  0.02  0.00  0.00  0.92  0.02  0.00
MS06                    1.00   0.04  0.02  0.00  0.03  0.00  0.00  0.91  0.03  0.00
MS07                    1.00   0.04  0.00  0.00  0.03  0.00  0.00  0.92  0.02  0.00
MS08                    1.00   0.04  0.00  0.00  0.03  0.00  0.00  0.93  0.01  0.00
MS09                    1.00   0.02  0.00  0.00  0.03  0.00  0.00  0.96  0.03  0.00
MS10                    1.00   0.01  0.69  0.00  0.27  0.03  0.00  0.00  0.95  0.00
MS11                    1.00   0.02  0.03  0.00  0.95  0.00  0.00  0.00  0.95  0.00
MS12                    1.00   0.04  0.00  0.00  0.02  0.00  0.00  0.94  0.01  0.00
MS13                    1.00   0.04  0.00  0.00  0.02  0.00  0.00  0.94  0.01  0.00
MS14                    1.00   0.04  0.00  0.00  0.03  0.00  0.00  0.92  0.03  0.00
MS15                    1.00   0.96  0.04  0.00  0.00  0.00  0.00  0.00  0.00  0.00
MS16                    1.00   0.95  0.05  0.00  0.00  0.00  0.00  0.00  0.00  0.00
MS17                    1.00   0.70  0.30  0.00  0.00  0.00  0.00  0.00  0.00  0.00
STM-OFFSITE-2-4_(STM-OFFSITE)    1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00


*************************
Conduit Surcharge Summary
*************************

----------------------------------------------------------------------------
                                                         Hours        Hours
                       --------- Hours Full --------   Above Full   Capacity
Conduit                Both Ends  Upstream  Dnstream   Normal Flow   Limited
----------------------------------------------------------------------------
MH02-MH100                 24.00     24.00     24.00       0.01         0.87
MH04-MH02                  24.00     24.00     24.00       0.01         0.01
MH06-MH04                  24.00     24.00     24.00       0.01         0.01
MH08-MH06                  24.00     24.00     24.00       0.01         0.01
Mh10-MH08                  24.00     24.00     24.00       0.01         0.01
MH12-MH10                  23.96     23.96     24.00       0.01         0.01
MH14-MH12                   1.43      1.43     23.89       0.01         0.01
MH16-MH14                   0.80      0.80      1.32       0.01         0.01
Mh18-MH16                   0.36      0.36      0.78       0.01         0.01
MH76-MH78                   0.47      0.47      0.50       0.34         0.35
MH78-MH06                   0.66      0.66      0.68       0.19         0.61
STM-OFFSITE-2-4_(STM-OFFSITE)       24.00     24.00     24.00       0.01         0.01


Analysis begun on:  Tue Jul 21 18:06:38 2020
Analysis ended on:  Tue Jul 21 18:06:41 2020
```

```
Total elapsed time: 00:00:03
```

NOVATECH
Engineers, Planners & Landscape Architects

MEMORANDUM

DATE: JULY 23, 2020

TO: SAM BAHIA / BEN SWEET

FROM: CONRAD STANG

RE: RIVERSIDE SOUTH POND 5 / WRIGHT LANDS
DOWNSTREAM HGL ANALYSIS

FILE NO.: 116037

This memorandum provides the downstream HGL analysis of the existing / proposed storm sewer from the proposed wright subdivision to Riverside South Stormwater Management Pond 5.

BACKGROUND

Riverside South Pond 5 (Stantec, 2018)

The design for Riverside South Pond 5 is documented in the *'Riverside South Pond 5 Design Brief' (Stantec, May 7, 2018)*. As part of the design a hydrologic / hydraulic stormwater management model (PCSWMM) was developed, which were based on the proposed ultimate built-out conditions of the contributing area. The PCSWMM model includes the physical features of the Pond 5 inlet and outlet structures. The components of the inlet and outlet structures are represented in the PCSWMM model as orifices, weirs, and closed circular conduits (pipes). The reported Pond 5 water levels based on this configuration were as follows:

Return Period	*Water Level Elev.*
100-year	83.97m
100-year (+20%)	84.00m

River's Edge – Phase 1 (IBI, 2019)

The PCSWMM model for Riverside South Pond 5 was subsequently updated by IBI as part of the design for River's Edge – Phase 1 (IBI, 2019). During the development of River's Edge – Phase 1, the City of Ottawa subsequently released Technical Bulletin 2016-01 to the City of Ottawa Sewer Design Guidelines (October, 2012). Technical Bulletin 2016-01 reduced the sizing requirements for storm sewers and allowing more stormwater to pond on the surface. This in turn lowered the inlet flow rates into the receiving storm sewer and ultimately hydraulic grade line (HGL) elevations. No modifications were made in the PCSWMM model to the features representing Pond 5; however, the reduction in peak flows the resulted in lower Pond 5 water levels, as follows:

Return Period	*Water Level Elev.*
100-year	83.83m
100-year (+20%)	84.92m

Proposed Wright Subdivision (Novatech, 2020)

The PCSWMM model for River's Edge – Phase 1 was provided to Novatech for review with respect to HGL elevations for the Proposed Wright Subdivision (Novatech, 2020). Specifically, the impact to the estimated HGL elevation at STMMH 28 located within River Road, 100m north of the Wright property. The limit of Novatech's review was primarily within the vicinity of the Pond 5 and its southern inlet.

MODEL REVIEW

Based on a review of the PCSWMM model provided by IBI, the following measures were noted that could improve the stability of the model and potentially reduce the estimated HGL elevation at STMMH 28:

- Change the 'large' orifices at the SWM pond to conduits; and,
- Change the weirs at the SWM pond to conduits.

Stantec (2018) included four (4) 'large' diameter orifices in the PCSWMM model within the vicinity of the SWM pond. These orifices represent storm sewers with diameters that range from 1.83 m to 2.44 m. Three (3) of these 'orifices' are immediately downstream a transverse weir with lengths ranging from 4.4 m to 11.0 m. The weirs represent the overflow weirs in the bypass MH at the inlet to the pond and the combined openings in the outlet control structure. A fourth weir represents the pond overflow weir.

The SWMM model represents orifices based on surcharged and non-surcharged conditions; where the water level is below the top of the orifice. When the orifice is surcharged, the orifice equation is used. For non-surcharged conditions, flow over the orifice is represented as a broad-crested weir.

https://www.openswmm.org/Topic/3756/swmm5-unsubmerged-orifices
https://www.openswmm.org/Topic/4625/swmm-5-1-weir-behavior-for-partially-full-orifices

The 'large' weir to 'small' weir (unsubmerged orifice) combination may be causing stability issues and artificially increasing the HGL. The backwater condition from the 'fixed' outfall may also cause further model instabilities. It has been previously noted through the openswmm.org community that large orifices and specifically weirs can cause stability issues.

https://www.openswmm.org/Topic/14406/dry-or-almost-dry-pipe
https://www.openswmm.org/Topic/3306/instabilities-when-using-weirs

When speaking with Dr. Nandana Perera, PhD, P.Eng. at CHI Water (developers of PCSWMM), he reiterated that weirs cause stability issues with SWMM. Especially if you have a large weir cross-section to small weir (unsubmerged orifice) cross-section. He recommended in this case to use conduits to represent both the orifices and weirs; with a minimum 0.10% longitudinal slope.

MODEL UPDATE

Per the suggestions from CHI Water, orifice and weirs within the vicinity of the Pond 5 were changed to conduits with 0.10% longitudinal slopes. This reduced the HGL elevations; however, resulted in higher release rates from Pond 5; refer to Table 1 and Table 2. As such, the modifications to the PCSWMM model were then limited to components of the south inlet structure (MH166). By representing the overflow weir and downstream storm sewer at MH166 as conduits, the resulting HGL elevations at storm MH28 was reduced by 0.51m. Refer to attached 100-year HGL profile plots.

Table 1: Hydraulic Grade Line Comparison (model updates)

Scenario	100-year HGL Elev. (m)				100-year (+20%) HGL Elev. (m)			
	MH28	MH29	MH166	Pond 5	MH28	MH29	MH166	Pond 5
Base Scenario (IBI)	**86.32**	86.29	85.45	83.83	**86.57**	86.54	85.66	83.92
Orifices as Conduits	**86.03**	86.00	85.09	83.74	**86.21**	86.17	85.22	83.78
Orifices & Weirs as Conduits	**85.79**	85.76	84.83	83.55	**85.98**	85.95	84.97	83.58
Modifications to MH166 Orifice	**86.04**	86.01	85.10	83.80	**86.22**	86.19	85.25	83.88
Modifications to MH166 Orifice & Weir	**85.81**	85.78	84.88	83.77	**86.05**	86.02	85.08	83.86

Table 2: Release Rate Comparison

Scenario	100-year Release Rate (L/s)			100-year (+20%) Release Rate (L/s)		
	P5-OR	P5-WR	OF1	P5-OR	P5-WR	OF1
Base Scenario (IBI)	16,110	4,058	10,601	16,690	5,765	10,819
Orifices as Conduits	18,415	2,481	12,503	19,790	3,198	12,915
Orifices & Weirs as Conduits	20,661	394	13,263	21,963	928	13,491
Modifications to MH166 Orifice	15,888	3,523	12,546	16,456	5,022	12,990
Modifications to MH166 Orifice & Weir	15,626	2,965	13,351	16,292	4,545	13,606

Note that the model contains over 200 nodes (out of 772) that have flow errors higher than 1.0% or lower than -1.0%. The above improvements may improve the local stability for representing the outlet structures for the SWM pond; however, the model may contain more instabilities that could impact the estimated HGL. This would require a more thorough review.

STATIC ANALYSIS

A static analysis was conducted to better understand the resulting HGL elevations and potential losses within the storm sewer system. This analysis includes headloss calculations and flow depths over the overflow weir at MH166.

Headloss Calculations

Headloss calculations were performed to estimate static HGL elevations at proposed MH100 (proposed Wright Subdivision); refer to Figure 1 – Proposed Storm Sewer Alignment. The starting Pond 5 water levels were per Stantec (2018) and losses were estimated based on the 2100mm dia. (low-flow pipe) that outlets to the forebay. Potential losses within the storm sewer system using Bernoulli's equation (see attached). Losses are based on the full flow pipe velocity and associated entrance, bend(s) and exit losses. Detailed headloss calculations for this scenario are attached. Table 3 provides a summary of the headloss calculations for the 100-year storm event.

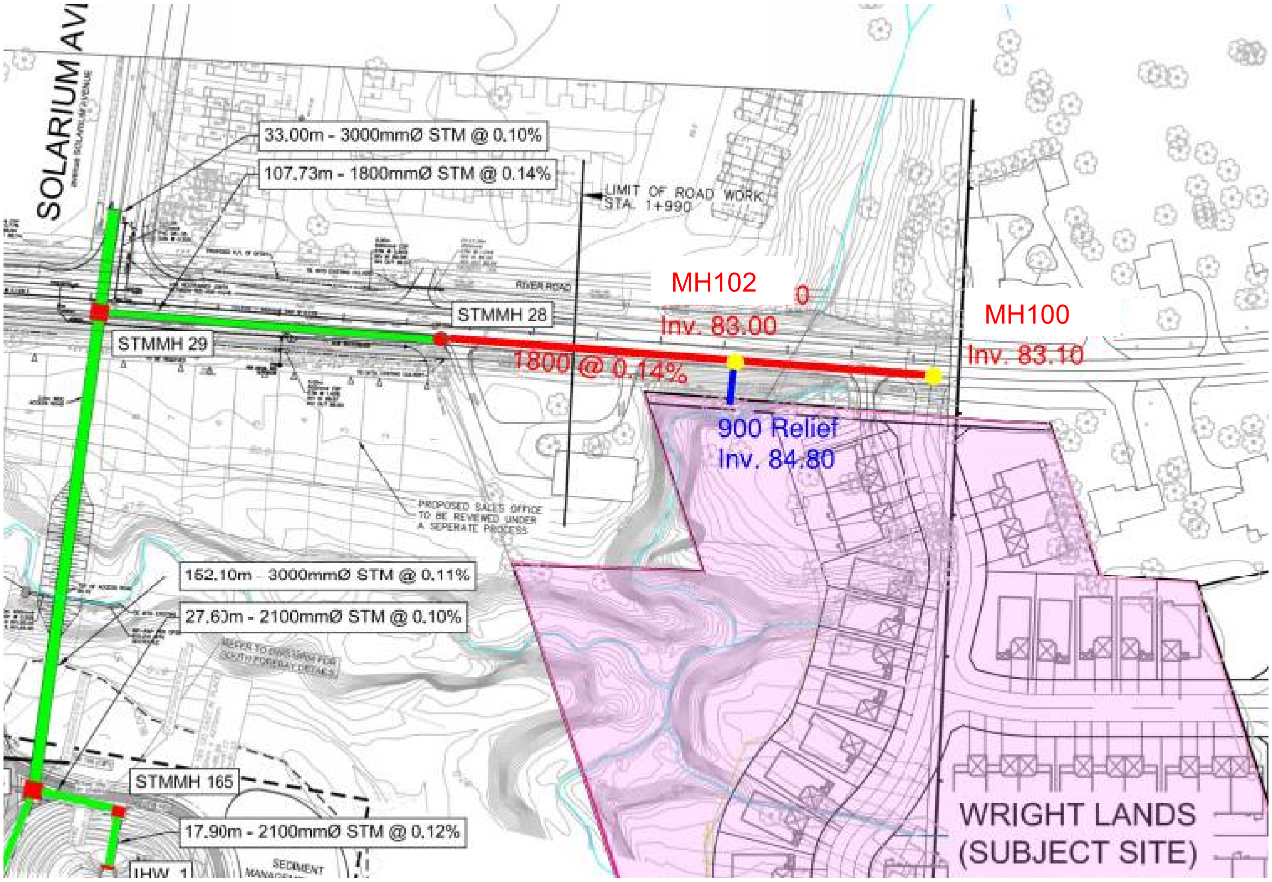


Figure 1 – Proposed Storm Sewer Alignment

Table 3: Headloss Calculations based on Water Level in Pond 5 (100-year)

Structure		Pipe Information			HGL		Headloss
U/S	D/S	Pipe Dia. (mm)	Pipe Length (m)	Pipe Slope (%)	U/S	D/S	
MH165	Pond 5*	2100	17.9	0.12%	84.15	83.97	0.18
MH166	MH165	2100	27.6	0.10%	84.48	84.15	0.32
MH29	MH166	3000	162.1	0.10%	85.05	84.48	0.58
MH28	MH29	1800	107.7	0.14%	85.42	85.05	0.37
MH102	MH28	1800	100.0	0.14%	85.60	85.42	0.18
MH100	MH102	1800	50.0	0.14%	85.77	85.60	0.18

**100-year water level in Pond 5 = 83.97m.*

Weir Calculations (MH166)

The existing south Pond 5 inlet structure (MH166) includes an overflow weir to direct lower flows towards the south Pond 5 forebay (2100mm storm sewer). Higher flows will overtop a 4.3m wide broad crested weir at an elevation of 83.51m and outlet via an 1800mm dia. storm sewer to the Rideau River. Refer to attached Pond 5 drawing excerpts (Stantec, 2018) for further details.

The flow depth over the weir and distribution of peak flows at MH166 is shown in Table 4. The peak flows are based on the PCSWMM model provided by IBI (3-hour Chicago storm distribution).

Table 4: Flow Depth over Weir (MH166)

Scenario	Peak Flow*			Flow Depth over Weir (HGL)
	Inflows (MH166)	2100mm Dia. (low-flow pipe)	Overflow Weir	
100-year	23.3 m^3/s	12.7 m^3/s	10.6 m^3/s	1.22m (84.73m)
100-year (+20%)	23.8 m^3/s	13.0 m^3/s	10.8 m^3/s	1.23m (84.74m)

**3-hour Chicago storm distribution.*

The corresponding 100-year flow depth over the weir is 1.22m (HGL of 84.73m on the upstream side of the weir). In comparison with the headloss calculations for the 2100mm dia. low-flow pipe, the flow depth over the weir governs the HGL within the upstream storm sewer system. Table 5 provides the updated headloss calculations based on the flow depth over the weir at MH166.

Table 5: Headloss Calculations based on Flow Depth over Weir at MH166 (100-year)

Structure		Pipe Information			HGL		Headloss
U/S	D/S	Pipe Dia. (mm)	Pipe Length (m)	Pipe Slope (%)	U/S	D/S	
MH29	MH166	3000	162.1	0.10%	85.31	84.73	0.58
MH28	MH29	1800	107.7	0.14%	85.67	85.31	0.37
MH102	MH28	1800	100.0	0.14%	85.85	85.67	0.18
MH100	MH102	1800	50.0	0.14%	86.02	85.85	0.18

**100-year flow depth over weir = 1.22m (84.73m).*

HGL Comparison

Table 6 provides a comparison of the hydraulic grade line (HGL) elevations, based on the flow depth over the weir (Table 5), with those presented in the model stability review memorandum (Novatech, May 4, 2020). The HGL elevations estimated using the dynamic hydrologic / hydraulic model (PCSWMM) are higher than those estimated using Bernoulli's equation. The model appears to account for additional losses, potentially due to higher velocities, that are not being represented in the Bernoulli's equation.

Table 6: Hydraulic Grade Line Comparison (static analysis)

Scenario	100-year HGL Elev. (m)				100-year (+20%) HGL Elev. (m)			
	MH28	MH29	MH166	Pond 5	MH28	MH29	MH166	Pond 5
Base Scenario (IBI)	**86.32**	86.29	85.45	83.83	**86.57**	86.54	85.66	83.92
Orifices as Conduits	**86.03**	86.00	85.09	83.74	**86.21**	86.17	85.22	83.78
Orifices & Weirs as Conduits	**85.79**	85.76	84.83	83.55	**85.98**	85.95	84.97	83.58
Modifications to MH166 Orifice	**86.04**	86.01	85.10	83.80	**86.22**	86.19	85.25	83.88
Modifications to MH166 Orifice & Weir	**85.81**	85.78	84.88	83.77	**86.05**	86.02	85.08	83.86
Bernoulli's Eqn. (per depth over weir)	**85.67**	85.31	84.73	83.97	**85.68**	85.32	84.74	84.00

**3-hour Chicago storm distribution.*

RELIEF PIPE

There is an existing 1200mm dia. CSP culvert that crosses River Road. Proposed to be constructed adjacent the culvert is a 1800mm (width) x 900mm (height) relief pipe (MH102). The intent of the relief pipe is to reduce the HGL elevations within the storm sewer system. The relief pipe would outlet into the watercourse along the northern portion of the proposed Wright Subdivision, which is situated in a deep valley.

The relief pipe has been set at an elevation of 84.50m. This represents the approximate obvert elevation of the 3000mm dia. storm sewer at MH29. The relief pipe was added to the PCSWMM model at MH28 as the additional pipe run to MH100 is not included in the PCSWMM model.

Table 7 provides a comparison of the HGL elevations, with the relief pipe at MH28, for the Base Scenario (IBI) and scenario where the orifices and weirs are represented as conduits (Novatech). As shown, the relief pipe can reduce the HGL within the Base Scenario (IBI) by 0.62m. Based on the changes proposed by Novatech, the HGL at MH28 can be reduced by an additional 0.30m (0.92m).

Table 7: Hydraulic Grade Line Comparison (with relief pipe)

Scenario	100-year HGL Elev. (m)				100-year (+20%) HGL Elev. (m)			
	MH28	MH29	MH166	Pond 5	MH28	MH29	MH166	Pond 5
Without Relief Pipe								
Base Scenario (IBI)	**86.32**	86.29	85.45	83.83	**86.57**	86.54	85.66	83.92
Orifices as Conduits	**86.03**	86.00	85.09	83.74	**86.21**	86.17	85.22	83.78
Orifices & Weirs as Conduits	**85.70**	85.70	85.01	83.79	**85.81**	85.81	85.11	83.87
Modifications to MH166 Orifice	**86.04**	86.01	85.10	83.80	**86.22**	86.19	85.25	83.88
Modifications to MH166 Orifice & Weir	**85.81**	85.78	84.88	83.77	**86.05**	86.02	85.08	83.86
With Relief Pipe								
Base Scenario (IBI)	**85.70**	85.70	85.01	83.79	**85.81**	85.81	85.11	83.87
Orifices as Conduits	**85.59**	85.59	84.84	83.72	**85.67**	85.67	84.90	83.76
Orifices & Weirs as Conduits	**85.38**	85.38	84.56	83.53	**85.53**	85.53	84.68	83.56
Modifications to MH166 Orifice	**85.58**	85.58	84.84	83.78	**85.68**	85.68	84.91	83.85
Modifications to MH166 Orifice & Weir	**85.40**	85.39	84.61	83.74	**85.56**	85.56	84.74	83.82

**3-hour Chicago storm distribution.*

CLOSURE

The proposed modifications can reduce HGL elevations. The use of the relief pipe is recommended as it will provide a benefit in maintaining HGL elevations for the proposed Wright Subdivision. It may also benefit the existing and proposed developments by maintaining the HGL within the storm sewer system. Modifications may only be required at the inlet structures to Pond 5 (i.e. MH166). The 100-year HGL elevation at MH28 during this scenario is 85.40m. This value is used as the boundary condition for the preliminary PCSWMM model to assess HGL elevations for the Wright Subdivion.

Attachments:

- Bernoulli Equation
- Headloss Calculations
- PCSWMM Model Schematic (IBI)
- PCSWMM 100-year HGL Profile Plots
    - Base Scenario (IBI)
    - Orifices as Conduits (Novatech)
    - Orifices & Weirs as Conduits (Novatech)
- Riverside Pond 5 Drawing Excerpts (Stantec, 2018)
    - Overall Grading Plan (GP01)
    - Overall Servicing Plan (SP01)
    - Structural Outlet Structure Plans, Elevations and Details (S2)
    - Structural STM166 and STM 167, Weir Walls, Plans and Details (S5)
- Packaged PCSWMM Models
    - Base Scenario (IBI)
    - Orifices as Conduits (Novatech)
    - Orifices & Weirs as Conduits (Novatech)

Bernoulli Equation

The Bernoulli equation was used to calculate the potential headloss's in the storm sewer:

$$\frac{P_1}{\partial} + z_1 + \frac{V_1^2}{2g} = \frac{P_2}{\partial} + z_2 + \frac{V_2^2}{2g} + \sum H_L$$

Assumptions:

1) The atmospheric pressure was assumed to remain the same at the inlet (P_1) and outlet (P_2) of the storm sewer; therefore, $\frac{P_1}{\partial}$ - $\frac{P_2}{\partial}$ = 0.

2) The flow rate, cross-sectional area, and thus velocity entering and exiting the storm sewer is equivalent; therefore, $\frac{V_1^2}{2g} - \frac{V_2^2}{2g} = 0$.

Based on the above assumptions, the simplified Bernoulii equation is:

$$z_1 - z_2 = \sum H_L$$

Where:

z_1 & z_2 = the water level elevations at the inlet and outlet (m)

Headloss ($\sum H_L$) is calculated as follows:

$$\sum H_L = \frac{V^2}{2g}(K_{entrance} + K_{bend1} + K_{bend2} + K_{bend3} + K_{exit}) + \frac{fL}{D}$$

Where:

V = pipe velocity (m/s)
g = acceleration due to gravity *(9.81 m/s^2)*
$K_{entrance}$ = entrance losses *(0.2 for a rounded inlet)*
K_{bend1}, K_{bend2} & K_{bend3} = bend losses (refer to Table 1)
K_{exit} = exit losses *(1.0 for open outlet)*
L = pipe length (m)
D = pipe diameter (m)
f = friction factor (unitless)

Table 1: Bend Losses

Bend Angle	Exit Loss Coefficient (K_{bend})
0°	0
15°	0.09
30°	0.24
45°	0.39
60°	0.64
75°	0.96
90°	1.32

**Per the City of Ottawa Sewer Design Guidelines (Appendix 6B).*

The friction factor (f) for circular pipes = 64 / Re

Bernoulli Equation

Reynolds Number (Re) is calculated as: Re = VD / v.

Where

v = kinematic viscosity (1.519×10^{-6} m^2/s for water at $5^{O}C$)

Simplifying the Bernoulli equation to solve for z_1 gives:

$$z_1 = z_2 + \frac{V^2}{2g}\left(K_{entrance} + K_{bend1} + K_{bend2} + K_{bend3} + K_{exit} + \frac{fL}{D}\right)$$

Wright Subdivision (116037)
Headloss Calculations (100-year)

NOVATECH
Engineers, Planners & Landscape Architects

Bernoulli's Equation

LOCATION		SEWER PROPERTIES						PIPE LOSSES					FRICTON FACTOR		Water Level Elevations		Headloss
FROM	**TO**	**Pipe Size (mm)**	**Actual Pipe Size (m)**	**Pipe Slope (%)**	**Length (m)**	**Capacity (l/s)**	**Full Flow Velocity (m/s)**	**Entrance Loss ($K_{entrance}$)**	**Bend Loss 1 (K_{bend1})**	**Bend Loss 2 (K_{bend2})**	**Bend Loss 3 (K_{bend3})**	**Exit Loss (K_{exit})**	**Reynolds Number (Re)**	**Friction Factor (f)**	**Outlet (m)**	**Inlet (m)**	**(m)**
HW1	MH165	2100	2.108	0.12	17.9	6067.9	1.74	0.2	0	0	0	1.0	2,412,551	2.65E-05	83.97	84.15	0.18
MH165	MH166	2100	2.108	0.10	27.6	5539.2	1.59	0.2	1.32	0	0	1.0	2,202,347	2.91E-05	84.15	84.48	0.32
MH166	MH29	3000	3.023	0.11	152.1	15186.0	2.12	0.2	1.32	0	0	1.0	4,211,296	1.52E-05	84.48	85.05	0.58
MH29	MH28	1800	1.803	0.14	107.7	4321.5	1.69	0.2	1.32	0	0	1.0	2,008,604	3.19E-05	85.05	85.42	0.37
MH28	MH100	1800	1.803	0.14	100.0	4321.5	1.69	0.2	0	0	0	1.0	2,008,604	3.19E-05	85.42	85.60	0.18
MH100	MH102	1800	1.803	0.14	50.0	4321.5	1.69	0.2	0	0	0	1.0	2,008,604	3.19E-05	85.60	85.77	0.18

Notes:

Kinematic Viscosity (v) = 1.519E-06 m^2/s (for water at 5ºC)

Reference Equations:

$$\boxed{z_1 = z_2 + \frac{V^2}{2g}\left(K_{entrance} + K_{bend1} + K_{bend2} + K_{bend3} + K_{exit} + \frac{fL}{D}\right)}$$

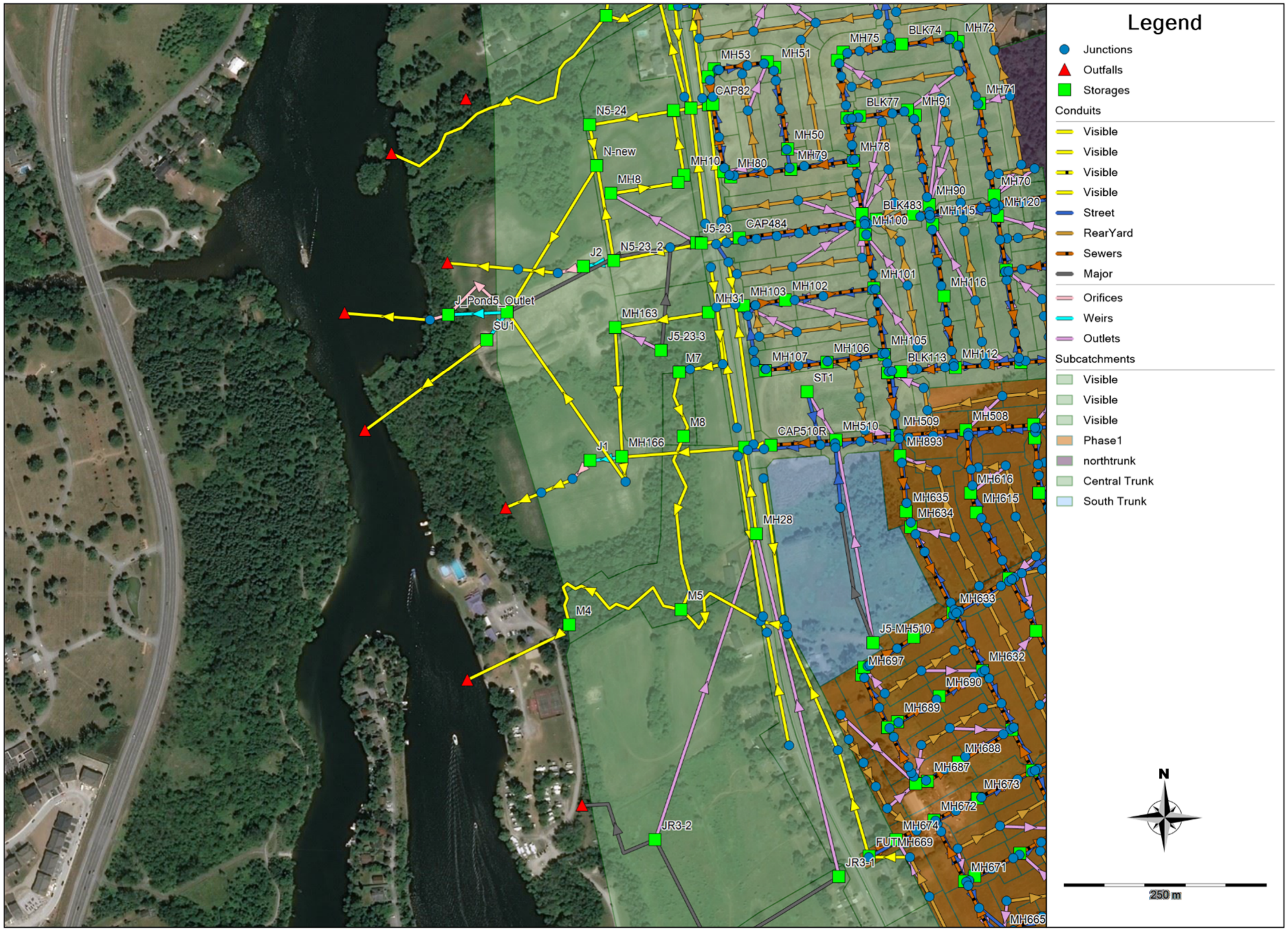
$$\boxed{f = \frac{64}{Re}} \quad \boxed{Re = \frac{VD}{v}}$$

Where:

z_1 = the water level elevations at the inlet (m)
z_2 = water level elevations at the outlet (m)
V = pipe velocity (m/s)
g = acceleration due to gravity (9.81 m/s^2)
$K_{entrance}$ = entrance losses (0.5 for a flat headwall)
K_{bend1}, K_{bend2} & K_{bend3} = bend losses (refer to Table 1)
K_{exit} = exit losses (1.0 for open outlet)
L = pipe length (m)
D = pipe diameter (m)
f = friction factor (unitless)
Re = Reynold Number (unitless)
v = kinematic viscosity (m^2/s)

Date: 6/16/2020
M:\2016\116037\DATA\Calculations\Sewer Calcs\SWM\HGL Analysis (Pond 5)\Bernoulli Calculations.xlsx

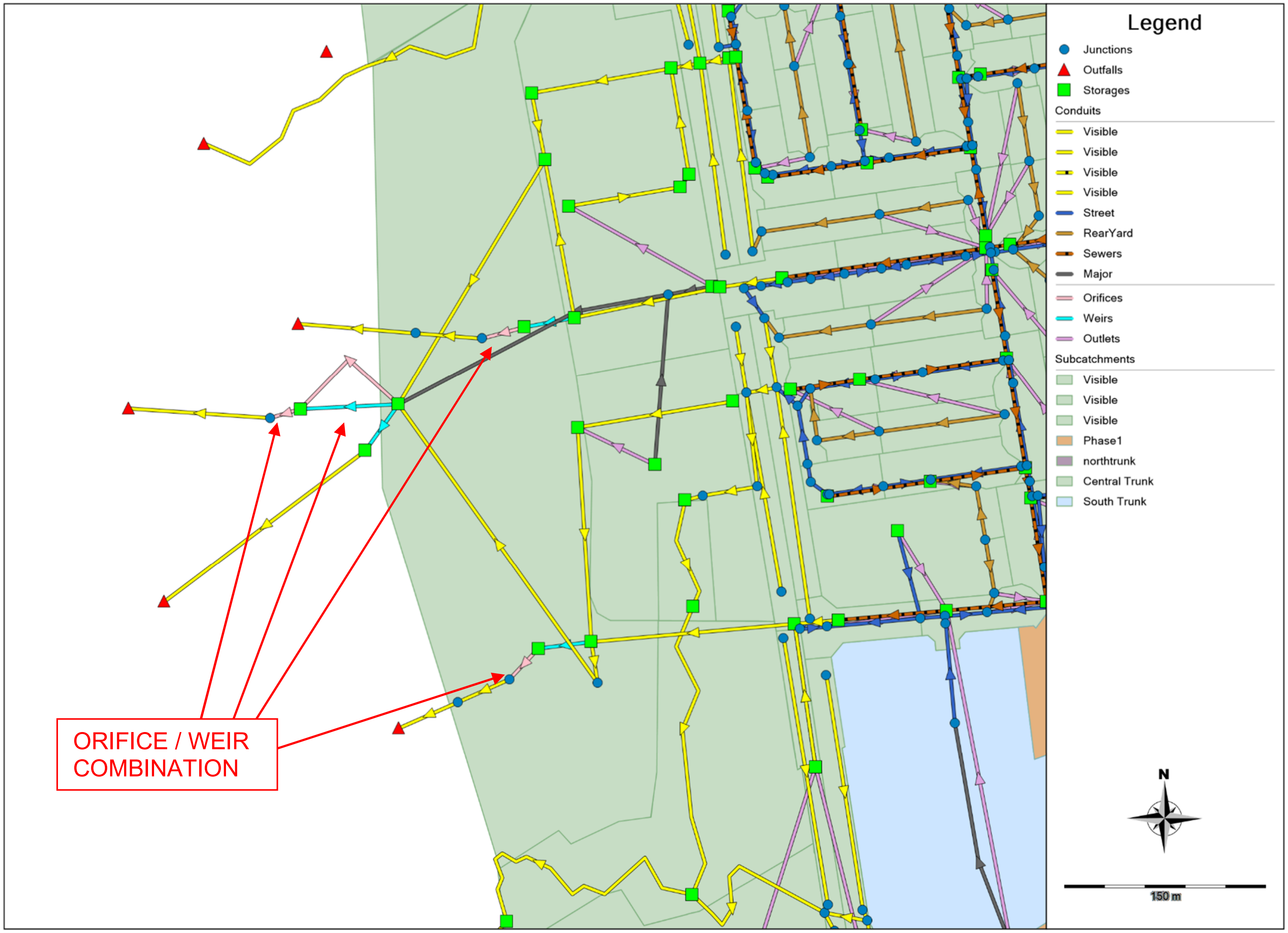
Riverside South Pond 5
PCSWMM Model Schematic (IBI)



Date: 2020-05-04

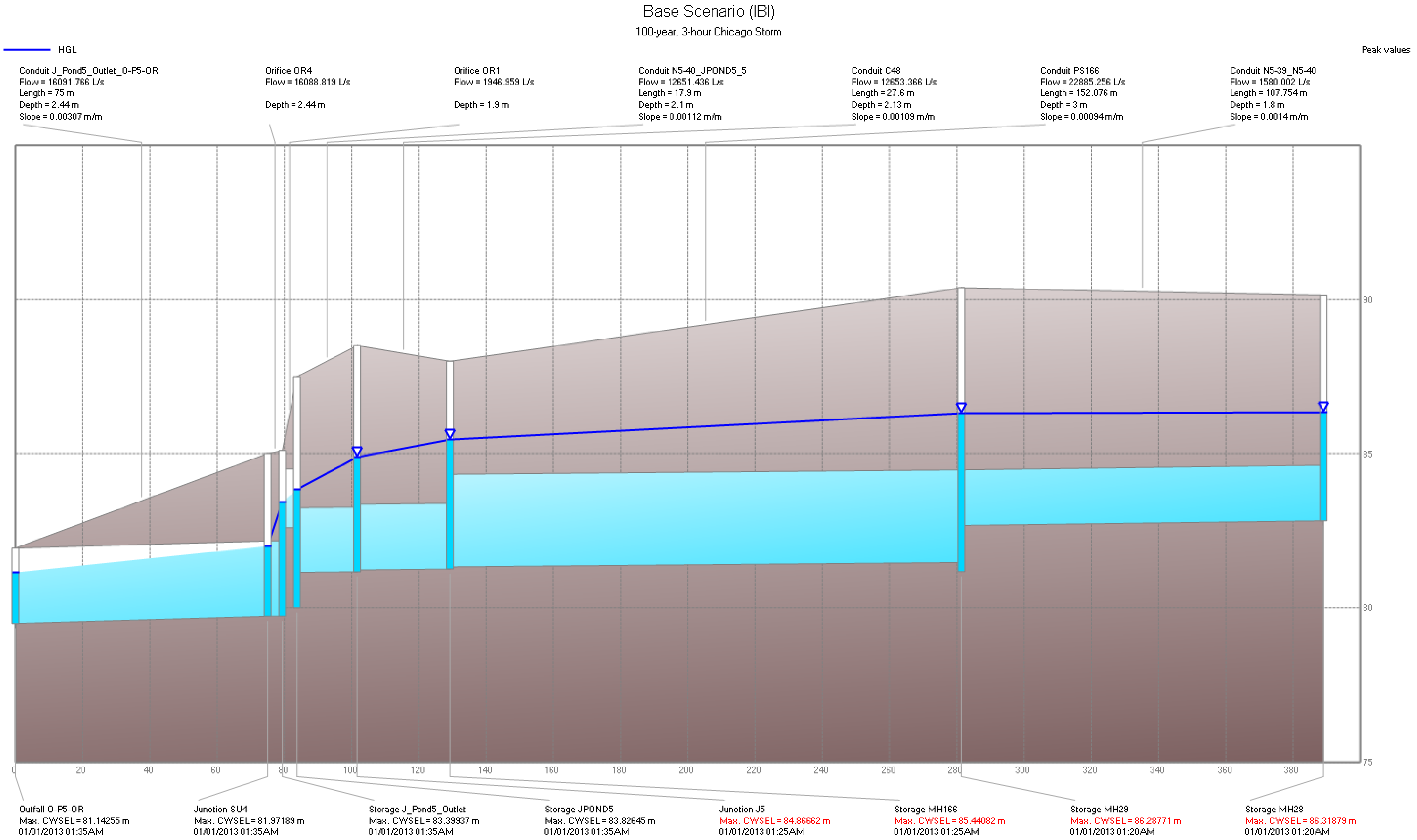
M:\2016\116037\DATA\Calculations\Sewer Calcs\SWM\IBI PCSWMM Model (Riverside South)\Model Schematics (IBI).docx

Riverside South Pond 5
PCSWMM Model Schematic (IBI)



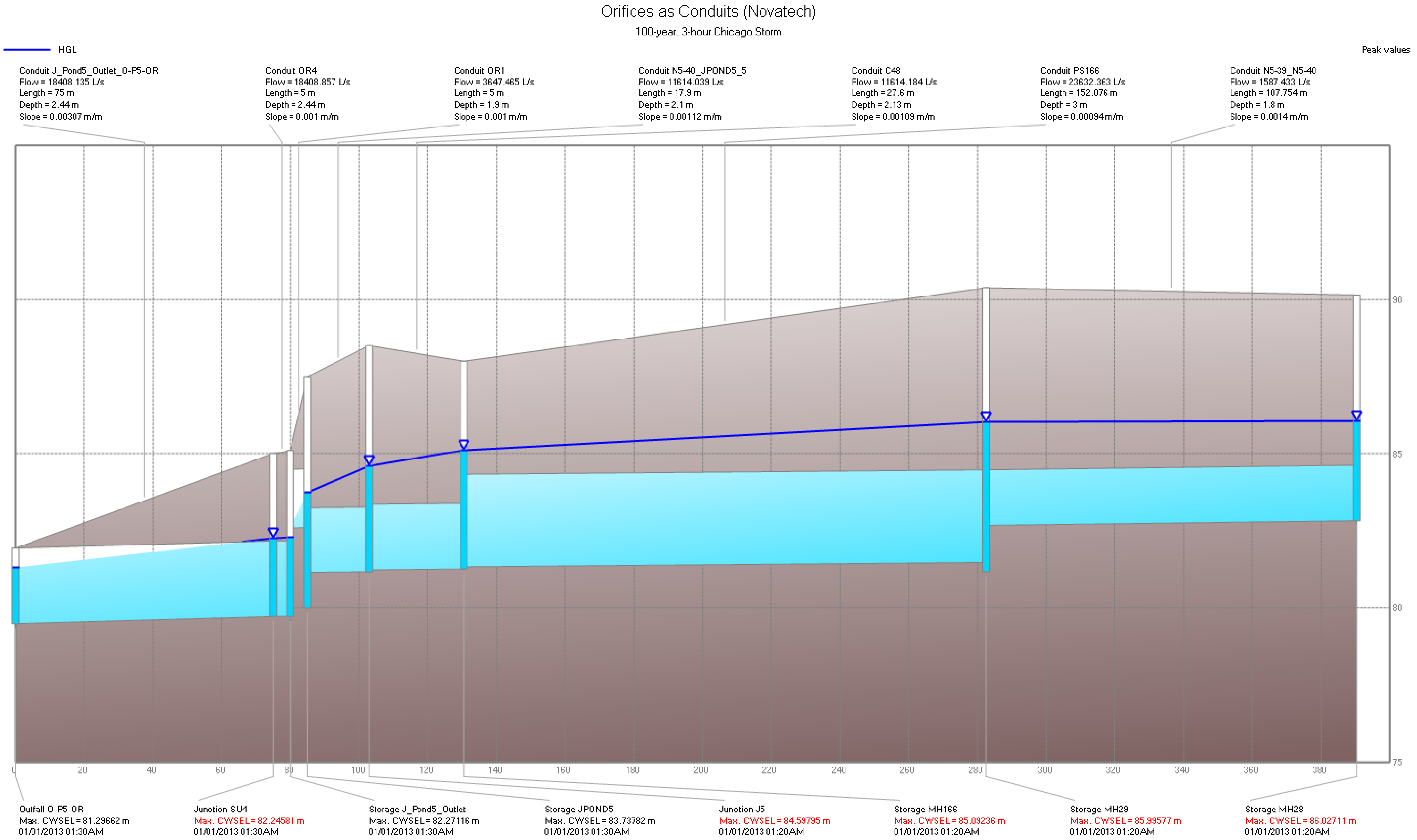
Date: 2020-05-04
M:\2016\116037\DATA\Calculations\Sewer Calcs\SWM\IBI PCSWMM Model (Riverside South)\Model Schematics (IBI).docx

Riverside South Pond 5
PCSWMM HGL Profile Plots (100-year, 3-hour Chicago Storm)



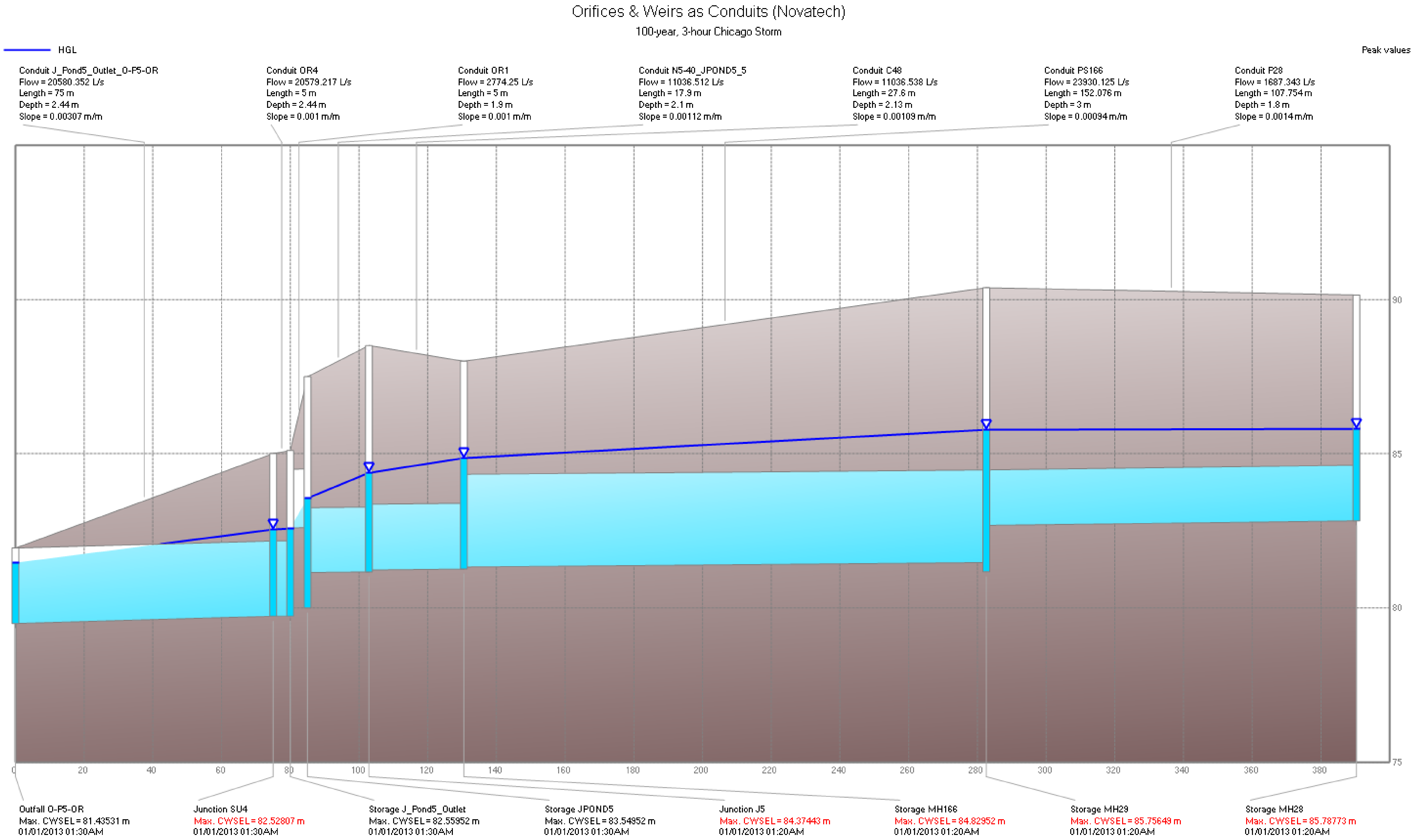
Date: 2020-07-24
M:\2016\116037\DATA\Calculations\Sewer Calcs\SWM\HGL Analysis (Pond 5)\HGL Profile Plots.docx

Riverside South Pond 5
PCSWMM HGL Profile Plots (100-year, 3-hour Chicago Storm)



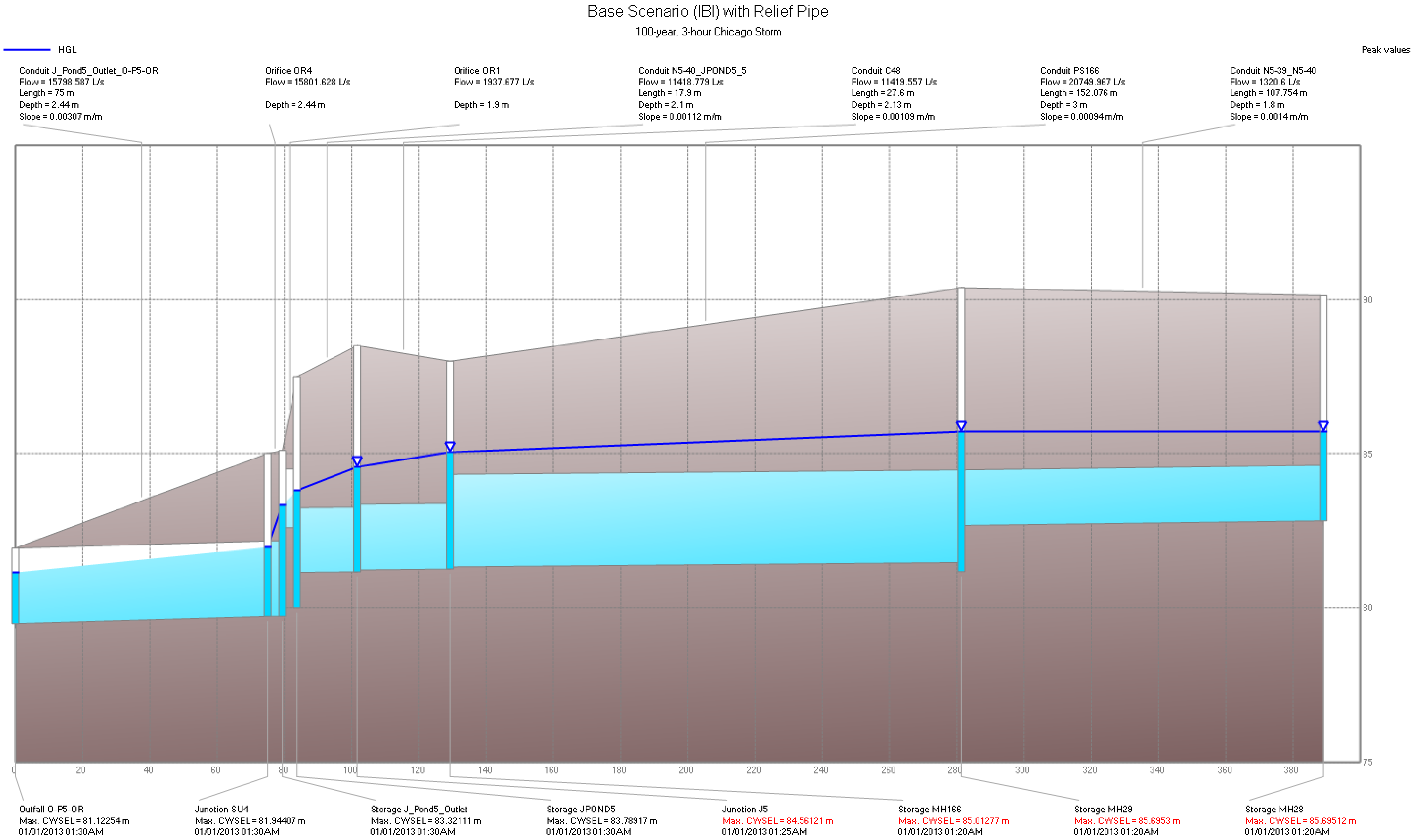
Date: 2020-07-24
M:\2016\116037\DATA\Calculations\Sewer Calcs\SWM\HGL Analysis (Pond 5)\HGL Profile Plots.docx

Riverside South Pond 5
PCSWMM HGL Profile Plots (100-year, 3-hour Chicago Storm)



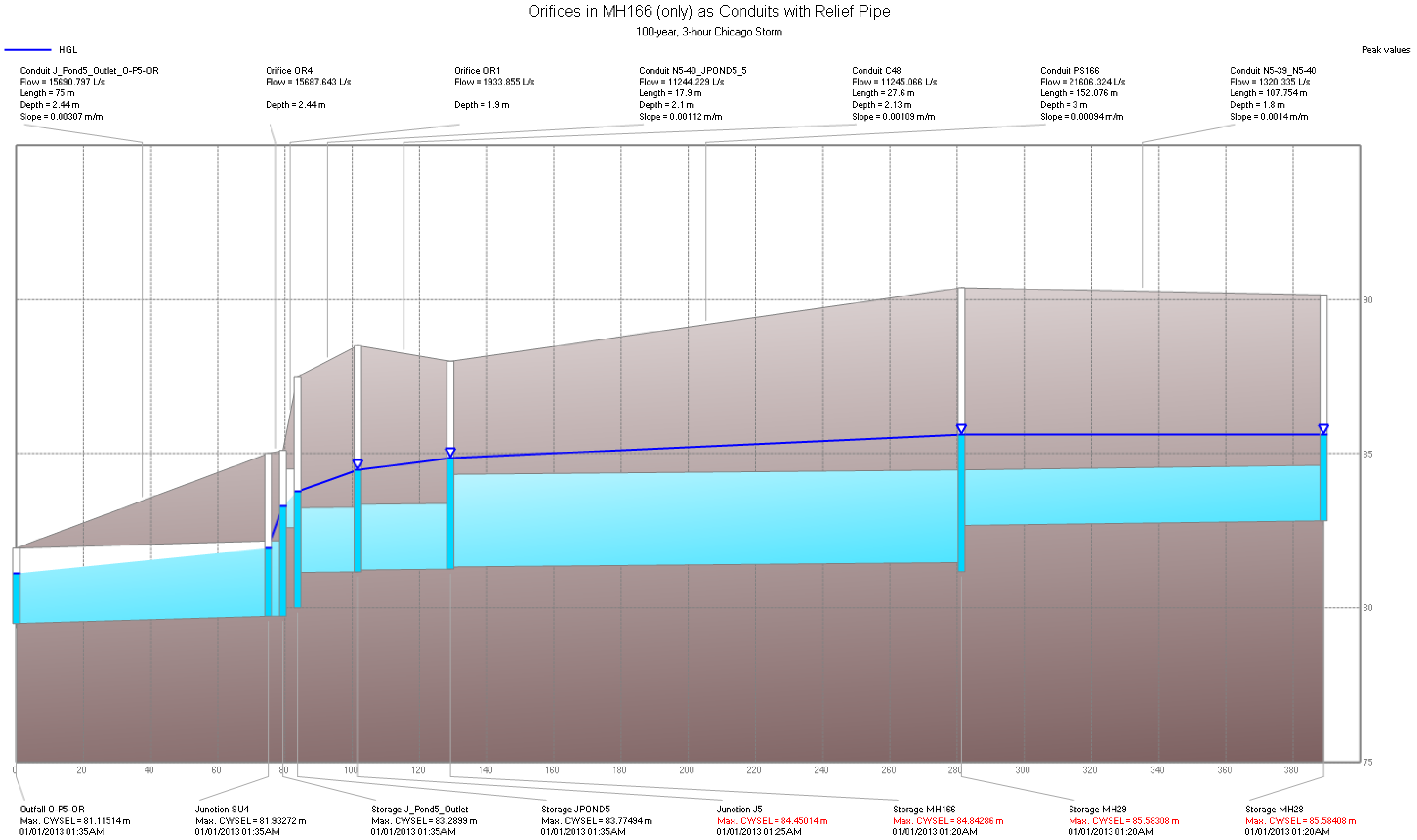
Date: 2020-07-24
M:\2016\116037\DATA\Calculations\Sewer Calcs\SWM\HGL Analysis (Pond 5)\HGL Profile Plots.docx

Riverside South Pond 5
PCSWMM HGL Profile Plots (100-year, 3-hour Chicago Storm)



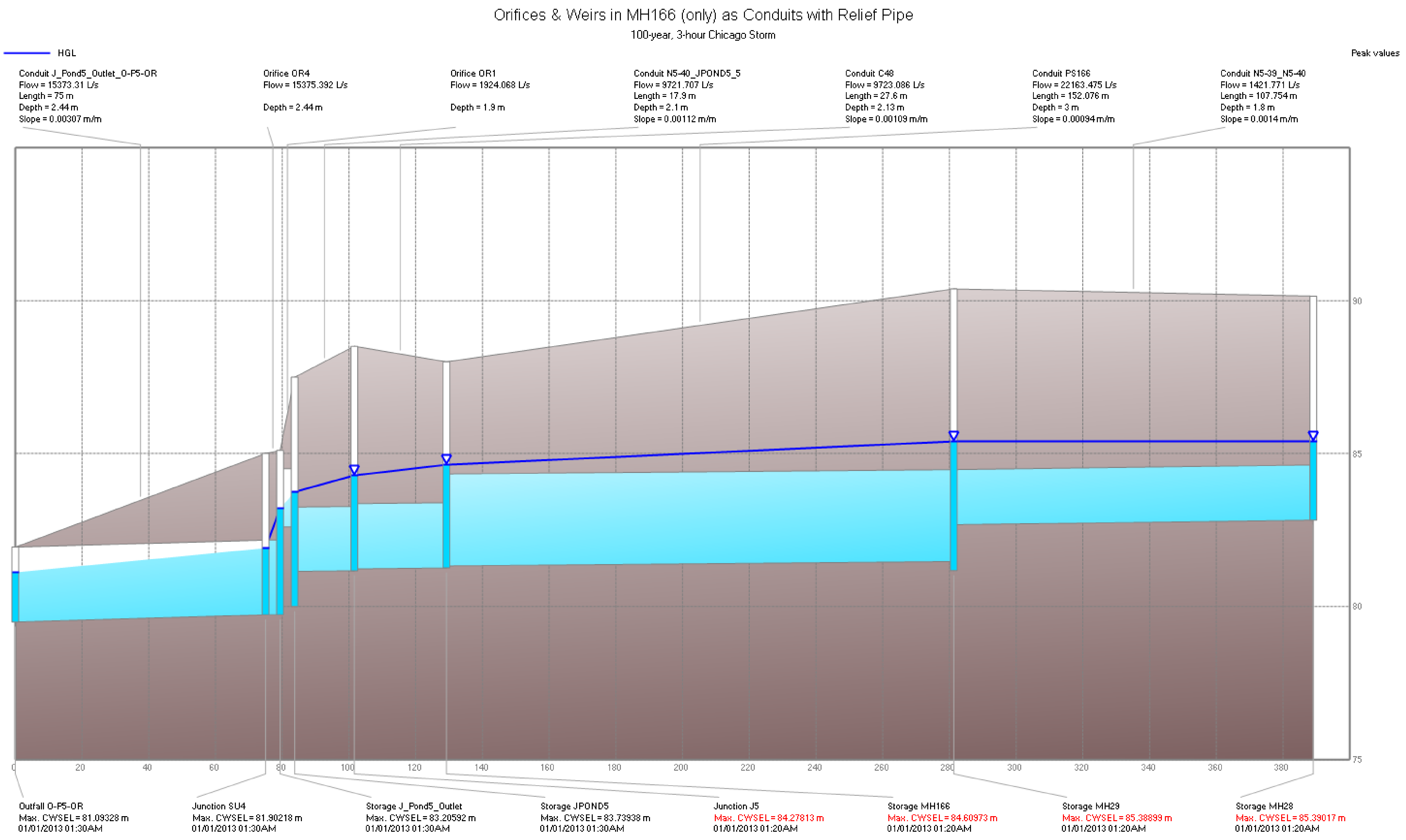
Date: 2020-07-24
M:\2016\116037\DATA\Calculations\Sewer Calcs\SWM\HGL Analysis (Pond 5)\HGL Profile Plots.docx

Riverside South Pond 5
PCSWMM HGL Profile Plots (100-year, 3-hour Chicago Storm)

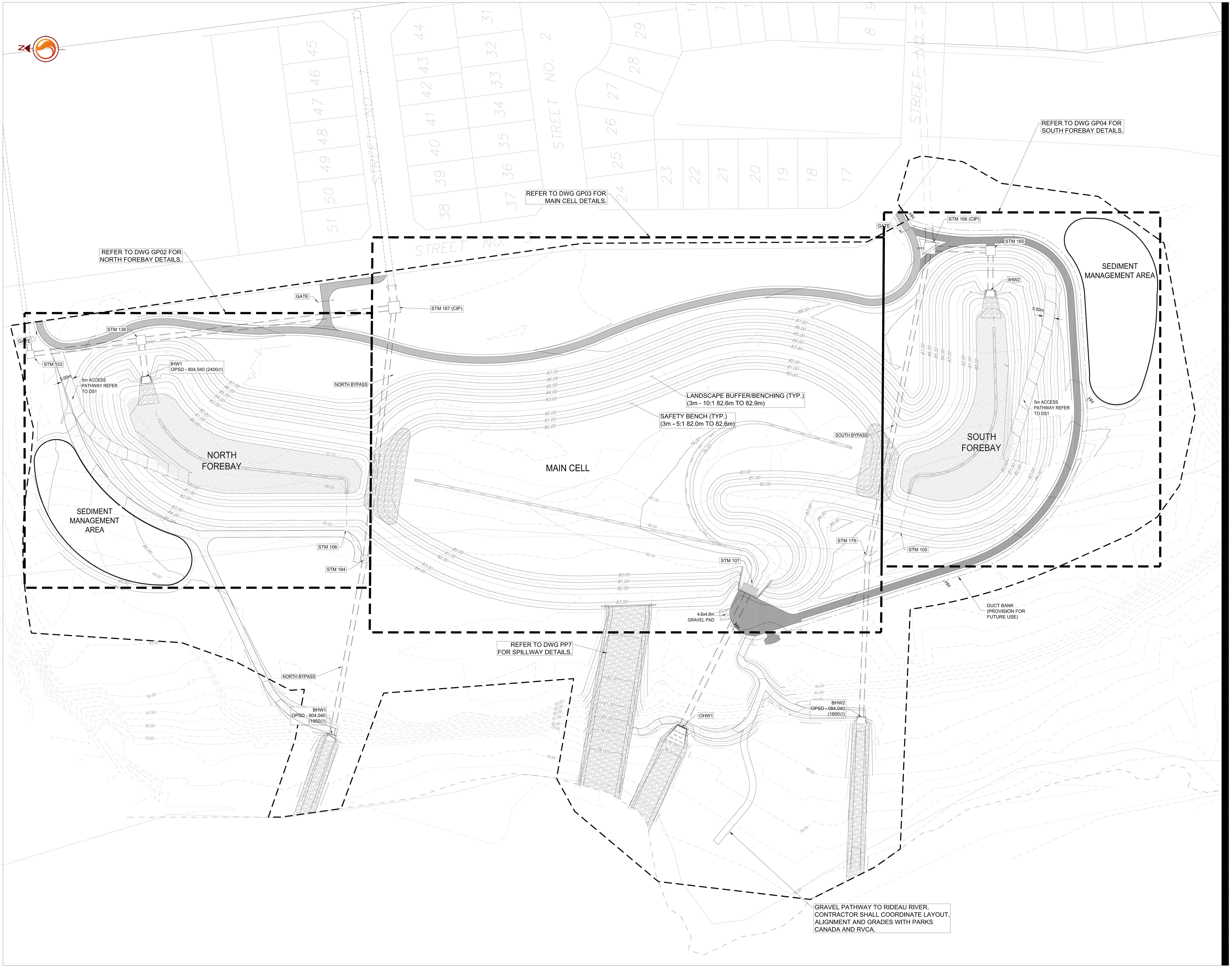


Date: 2020-07-24
M:\2016\116037\DATA\Calculations\Sewer Calcs\SWM\HGL Analysis (Pond 5)\HGL Profile Plots.docx

Riverside South Pond 5
PCSWMM HGL Profile Plots (100-year, 3-hour Chicago Storm)



Date: 2020-07-24
M:\2016\116037\DATA\Calculations\Sewer Calcs\SWM\HGL Analysis (Pond 5)\HGL Profile Plots.docx



WATER LEVELS	INITIAL INTERIM	INTERIM	ULTIMATE
2yr	82.43	83.15	83.50
5yr	82.78	83.34	83.63
10yr	82.95	83.43	83.71
25yr	83.08	83.54	83.82
100yr	83.28	83.67	83.96

Stantec

Stantec Consulting Ltd.
400 - 1331 Clyde Avenue
Ottawa ON
Tel. 613.722.4420
www.stantec.com

Copyright Reserved

Legend

- - - -	FUTURE STORM SEWER
◌	FUTURE STORM MANHOLE
— — —	PROPOSED STORM SEWER
○	PROPOSED STORM MANHOLE
□	PROPOSED BOX MANHOLE
▨	PROPOSED HEADWALL
▬	PROPOSED MULTI-USE PATHWAY
▭	PROPOSED REINFORCED GRASS ACCESS PATHWAY
━	PROPOSED INTERIM AND ULTIMATE NORMAL WATER LEVELS
— — —	CONSTRUCTION LIMITS
C / XS5	SECTION NAME SHEET LOCATION
▨	APPROXIMATE LOCATION OF RIP-RAP. CLASS AND EXTENT AS IDENTIFIED WITHIN PROFILES, SECTIONS AND DETAILS.
▨	GRANULAR 'B' AS IDENTIFIED WITHIN PROFILES, SECTIONS AND DETAILS.
▬ ▬ ▬	PROPOSED TREE PROTECTION SNOW FENCE BARRIER

12	ISSUED FOR CONSTRUCTION	AL	MJT	18.08.28
11	ISSUED FOR ADDENDUM No. 3	AL	MJT	18.07.25
10	ISSUED FOR ADDENDUM No. 1	AL	MJT	18.07.17
9	ISSUED FOR TENDER	AL	MJT	18.06.22
8	ISSUED FOR 90% DETAIL DESIGN	AL	MJT	18.05.09
7	ISSUED FOR DESIGN REVIEW	WAJ	MJT	18.02.02
6	ISSUED FOR DESIGN REVIEW	WAJ	MJT	17.12.15
5	ISSUED FOR 90% DESIGN REVIEW	WAJ	MJT	17.11.17
4	ISSUED FOR DRAFT DESIGN REVIEW	WAJ	AML	17.06.30
3	REVISED SETBACKS PER RVCA COMMENT	AML	AML	17.05.09
2	REVISED PER RVCA COMMENT	AML	AML	17.03.31
Revision		By	Appd.	YY.MM.DD

Permit-Seal

S.G. D'AOUST
18.08.28

M.J.H. THIVIERGE
100103993
18.08.28

Client/Project

RIVERSIDE SOUTH
DEVELOPMENT CORPORATION

RIVERSIDE POND 5

OTTAWA, ON

Title

OVERALL GRADING PLAN

Project No.
163401322

Scale
1:750
0 7.5 22.5 37.5m

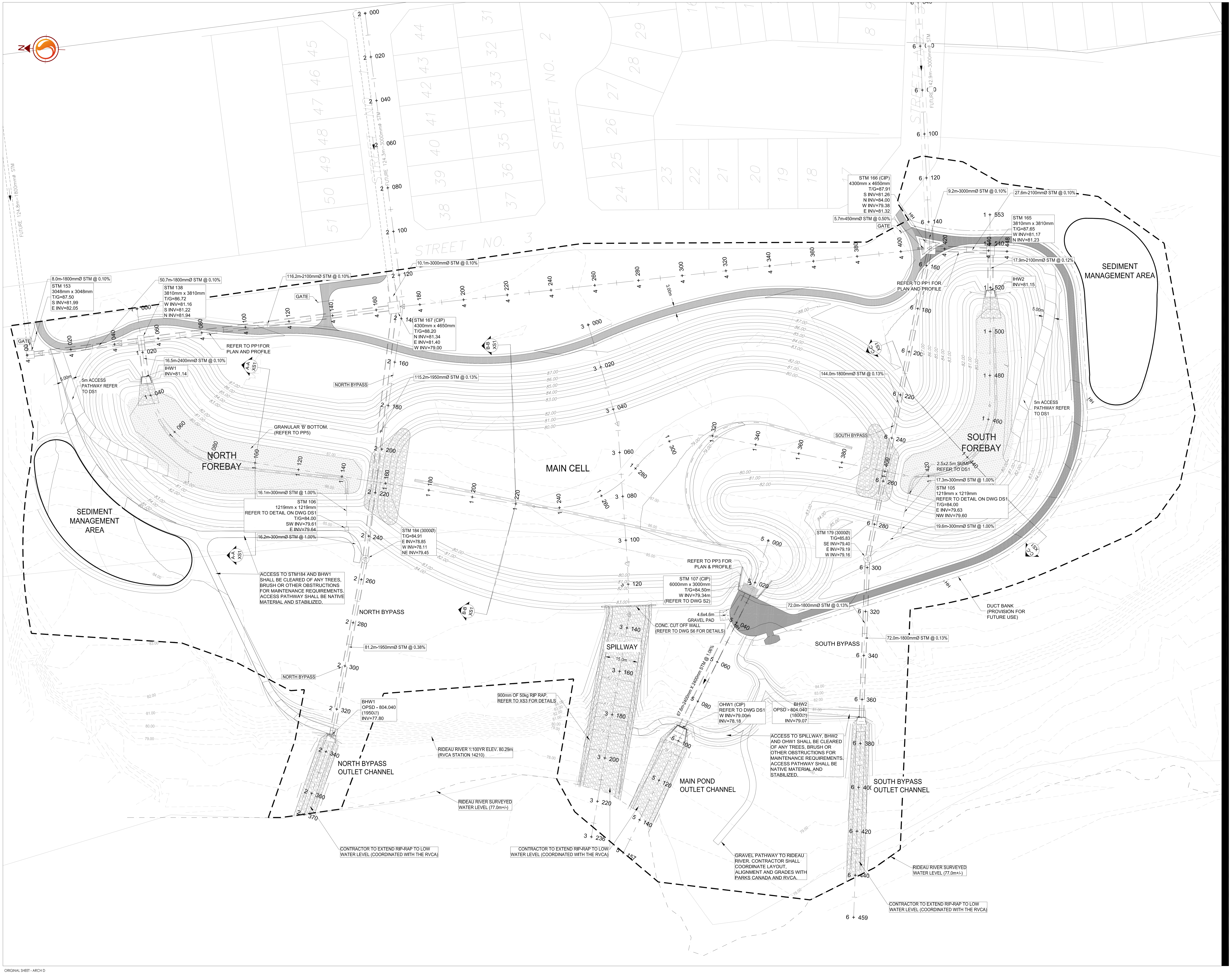
Drawing No.
GP01

Sheet
04 of 31

Revision
12

W:\active\1634_01322\design\drawing\civil\drawing\163401322-FB.dwg
2018/08/27 3:44 PM By: Thivierge, Michael

ORIGINAL SHEET - ARCH D



Stantec Consulting Ltd.
400 - 1331 Clyde Avenue
Ottawa ON
Tel. 613.722.4420
www.stantec.com

Copyright Reserved

The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing - any errors or omissions shall be reported to Stantec without delay.

Legend

- - - - -	FUTURE STORM SEWER
◌	FUTURE STORM MANHOLE
— — — —	PROPOSED STORM SEWER
○	PROPOSED STORM MANHOLE
□	PROPOSED BOX MANHOLE
⏢	PROPOSED HEADWALL
▬	PROPOSED MULTI-USE PATHWAY
▤	PROPOSED REINFORCED GRASS ACCESS PATHWAY
▬ ▬ ▬	CONSTRUCTION LIMITS

NOTES:

1. EXTENT OF RIP-RAP IS NOT SHOWN. REFER TO POND SECTIONS FOR DETAILS.
2. GEOTEXTILE AS IDENTIFIED ON THESE DRAWINGS SHALL BE TERRAFIX 270R (OR APPROVED EQUAL)

		By	Appd.	YY.MM.DD
12	ISSUED FOR CONSTRUCTION	AL	MJT	18.08.28
11	ISSUED FOR ADDENDUM No. 3	AL	MJT	18.07.25
10	ISSUED FOR ADDENDUM No. 1	AL	MJT	18.07.17
9	ISSUED FOR TENDER	AL	MJT	18.06.22
8	ISSUED FOR 90% DETAIL DESIGN	AL	MJT	18.05.09
7	ISSUED FOR DESIGN REVIEW	WAJ	MJT	18.02.02
6	ISSUED FOR DESIGN REVIEW	WAJ	MJT	17.12.15
5	ISSUED FOR 90% DESIGN REVIEW	WAJ	MJT	17.11.17
4	ISSUED FOR DRAFT DESIGN REVIEW	WAJ	AML	17.06.30
3	REVISED SETBACKS PER RVCA COMMENT	AML	AML	17.05.09
2	REVISED PER RVCA COMMENT	AML	AML	17.03.31

Revision

Permit-Seal

S.G. D'AOUST
18.08.28

M.J.H. THIVIERGE
100103993
18.08.28

Client/Project

RIVERSIDE SOUTH
DEVELOPMENT CORPORATION

RIVERSIDE POND 5

OTTAWA, ON

Title

OVERALL SERVICING PLAN

Project No.
163401322

Scale
1:750
0 7.5 22.5 37.5m

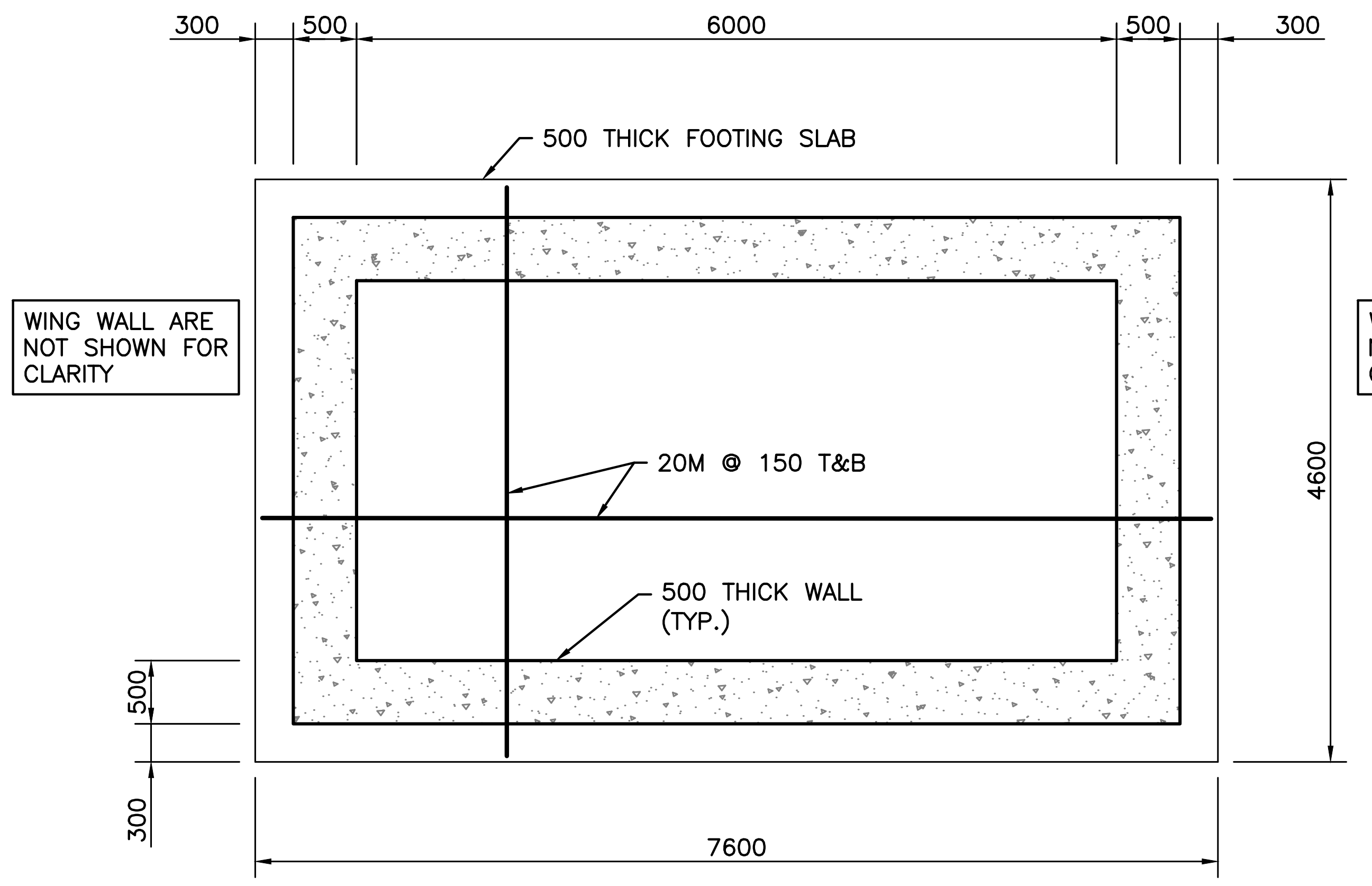
Drawing No.
SP01

Sheet
05 of 31

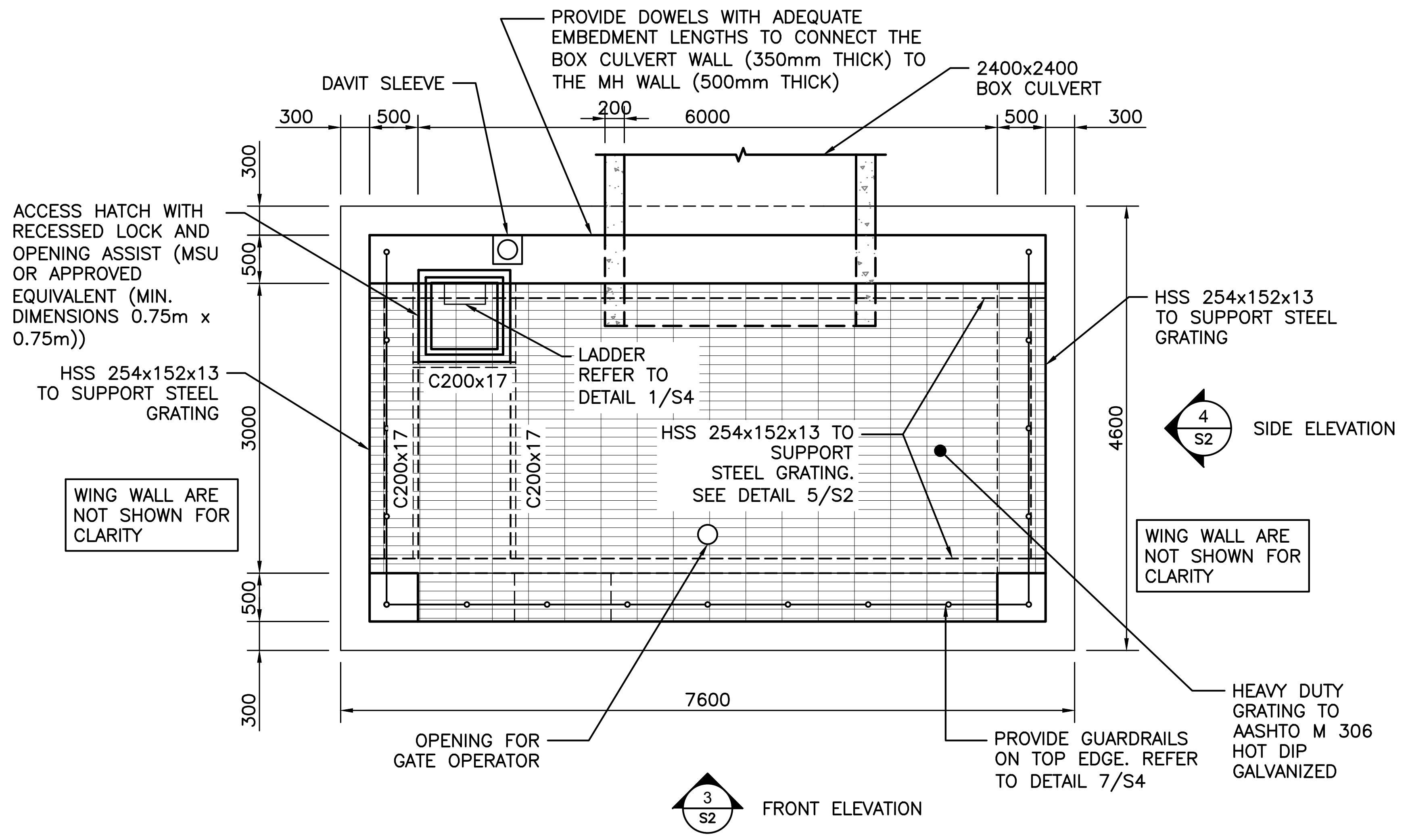
Revision
12

W:\active\1634_01322\design\drawing\civil\drawing\163401322-FB.dwg
2018/08/27 3:42 PM By: Thivierge, Michael

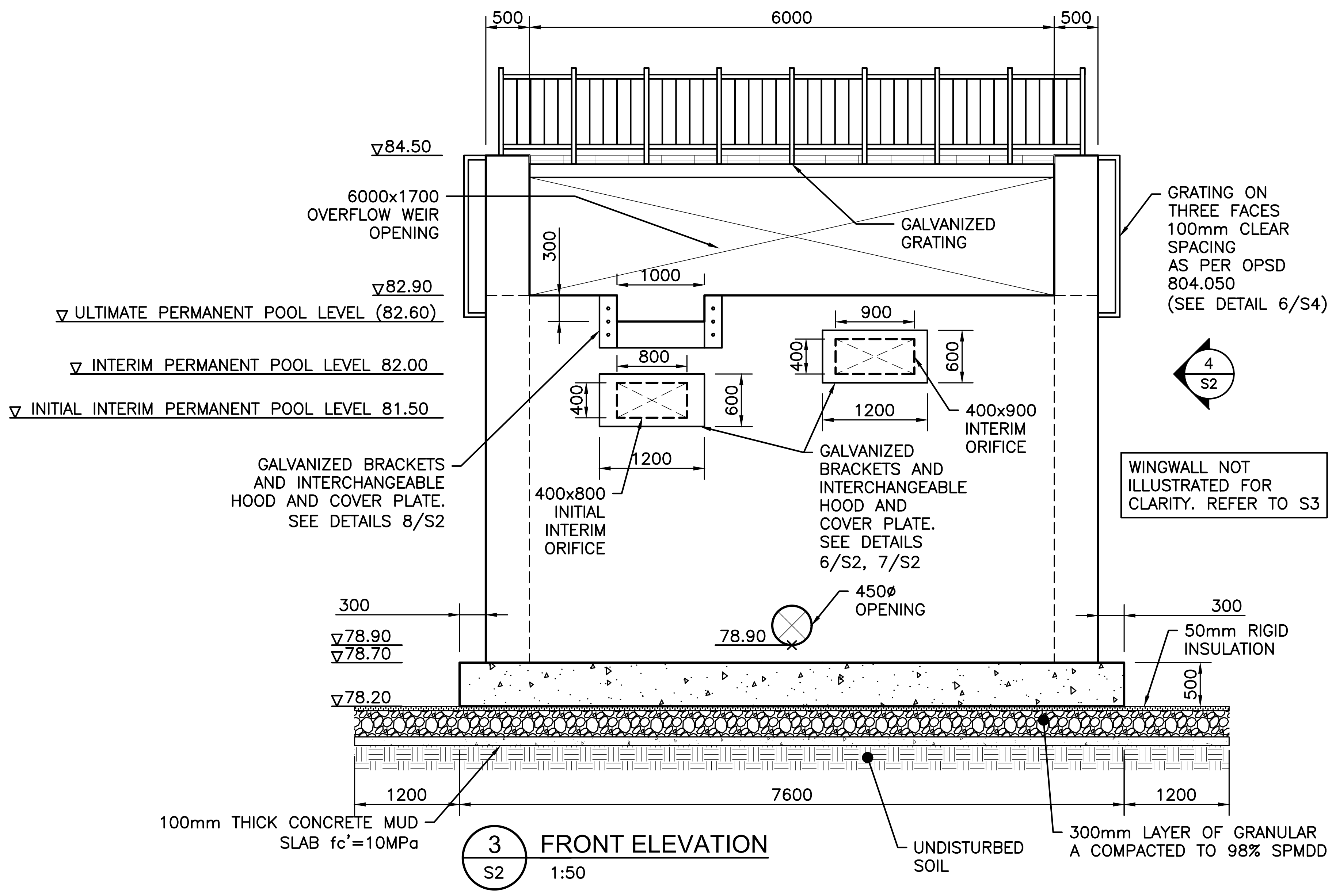
ORIGINAL SHEET - ARCH D



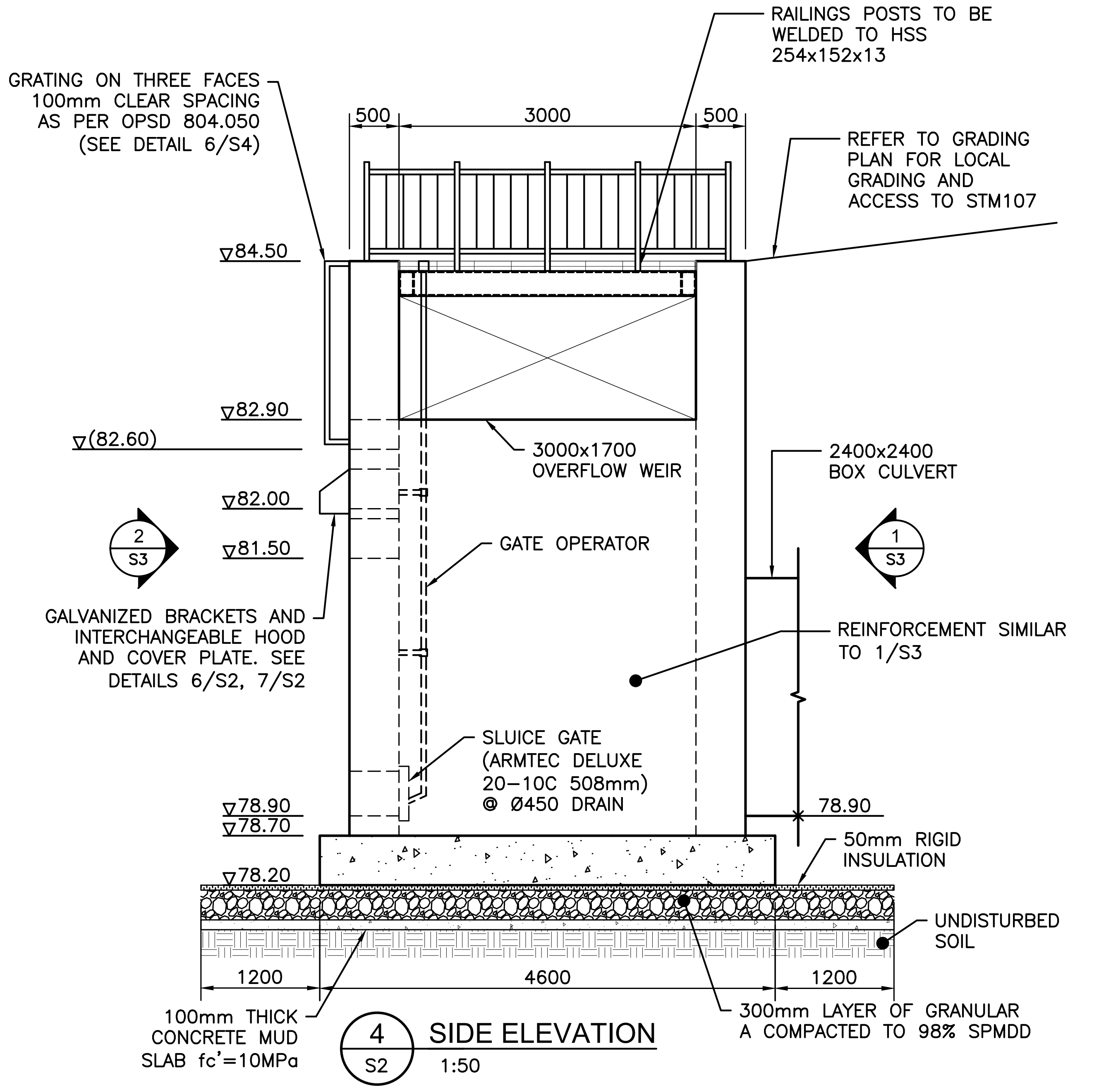
1 PLAN AT FOOTING (EL. 78.70m)
S2 1:50



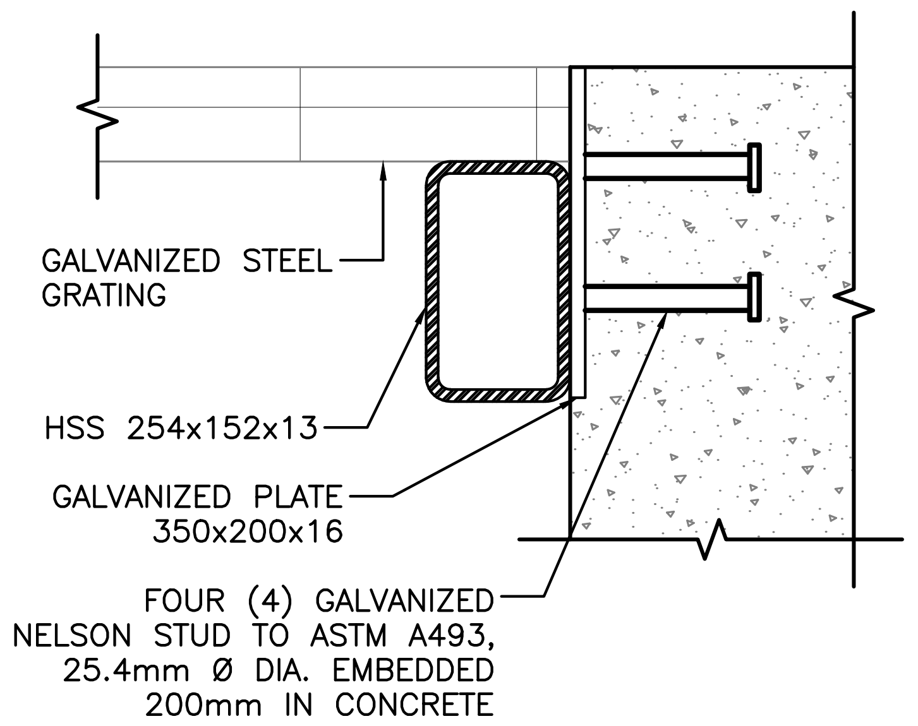
2 PLAN (EL. 84.50m)
S2 1:50



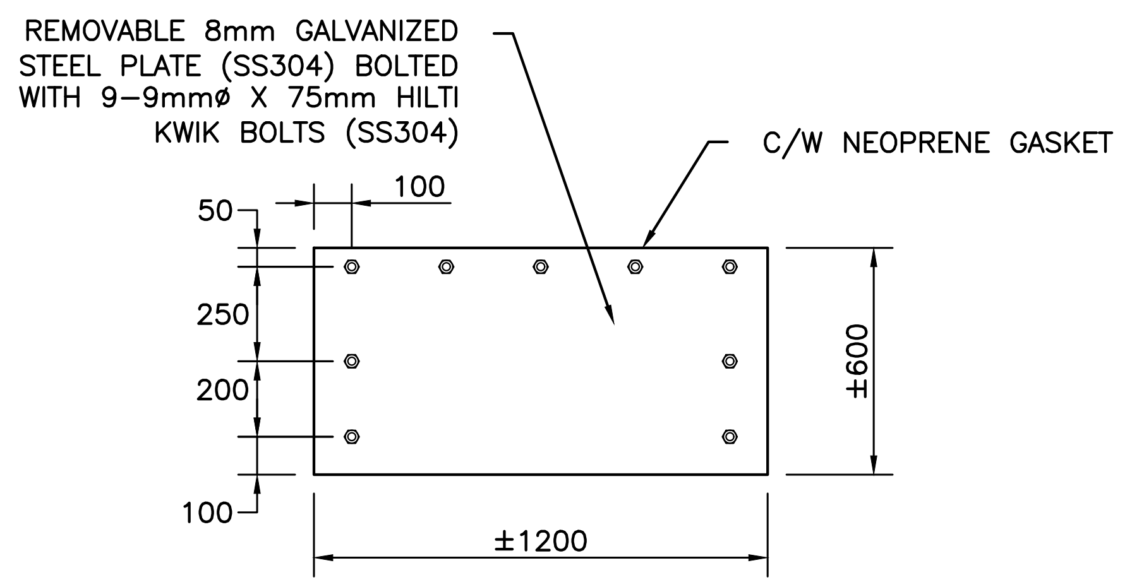
3 FRONT ELEVATION
S2 1:50



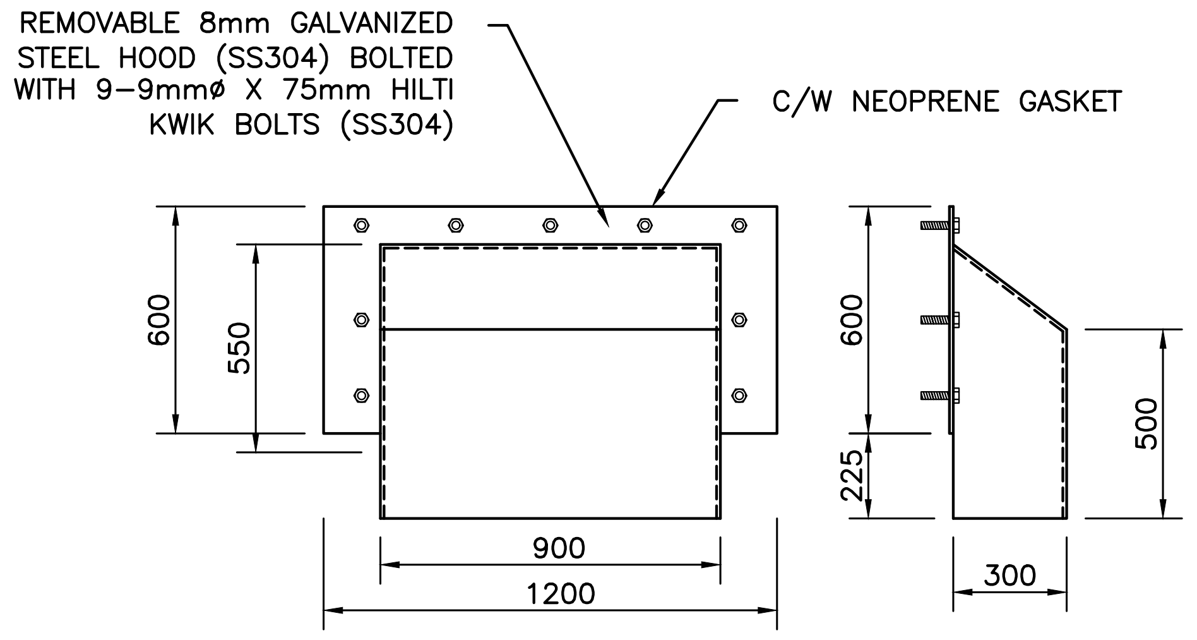
4 SIDE ELEVATION
S2 1:50



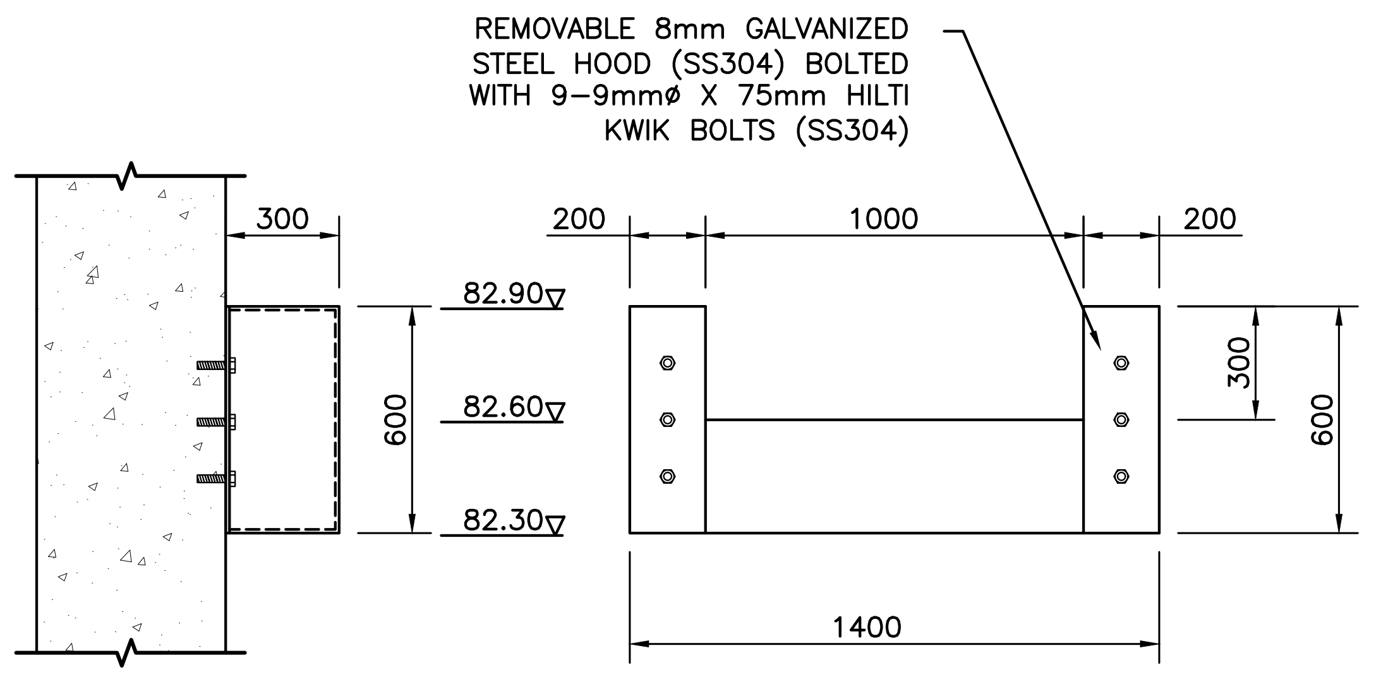
5 HSS CONNECTION DETAIL
S2 1:8



6 REMOVABLE PLATE SCHEMATIC DETAIL
S2 1:20



7 REMOVABLE HOOD SCHEMATIC DETAIL
S2 1:20



8 REMOVABLE HOOD SCHEMATIC DETAIL
S2 1:20

V:\01-634\active\1634_01322\design\drawing\structural\drawing\163401322_S2.dwg
2018/08/28 1:49 PM By: Bonneau, Claudia

Stantec

Stantec Consulting Ltd.
400 - 1331 Clyde Avenue
Ottawa ON
Tel. 613.722.4420
www.stantec.com

Copyright Reserved

Legend

1. MANHOLE BENCHING NOT SHOWN FOR CLARITY BENCH MANHOLE AS DIRECTED BY CONTRACT ADMINISTRATOR
2. TRASH BARS NOT SHOWN ON FACE FOR CLARITY.

18				
17				
16				
15				
14				
13				
12	ISSUED FOR CONSTRUCTION	P.S.	R.S./T.M.	18.08.28
Revision		By	Appd.	YY.MM.DD

File Name: 163401322-POND				
	Dwn.	Chkd.	Dsgn.	YY.MM.DD

Permit-Seal

R. S. SIDAROS
100124382
AUG 28, 2018

T. G. L. MILLER
100178332
Aug 29, 2018

Client/Project

RIVERSIDE SOUTH
DEVELOPMENT CORPORATION

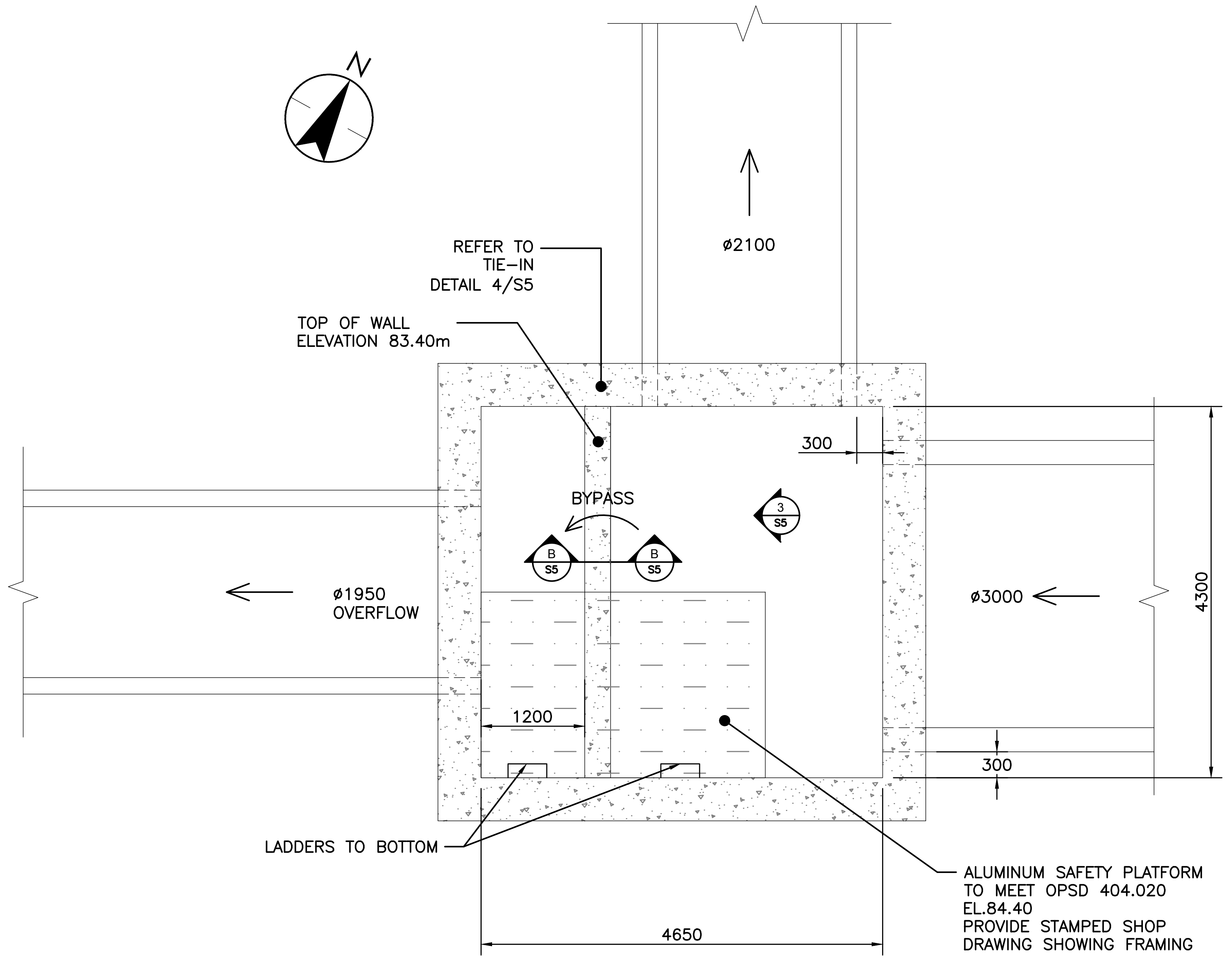
RIVERSIDE POND 5

OTTAWA, ON

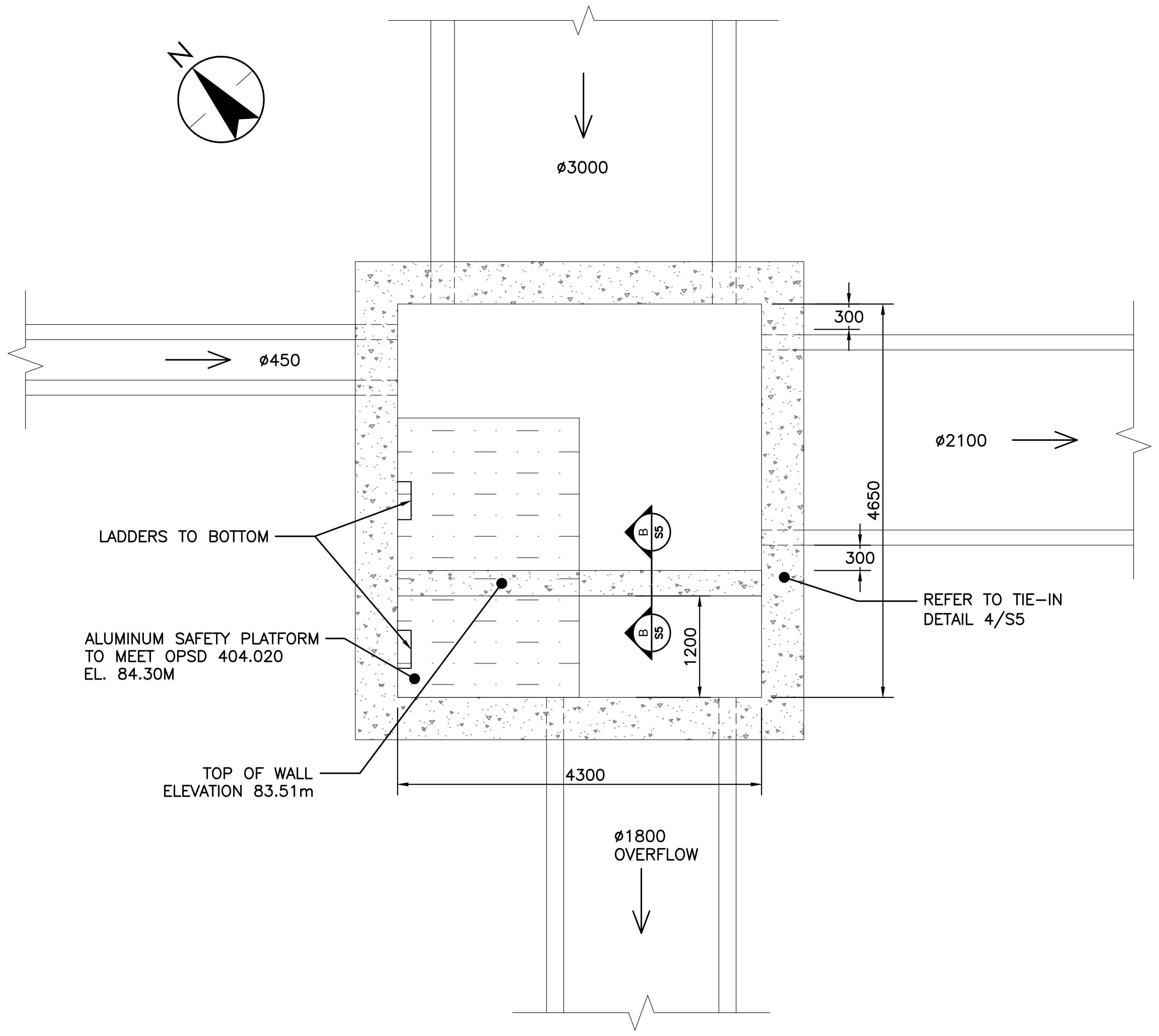
Title

STRUCTURAL
OUTLET STRUCTURE PLANS, ELEVATIONS,
AND DETAILS

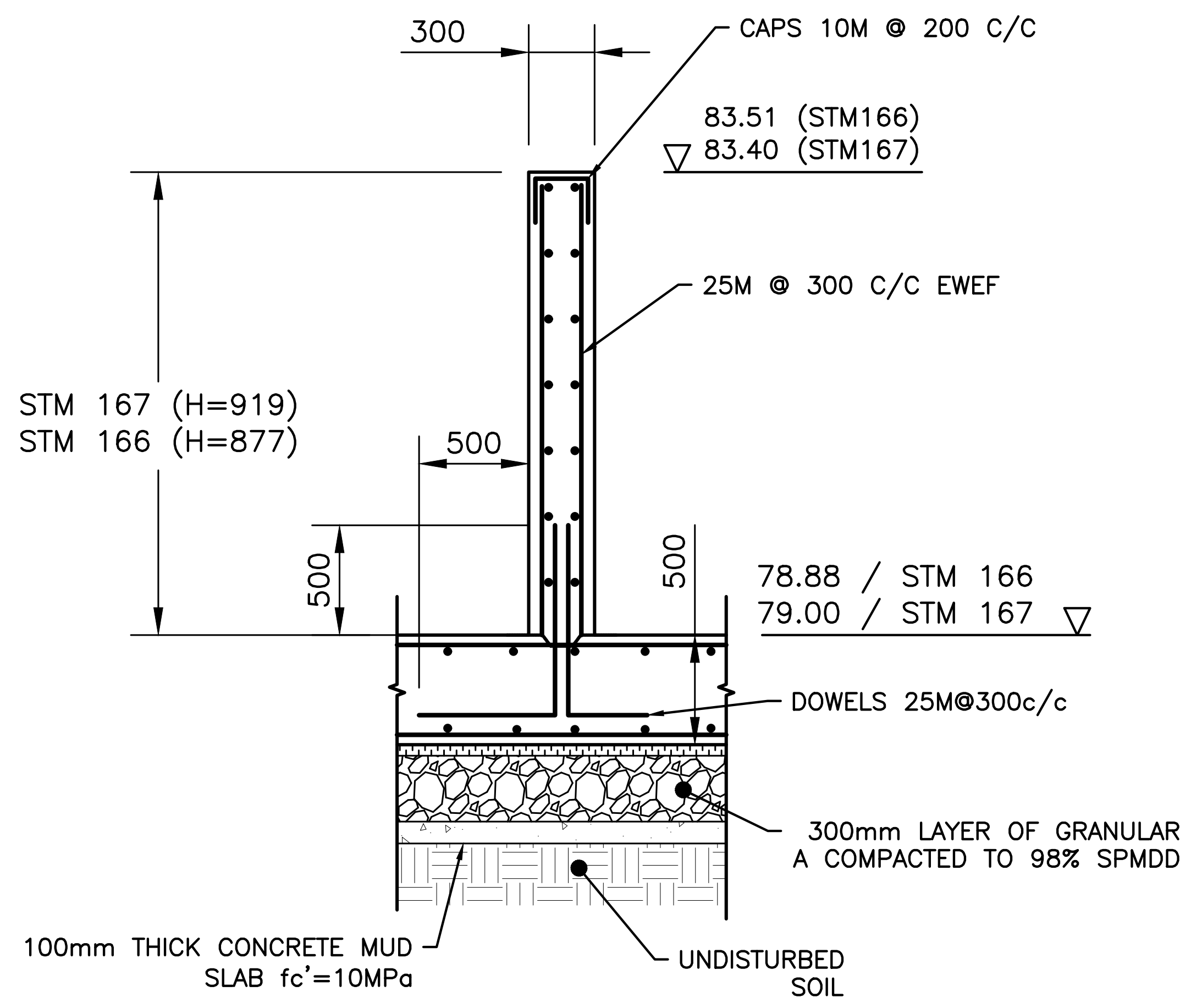
Project No.	Scale	
1634-01322	AS SHOWN	
Drawing No.	Sheet	Revision
S2	21 of 31	12

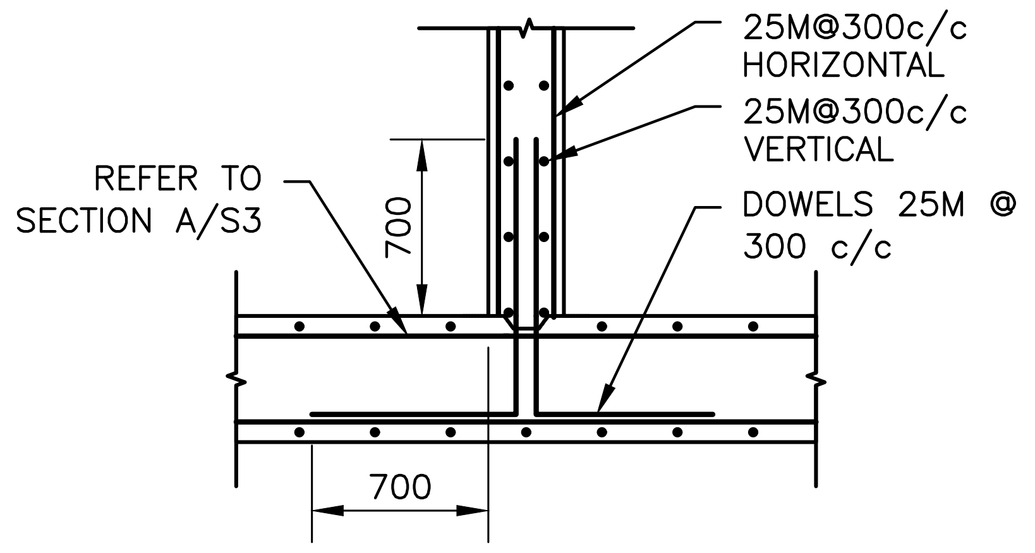


1 S5 STM167
NORTH BYPASS PLAN VIEW
1:100



2 S5 STM166
SOUTH BYPASS PLAN VIEW
1:100





4 S5 TYP. TIE-IN DETAIL
N.T.S.

B S5 STM166 & STM167
WEIR WALL SECTION B-B
1:30

Stantec

Stantec Consulting Ltd.
400 - 1331 Clyde Avenue
Ottawa ON
Tel. 613.722.4420
www.stantec.com

Copyright Reserved

Legend

1. MANHOLE BENCHING NOT SHOWN FOR CLARITY. BENCH MANHOLE AS DIRECTED BY CONTRACT ADMINISTRATOR.

18				
17				
16				
15				
14				
13				
12	ISSUED FOR CONSTRUCTION	P.S.	R.S./T.M.	18.08.28
Revision		By	Appd.	YY.MM.DD

File Name: 163401322-POND				
	Dwn.	Chkd.	Dsgn.	YY.MM.DD

Permit-Seal

R. S. SIDAROS
100124382
AUG 28, 2018

T. G. L. MILLER
100178332
Aug 29, 2018

Client/Project

RIVERSIDE SOUTH
DEVELOPMENT CORPORATION

RIVERSIDE POND 5

OTTAWA, ON

Title

STRUCTURAL
STM166 AND STM167 WEIR WALLS
PLANS AND DETAILS

Project No. 1634-01322
Scale AS SHOWN
Drawing No. S5
Sheet 24 of 31
Revision 12

V:\01-634\active\1634_01322\design\drawing\structural\drawing\163401322_S5.dwg
2018/08/28 1:50 PM By: Bonneau, Claudia

Appendix D
Sanitary Sewer Design Sheets and Sanitary Calculations

STANTEC CONSULTING LTD.
400 1331 CLYDE AVENUE
OTTAWA, ON
TEL. 613.722.4420
WWW.STANTEC.COM

Legend

- Major Water
- Parcels
- Streets
- Rideau River Study Area
- Pond 5

Catchments

- **Catchment Name**
  Catchment Size (ha)

Sanitary Manholes

- ● Sanitary Manholes
- Existing Sanitary Sewers
- Recommended Sanitary Sewers

Client / Project:

CITY OF OTTAWA

RIVERSIDE SOUTH ISSU UPDATE

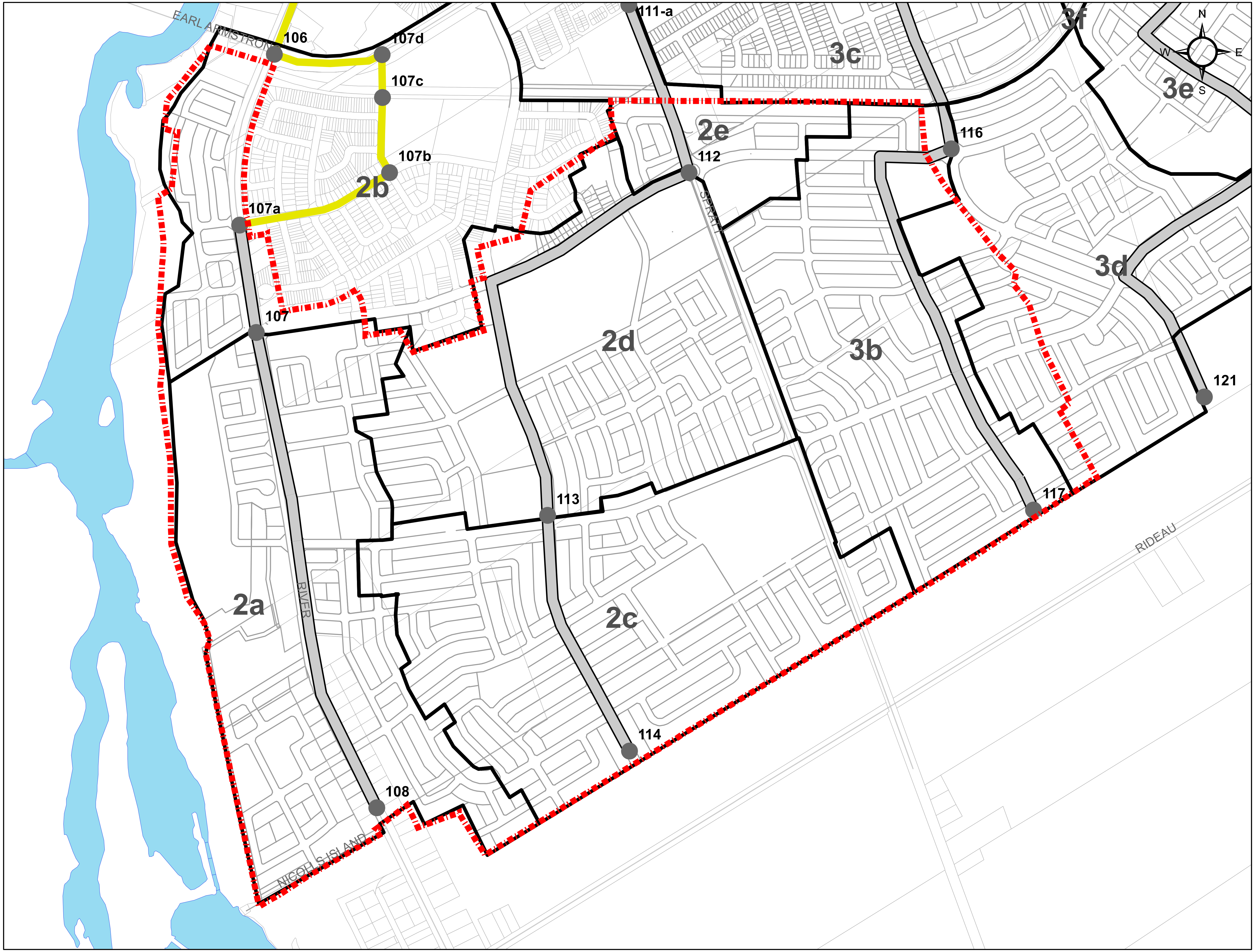
OTTAWA, ON

Title:

SANITARY DRAINAGE PLAN

Project No.:	Scale:
163401101	0 125 250 500 Meters

Drawing No.:	Sheet:	Revision:
SAN-1	6 of 7	0



Stantec

STANTEC CONSULTING LTD.
400 1331 CLYDE AVENUE
OTTAWA, ON
TEL. 613.722.4420
WWW.STANTEC.COM

Legend

- Rideau River Study Area
- Recomended Sanitary Catchments
- ● Sanitary Manholes
- Constructed Sanitary Sewers
- Recommended Sanitary Sewers

Client / Project:

CITY OF OTTAWA

RIVERSIDE SOUTH ISSU UPDATE

OTTAWA, ON

Title:

RECOMMENDED SANITARY SERVICING (2017 UPDATE)

Project No.: **163401101**

Scale: 0 62.5 125 250 Meters

Figure No.:

4-2

Stantec

Riverside South Community
Infrastructure Servicing Study

Revision Date: June 5, 2017
Revison : 3
Designed by: Megan Young
Checked By: Amanda Lynch

File Number: 1634-01101

SANITARY SEWER DESIGN SHEET

CITY CRITERIA & DENSITIES
Approved area

DESIGN PARAMETERS

Average Daily Flow / Person:	350	l/p/day
Minimum Velocity:	0.60	m/s
n =	0.013	
Max Peaking Factor:	4.0	
Min. Peaking Factor:	2.0	
Peaking Factor Industrial:	Based on Appendix 4-B	
Peaking Factor Comm. / Inst.:	1.5	

Commercial:		0.579	l/s/ha
Employment		0.579	l/s/ha
Institutional:		0.579	l/s/ha
Infiltration:		0.280	l/s/ha
Low Density:	@	3.2	pers/unit
Medium Density:	@	2.4	pers/unit
High Density:	@	1.9	pers/unit

Existing Sanitary Sewer flows estimated by existing land use. Existing Phase 9 area contribution based on JLR 2011 report

STREET	ID Area	From MH	To MH	RESIDENTIAL															COMMERCIAL		EMPLOYMENT		INSTITUTIONAL		C+I+I	ROAD		INFILTRATION				PIPE						
				AREA	LOW			MED			HIGH																										Velocity	
				(ha)	Area (ha)	Pop.	Accum. Pop.	Area (ha)	Pop.	Accum. Pop.	Area (ha)	Pop.	Accum. Pop.	Units	Accum. Units	Total Accum. Pop.	Peak Factor	Peak Flow (l/s)	Area (ha)	Accum. Area (ha)	Area (ha)	Accum. Area (ha)	Area (ha)	Accum. Area (ha)	Peak Flow (l/s)	Area (ha)	Accum. Area (ha)	Total Area (ha)	Accum. Area (ha)	Infilt. Flow (l/s)	Total Flow (l/s)	Distance (m)	Diameter (mm)	Slope (%)	Qa/Qc	Capacity (Full) (l/s)	(Full) (m/s)	(Actual) (m/s)
RIVER ROAD	**2a**	108	107	50.51	44.40	2189	2189	6.11	389	389	0.00	0	0	846	846	2578	3.5	36.5	1.19	1.19	0.00	0.00	1.01	1.01	1.9	4.48	4.48	57.18	57.18	16.0	54.4	1255	450	0.12	0.53	103.0	0.63	0.63
RIVER ROAD	**2b Future**	107	107a	12.21	10.22	502	2691	1.99	127	516	0.00	0	0	210	1056	3207	3.4	44.4	0.00	1.19	0.00	0.00	0.00	1.01	1.9	2.64	7.12	14.85	72.03	20.2	66.5	254	525	0.12	0.43	155.4	0.70	0.66
RIVER ROAD	**2b Existing (Phase 9)**	107a	107b	43.20	43.20	2351	5042	0.00	0	516	0.00	0	0	N/A	1056	5558	3.2	72.1	0.00	1.19	0.00	0.00	2.46	3.47	4.0	0.00	7.12	45.66	117.69	33.0	109.1	**405**	**525**	**0.10**	**0.76**	**144.5**	**0.65**	**0.71**
RIVER ROAD		107b	107c	0.00	0.00	0	5042	0.00	0	516	0.00	0	0	0	1056	5558	3.2	72.1	0.00	1.19	0.00	0.00	0.00	3.47	4.0	0.00	7.12	0.00	117.69	33.0	109.1	**217**	**525**	**0.12**	**0.72**	**152.3**	**0.68**	**0.74**
RIVER ROAD		107c	107d	0.00	0.00	0	5042	0.00	0	516	0.00	0	0	0	1056	5558	3.2	72.1	0.00	1.19	0.00	0.00	0.00	3.47	4.0	4.70	11.82	4.70	122.39	34.3	110.4	**107**	**525**	**0.10**	**0.77**	**143.9**	**0.64**	**0.71**
		107d	106	0.00	0.00	0	5042	0.00	0	516	0.00	0	0	0	1056	5558	3.2	72.1	0.00	1.19	0.00	0.00	0.00	3.47	4.0	0.00	11.82	0.00	122.39	34.3	110.4	**278**	**525**	**0.08**	**0.90**	**123.3**	**0.55**	**0.63**
	Ex3	106	103	17.90	10.04	413	5455	7.86	564	1080	0.00	0	0	364	1420	6535	3.1	83.0	5.35	6.54	0.00	0.00	0.00	3.47	8.7	0.00	11.82	23.25	145.64	40.8	132.5	**835**	**525**	**0.10**	**0.93**	**141.9**	**0.63**	**0.73**
	Ex2	103	102	16.42	16.42	573	6028	0.00	0	1080	0.00	0	0	179	1599	7108	3.1	89.3	0.00	6.54	0.00	0.00	0.00	3.47	8.7	5.11	16.93	21.53	167.17	46.8	144.8	**1100**	**525**	**0.10**	**1.02**	**141.9**	**0.63**	**0.74**
SPRATT SOUTH	**2c**	114	113	53.79	51.84	2554	2554	1.95	125	125	0.00	0	0	850	850	2679	3.5	37.8	0.00	0.00	0.00	0.00	7.68	7.68	6.7	5.93	5.93	67.41	67.41	18.9	63.4	695	450	0.11	0.64	98.6	0.60	0.64
SPRATT SOUTH	**2d**	113	112	39.28	28.89	1424	3978	10.40	665	790	0.00	0	0	722	1572	4768	3.3	63.0	0.00	0.00	0.00	0.00	14.95	22.63	19.7	5.45	11.38	59.69	127.09	35.6	118.3	1155	525	0.11	0.79	148.8	0.67	0.74
SPRATT SOUTH	**2e**	112	111-a	17.48	0.00	0	3978	13.28	847	1637	4.19	479	479	605	2177	6094	3.2	78.1	2.55	2.55	0.00	0.00	0.00	22.63	21.9	6.14	17.52	26.17	153.26	42.9	142.9	470	525	0.12	0.92	155.4	0.70	0.80
SPRATT SOUTH		111-a	111	0.00	0.00	0	3978	0.00	0	1637	0.00	0	479	0	2177	6094	3.2	78.1	0.00	2.55	0.00	0.00	0.00	22.63	21.9	0.00	17.52	0.00	153.26	42.9	142.9	215	525	0.11	0.96	148.8	0.67	0.77
SPRATT SOUTH	**Ex4**	111	110	14.93	13.31	90	4068	1.62	468	2105	0.00	0	479	223	2400	6652	3.1	84.3	0.91	3.46	0.00	0.00	0.00	22.63	22.7	0.00	17.52	15.84	169.10	47.3	154.3	**600**	**525**	**0.12**	**0.99**	**155.4**	**0.70**	**0.81**
SHORELINE DRIVE	**3b**	117	116	48.13	43.40	2138	2138	4.73	302	302	0.00	0	0	794	794	2440	3.5	34.8	0.66	0.66	0.00	0.00	0.05	0.05	0.6	2.77	2.77	51.60	51.60	14.4	49.8	1270	450	0.11	0.51	98.6	0.60	0.60
SHORELINE DRIVE	**3c**	116	115	47.51	27.40	1350	3488	15.47	989	1291	4.64	530	530	1113	1907	5309	3.2	69.3	0.00	0.66	0.00	0.00	11.13	11.17	10.3	10.02	12.79	68.67	120.26	33.7	113.2	990	450	0.17	0.92	122.6	0.75	0.86
SHORELINE DRIVE	**Ex5**	115	110	20.60	14.47	480	3968	6.13	302	1593	0.00	0	530	276	2183	6091	3.2	78.1	0.80	1.46	0.00	0.00	3.16	14.33	13.7	0.00	12.79	24.56	144.82	40.6	132.3	**480**	**450**	**0.20**	**0.99**	**133.0**	**0.81**	**0.94**
SPRATT SOUTH	**Ex6**	110	109	25.47	20.32	822	8858	5.15	288	3986	0.00	0	1009	377	4960	13853	2.8	157.9	0.00	4.92	0.00	0.00	2.39	39.36	38.5	0.00	30.31	27.86	341.78	95.7	292.0	**675**	**675**	**0.12**	**0.96**	**303.8**	**0.82**	**0.95**
CANYON WALK DRIVE	**3d**	121	120	46.05	35.39	1744	1744	10.66	679	679	0.00	0	0	828	828	2423	3.5	34.5	0.60	0.60	0.00	0.00	3.72	3.72	3.8	5.41	5.41	55.78	55.78	15.6	53.9	820	450	0.15	0.47	115.2	0.70	0.69
CANYON WALK DRIVE	**3e**	120	119	54.06	40.27	1984	3728	13.79	881	1560	0.00	0	0	987	1815	5288	3.2	69.0	0.00	0.60	0.00	0.00	3.91	7.63	7.2	9.21	14.62	67.19	122.97	34.4	110.6	925	525	0.18	0.58	190.3	0.85	0.89
CANYON WALK DRIVE	**3f-4a**	119	118	17.44	0.00	0	3728	3.06	194	1754	14.38	1007	1007	577	2392	6489	3.1	82.5	6.01	6.61	0.00	0.00	5.28	12.92	17.0	16.75	31.37	45.49	168.46	47.2	146.6	880	525	0.19	0.75	195.6	0.88	0.97
internal south	**6a**	123	122	49.84	31.53	1555	1555	18.31	1169	1169	0.00	0	0	973	973	2724	3.5	38.4	1.18	1.18	0.00	0.00	5.33	5.33	5.7	6.44	6.44	62.80	62.80	17.6	61.6	600	525	0.14	0.37	167.9	0.75	0.68
ARMSTRONG ROAD	**4b**	122	118	58.24	0.00	0	1555	0.00	0	1169	58.24	4070	4070	2005	2978	6794	3.1	85.8	24.34	25.53	0.00	0.00	0.00	5.33	26.8	24.91	31.35	107.49	170.29	47.7	160.3	1810	600	0.13	0.69	231.0	0.79	0.86
CANYON WALK DRIVE	**Ex1**	118	124	45.64	22.12	896	6179	23.52	1687	4610	0.00	0	5077	983	6353	15866	2.8	177.0	1.55	33.69	0.00	0.00	0.00	18.25	45.1	0.00	62.72	47.19	385.94	108.1	330.2	**860**	**750**	**0.15**	**0.73**	**449.8**	**0.99**	**1.08**
SPRATT ROAD	**5c**	130	129	25.52	20.06	989	989	5.46	348	348	0.00	0	0	454	454	1337	3.7	20.1	0.00	0.00	0.00	0.00	2.38	2.38	2.1	4.86	4.86	32.77	32.77	9.2	31.4	420	600	0.15	0.13	248.1	0.85	0.56
SPRATT ROAD	**1a**	129	128	10.26	7.00	346	1335	3.26	209	557	0.00	0	0	195	649	1892	3.6	27.6	0.00	0.00	0.00	0.00	0.00	2.38	2.1	7.76	12.63	18.02	50.79	14.2	43.9	450	675	0.15	0.13	339.6	0.92	0.61
SPRATT ROAD	**1b**	128	127	18.80	4.11	202	1537	13.56	866	1423	1.13	129	129	492	1141	3089	3.4	42.9	0.00	0.00	0.00	0.00	2.82	5.20	4.5	5.34	17.97	26.97	77.76	21.8	69.2	490	675	0.15	0.20	339.6	0.92	0.70
internal north	**5b**	135	134	17.31	10.06	496	496	7.25	463	463	0.00	0	0	348	348	959	3.8	14.8	0.00	0.00	0.00	0.00	0.03	0.03	0.0	1.32	1.32	18.66	18.66	5.2	20.1	385	375	0.15	0.28	70.8	0.62	0.53
internal north	**1d**	134	127	21.95	12.43	611	1107	9.52	607	1070	0.00	0	0	444	792	2177	3.6	31.4	2.66	2.66	0.00	0.00	0.01	0.04	2.3	4.33	5.66	28.95	47.61	13.3	47.0	550	375	0.15	0.66	70.8	0.62	0.67
	BP-1	137	127	39.70	20.70	1173	1173	17.00	1019	1019	2.00	398	398	891	891	2590	3.5	36.7	0.00	0.00	16.18	16.18	0.00	0.00	9.4	6.81	6.81	62.69	62.69	17.6	63.6	725	375	0.15	0.90	70.8	0.62	0.71
SPRATT ROAD	**1c**	127	126	14.01	0.00	0	3817	8.98	574	4086	5.03	574	1101	541	3365	9004	3.0	109.4	0.74	3.40	0.00	16.18	6.60	11.84	22.6	6.42	36.86	27.77	215.82	60.4	192.4	795	750	0.15	0.43	449.8	0.99	0.94
internal north	**5a**	133	132	11.48	4.65	230	230	6.83	437	437	0.00	0	0	254	254	667	3.9	10.6	1.02	1.02	0.00	0.00	1.15	1.15	1.9	4.02	4.02	17.68	17.68	5.0	17.4	410	375	0.15	0.25	70.8	0.62	0.50
internal north	**1e**	132	126	34.06	22.08	1088	1318	11.98	766	1203	0.00	0	0	659	913	2521	3.5	35.8	0.00	1.02	0.00	0.00	1.37	2.52	3.1	6.18	10.21	41.61	59.29	16.6	55.5	810	450	0.15	0.48	115.2	0.70	0.69
	BP-2	138	126	0.11	0.00	0	0	0.11	7	7	0.00	0	0	3	3	7	4.0	0.1	0.00	0.00	15.00	15.00	0.00	0.00	8.7	1.48	1.48	16.59	16.59	4.6	13.4	440	375	0.15	0.19	70.8	0.62	0.46
SPRATT ROAD	**1g**	126	125	14.19	1.66	83	5218	9.47	605	5901	3.05	348	1449	461	4742	12568	2.9	145.4	0.98	5.40	0.00	31.18	10.12	24.48	44.0	3.45	52.00	28.74	320.44	89.7	279.1	710	750	0.17	0.58	478.9	1.05	1.09
SPRATT ROAD	**1f**	131	125	9.29	5.05	250	250	4.24	271	271	0.00	0	0	191	191	521	4.0	8.4	0.00	0.00	0.00	0.00	0.00	0.00	0.0	3.48	3.48	12.77	12.77	3.6	11.9	420	300	0.20	0.26	45.1	0.62	0.51
	BP3	136	125	0.00	0.00	0	0	0.00	0	0	0.00	0	0	0	0	0	0.0	0.0	0.00	0.00	38.46	38.46	0.00	0.00	22.3	5.69	5.69	44.15	44.15	12.4	34.6	986	375	0.14	0.51	68.4	0.60	0.60
SPRATT ROAD	**1h**	125	124	1.69	0.00	0	5468	1.69	108	6280	0.00	0	1449	45	4978	13197	2.8	151.5	2.20	7.60	0.00	69.64	1.66	26.14	69.6	3.04	64.20	8.59	385.95	108.1	329.2	**830**	**900**	**0.15**	**0.45**	**731.4**	**1.11**	**1.07**
SPRATT ROAD	**Ex7**	124	109	17.26	11.40	768	12415	3.00	250	11140	2.86	327	6853	516	11847	30408	2.5	304.4	0.64	41.93	0.00	69.64	0.00	44.39	115.3	0.00	126.93	17.90	789.79	221.1	640.9	**515**	**1050**	**0.15**	**0.58**	**1103.3**	**1.23**	**1.28**
CANYON WALK DRIVE	**Ex8**	109	102	56.40	54.40	2150	23423	2.00	134	15260	0.00	0	7862	728	17535	46545	2.3	432.5	0.00	46.85	0.00	69.64	0.00	83.75	153.7	5.45	162.68	61.85	1193.42	334.2	920.4	**1100**	**1050**	**0.15**	**0.83**	**1103.3**	**1.23**	**1.39**
SPRATT ROAD	**BP-4**	139	102	0.00	0.00	0	0	0.00	0	0	0.00	0	0	0	0	0	0.0	0.0	0.00	0.00	127.52	127.52	0.00	0.00	169.8	19.76	19.76	147.28	147.28	41.2	211.1	2790	675	0.15	0.62	339.6	0.92	0.97
CROSSING		102	101	0			29451			16340			7862		**19134**	**53653**	2.2	486.0		53.39		197.16		87.21	384.7		199.37	0	1507.87	422.2	1292.9	**145**	**1200**	**0.11**	**0.96**	**1349.0**	**1.16**	**1.33**

CROSSING

***Note:**

Area BP-4 also accounts for additional 39ha area outside the CDP that was accounted for in calculation of Employment Area
PIPE Capacity (Full) calculated using ACTUAL PIPE SIZE
Limiting Capacity Calculated based on 1200 mm pipe @ 0.11% between Rideau Road and River
Additional sanitary flow of 29.21 L/s from Rideau Carleton Raceway (RCR) is not included in the above calculation, as it is proposed that flow from this area be pumped into the system at off-peak times

From:	Sevigny, John <John.Sevigny@ottawa.ca>
Sent:	Thursday, July 20, 2017 10:18 AM
To:	Bob Wingate
Cc:	Terry Brule; Jim Moffatt
Subject:	RE: Riverside South , Rideau River Drainage Area

Hi Bob.
Yes, this is satisfactory.
Regards,

*****Absence alert: Please note that I will be out of the office as of July 31, 2017 and will be returning to the office on August 8, 2017*****

John Sevigny, C.E.T.
Project Manager, Infrastructure Approvals
Development Review, Suburban Services | *Examen des projets d'aménagement, Services suburbains*
Planning, Infrastructure and Economic Development Department | Services de la planification, de l'infrastructure et du développement économique
City of Ottawa | Ville d'Ottawa
110 Laurier Avenue West. Ottawa, ON | 110, avenue. Laurier Ouest. Ottawa (Ontario) K1P 1J1
613.580.2424 ext./poste **14388**, fax/téléc:613-580-2576, john.sevigny@ottawa.ca

---

From: Bob Wingate [mailto:rwingate@IBIGroup.com]
Sent: Wednesday, July 19, 2017 10:18 AM
To: Sevigny, John <John.Sevigny@ottawa.ca>
Cc: Terry Brule <tbrule@IBIGroup.com>; Jim Moffatt <jmoffatt@IBIGroup.com>
Subject: Fw: Riverside South , Rideau River Drainage Area

Hi John
We assume this satisfies your requirement for acknowledgment from Cardel regarding concurrence with our proposed Revision to the sanitary drainage limit for the River Road trunk sewer.
Regards
Bob

Sent from my BlackBerry 10 smartphone on the Bell network.

From: Matt Wingate <MWingate@dsel.ca>
Sent: Tuesday, July 18, 2017 10:37 PM
To: John Sevigny
Cc: Bob Wingate; Terry Brule
Subject: Fwd: Riverside South , Rideau River Drainage Area

Hi John,
Please find Lisa Dalla Rosa's agreement below to IBI's proposed sanitary drainage plan described below.
Please feel free to call if you have any questions or need further input from our end.
Thanks

Matt Wingate, P.Eng.
DSEL
david schaeffer engineering ltd.

Begin forwarded message:

From: Lisa Dalla Rosa <lisa.dallarosa@cardelhomes.com>
Date: July 18, 2017 at 12:36:59 PM EDT
To: Matt Wingate <MWingate@dsel.ca>
Subject: RE: Riverside South , Rideau River Drainage Area

Agreed.
LDR

From: Matt Wingate [mailto:MWingate@dsel.ca]
Sent: Thursday, July 13, 2017 11:43 AM
To: Lisa Dalla Rosa <lisa.dallarosa@cardelhomes.com>
Cc: Laura Maxwell <LMaxwell@dsel.ca>; 'Bob Wingate P.Eng. (rwingate@ibigroup.com)' <rwingate@ibigroup.com>
Subject: RE: Riverside South , Rideau River Drainage Area

Hi Lisa,

IBI has requested that acceptance of their sanitary proposal come directly from Cardel. Can you respond to this email with your agreement?

Thanks

Matt

From: Matt Wingate
Sent: July 12, 2017 1:38 PM
To: 'Lisa Dalla Rosa (lisa.dallarosa@cardelhomes.com)' <lisa.dallarosa@cardelhomes.com>
Cc: Laura Maxwell <LMaxwell@dsel.ca>
Subject: FW: Riverside South , Rideau River Drainage Area

Hi Lisa,
Please see below related to the Urbandale/Claridge/Cardel coordinated sanitary servicing plan for Riverside south, as discussed two weeks ago.
Let me know if you have any questions.
We will forward the final draft of our functional servicing report to you shortly for your review.

Matt

From: Matt Wingate
Sent: July 12, 2017 1:35 PM
To: 'Bob Wingate' <rwingate@IBIGroup.com>
Cc: Steve Pichette <SPichette@dsel.ca>; Terry Brule <tbrule@IBIGroup.com>; Sevigny, John <John.Sevigny@ottawa.ca>
Subject: RE: Riverside South , Rideau River Drainage Area

Att Fig S.1

Hi Bob;
Thanks for including us in this circulation.
I can confirm that we are in agreement with your proposal to include Cardel's developable property area west of the Brian Good collector road within the River Road trunk sanitary sewer catchment, as illustrated in your Figure S-1.

We are currently finalizing our functional servicing report to be submitted in support of Cardel's application for plan of subdivision approval, and we will present a preferred alternative wastewater servicing plan for Cardel's subdvision that will match the drainage boundaries presented in IBI's proposal.
If there are any further questions or you require additional info related to our proposed servicing plan, please do not hesitate to call.

regards

Matt Wingate, P.Eng.
Manager of Design Administration

DSEL
david schaeffer engineering ltd.

120 Iber Road, Unit 103
Stittsville, ON K2S 1E9

phone: (613) 836-0856 ext 522
direct: (613) 836-1522
cell: (613) 858-4975
e-mail: mwingate@DSEL.ca

From: Bob Wingate [mailto:rwingate@IBIGroup.com]
Sent: July 12, 2017 11:46 AM
To: Matt Wingate <MWingate@dsel.ca>
Cc: Steve Pichette <SPichette@dsel.ca>; Terry Brule <tbrule@IBIGroup.com>; Sevigny, John <John.Sevigny@ottawa.ca>
Subject: FW: Riverside South , Rideau River Drainage Area

Hi Matt
We have submitted our sanitary analysis for Riverside South to the City of Ottawa(John Sevigny) for their review and approval , as per our previous discussion. This morning John called to advise that he has circulated this request to expand the tributary area to the River Road trunk sanitary sewer and use the revised sanitary design parameters currently being considered by the City internally at the City . To support this submission he would appreciate it if we could get confirmation from Cardel / DSEL that you have seen this proposal and that you are in general agreement with the proposed drainage expansion through Cardel's lands as an initial servicing scenario. The e-mail below and supporting attachments included is a complete copy of the submission to reconfirm it is consistent with our discussions .
If you would provide us with the confirmation John is requesting that would be appreciated so we can ensure that this request maintains momentum at the City .

Bob Wingate

IBI GROUP
400-333 Preston Street
Ottawa ON K1S 5N4 Canada
tel +1 613 225 1311 fax +1 613 225 9868

<image007.png>

From: Bob Wingate
Sent: Thursday, June 29, 2017 2:20 PM
To: Sevigny, John <John.Sevigny@ottawa.ca>
Cc: Terry Brule (tbrule@ibigroup.com) <tbrule@ibigroup.com>; Marcel Denomme (mdenomme@urbandale.com) <mdenomme@urbandale.com>; Jim Burghout (jim.burghout@claridgehomes.com) <jim.burghout@claridgehomes.com>; Matt Wingate <mwingate@dsel.ca>
Subject: Riverside South , Rideau River Drainage Area

Get Plan + Spreadsheet

Hi John
Further to our previous discussions , attached is a figure which illustrates a proposed expansion of the River Road trunk sanitary sewer tributary area , easterly from the existing developed area to the north to the south limit of the urban boundary . This figure shows the drainage divide between the River Road sanitary collector sewer and the Spratt Road collector as currently proposed in the recently updated MSS , overlaid on the latest draft plans as proposed by the three major developers in the area (RSDC , Claridge , and Cardel) . also shown on this figure is a proposed expansion of the River Road collector drainage area easterly based on the use of monitored parameters from the current City design guidelines , as suggested by John Bougadis , and the use of revised design parameters currently being considered by the City for the undeveloped portion of the proposed tributary area to the River Road trunk sewer . To support the proposed expanded drainage area to the River Road trunk sewer we have recreated the sanitary spread sheet from the MSS and attached a copy of the unaltered version of this spread sheet for your use in confirming that the analysis prepared by IBI is based on exactly the same assumptions regarding land use , density , etc. as the final MSS document . The second spread sheet attached has only the design parameters for the areas tributary to the River Road trunk sewer adjusted to reflect the use of monitored parameters for the built out areas , and revised design parameters for the undeveloped areas tributary to the River Road trunk sewer . This last spread sheet demonstrates that the proposed expanded drainage area can be accommodated in the existing River Road collector sewer without surcharging the system . Given that this expanded drainage area significantly reduces the potential for grade raise issues , maximizes the use of parallel sewers in the local road network , and improves phasing potential for all three major developers involved , we request that the City confirm acceptance of this proposal as a minor adjustment to the MSS , so that all three developers can finalize their individual serviceability reports based on this revision to the drainage areas.
It should be noted that IBI represents both Claridge and RSDC for this development area and that we have met with DSEL who represents Cardel , the other major developer in the area , and all three developers are in agreement with the proposed new drainage limit , and support the implementation of this change .
If you have any questions regarding this submission please do not hesitate to contact me directly .

Regards

Bob Wingate

IBI GROUP
400-333 Preston Street
Ottawa ON K1S 5N4 Canada
tel +1 613 225 1311 fax +1 613 225 9868

<image008.jpg><image009.jpg><image010.jpg><image011.jpg><image012.jpg>

<image007.png>

NOTE: This email message/attachments may contain privileged and confidential information. If received in error, please notify the sender and delete this e-mail message.
NOTE: Ce courriel peut contenir de l'information privilégiée et confidentielle. Si vous avez recu ce message par erreur, veuillez le mentionner immédiatement à l'expéditeur et effacer ce courriel.

IMPORTANT NOTICE: This message and any attached documents are only for the use of the intended recipient(s), are confidential and may contain privileged information. Any unauthorized review, use, retransmission, or other disclosure is strictly prohibited. If you have received this message in error, notify the sender immediately, and delete the original message.

This e-mail originates from the City of Ottawa e-mail system. Any distribution, use or copying of this e-mail or the information it contains by other than the intended recipient(s) is unauthorized. Thank you.

Le présent courriel a été expédié par le système de courriels de la Ville d'Ottawa. Toute distribution, utilisation ou reproduction du courriel ou des renseignements qui s'y trouvent par une personne autre que son destinataire prévu est interdite. Je vous remercie de votre collaboration.

IBI GROUP
400–333 Preston Street
Ottawa ON K1S 5N4 Canada
tel 613 225 1311 fax 613 225 9868
ibigroup.com

Memorandum

To/Attention:	John Sevigny, City of Ottawa Marcel Denomme, Urbandale (RSDC) Jim Burghout, Claridge Homes	**Date:**	July 25, 2017
From:	Robert W. Wingate	**Project No:**	38269-5.3.1
cc:			
Subject:	**DEVIATION REPORT MEMORANDUM** **RIVERSIDE SOUTH, RIDEAU RIVER DRAINAGE AREA** **SANITARY SEWER DESIGN PARAMETERS**		

INTRODUCTION:

Urbandale Corporation (RSDC), Claridge Homes and Cardel Homes are in the process of advancing the development of their lands in Riverside South located in the area known as the Rideau River Drainage Area (Figure A-1 illustrates the ownership limits).

As part of the draft plan approval process, IBI Group has been retained to prepare “Adequacy of Services Reports” to support the proposed development of the RSDC lands and the Claridge lands. In reviewing the Final Master Servicing Study (MSS) IBI Group has determined that an alternative method of calculating the design flow for the trunk sanitary sewer in River Road will be beneficial to the design of the internal sanitary sewer system for the subject area, and will ultimately benefit development of the overall development area.

PURPOSE:

The purpose of this memorandum is to present the alternative method of design for the River Road Sanitary Collector Sewer, identify the benefits of implementing the proposed deviation, and request approval to proceed with the implementation of the proposed deviation in design procedure.

JUSTIFICATION:

In advancing the detailed local sanitary sewer system layout for the development lands in the Rideau River Drainage Area west of Spratt Road, it became apparent that the drainage divide between the River Road Sanitary Collector Sewer and the Spratt Road Collector Sewer was problematic as presented in the recent update to the MSS for this area. The combination of the Spratt Road Collector Sewer being significantly higher than the River Road Collector, and the fact that the existing ground surface drops off significantly between the Spratt Road Collector and the current drainage divide is problematic as proposed in the updated MSS. It is problematic because these facts combine to produce a high risk of grade raise issues along the corridor between the Spratt Road sewer and the drainage divide. This grade raise risk is further compounded by the fact that the MSS drainage proposal results in reverse flowing sewers between the sanitary sewer and storm sewer on most streets in that area.

The simple solution to resolve all these issues is to expand the drainage limit of the deeper River Road Collector sewer easterly. Figure A-2 illustrates the proposed expansion of the River Road Collector Sewer Drainage Area. This adjustment to the drainage area reduces the potential for grade raise issues, maximizes the use of parallel sewers in the local road network, and improves the phasing potential for all three developers.

The problem with implementing the proposed expansion of the River Road Collector Sewer drainage area is that the free flow design capacity of the existing River Road Collector Sewer is exceeded using the City of Ottawa's current design guideline design parameter for sanitary sewers. To alleviate this theoretical issue we have evaluated the River Road Sanitary Collector Sewer using monitored parameters for the existing development area tributary to the River Road Collector Sewer, and the City's proposed revised sanitary sewer design parameters, as presented in Table 1, for the remainder of the development area tributary to the River Road Collector Sewer. The attached spreadsheet was created to replicate the sanitary spreadsheet in the current MSS. The City's proposed revised design parameters were then applied to the un-built area tributary to the River Road Collector Sewer using the proposed expanded drainage area (see pink highlighted section of spreadsheet). The modified spreadsheet demonstrates that the River Road Collector Sewer's capacity under free flow conditions is not exceeded at build-out under this design scenario.

CONCLUSION:

Given the significance of the benefits to expanding the River Road Sanitary Collector Sewers drainage area easterly, including reducing the risk of grade raise issues, maximizing the use of parallel sanitary and storm sewers, and enhancing construction phasing potential for all three developers involved, it is recommended that the City approve the use of the revised sanitary sewer design parameters for use in the Riverside South Rideau River Drainage Area in advance of formal approval of these revised parameters. In considering this recommendation, it should also be noted that shifting the drainage areas as proposed will provide additional residual capacity in the more easterly Spratt Road Sanitary Collector Sewer. This will help support more intensification beyond that currently proposed in the existing CDP for the eastern portion of the development area. This is consistent with the City's Building Better Smarter Suburbs (BBSS) initiative and the recent decision to extend the next phase of the LRT to Riverside South. Given these recent facts the City may want to approve the use of the proposed revised sanitary sewer design parameters for all of Riverside South at this time, to maximize the implementation of the BBSS initiative and further support the imminent extension of the LRT to Riverside South by facilitating additional intensification of development.

Yours truly,

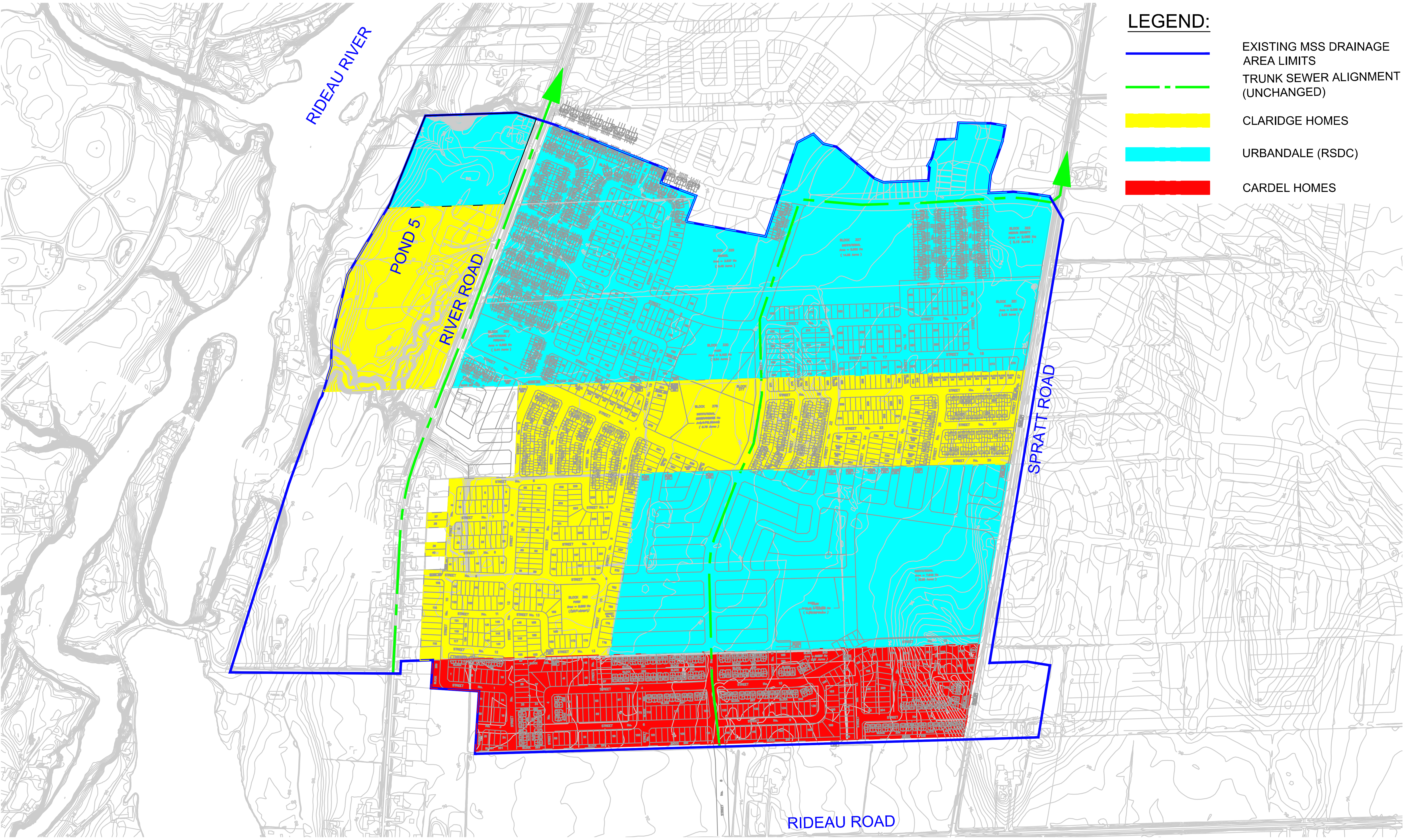
IBI GROUP

REGISTERED PROFESSIONAL ENGINEER
R. W. WINGATE
25/7/17
PROVINCE OF ONTARIO

Robert W. Wingate, P. Eng.
Associate

RWW/ks
Encl.

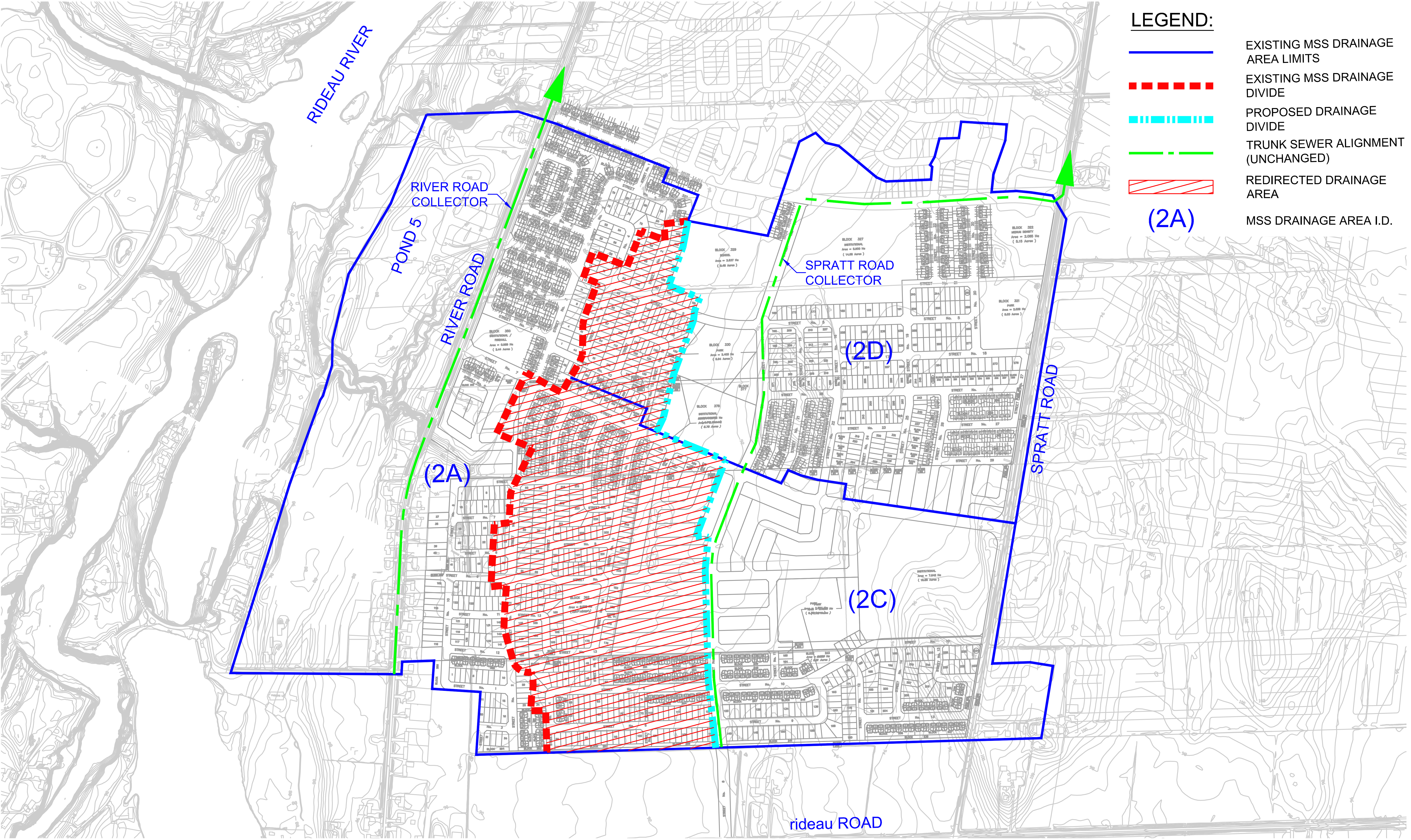
J:\38269-RiversideSthPh15\5.3 Approvals\5.3.1 Municipal\CTB_sevigny_2017-07-24.docx\2017-07-25\KS



IBI

Scale	Project Title	Drawing Title	Sheet No.
N.T.S.	RIVERSIDE SOUTH RIDEAU RIVER POND 5 DRAINAGE AREA	OWNERSHIP	FIGURE A-1

J:\38269-RiversideSthPh15\5.9 Drawings\59civil\current\Deviation Report figures\FIGURE A-2.dwg Layout Name: FIGURE S-1 Plot Scale: 1:5.13 Plotted At: 7/25/2017 Last Saved By: chris.cormier Last Saved



IBI

Scale	Project Title	Drawing Title	Sheet No.
N.T.S.	RIVERSIDE SOUTH RIDEAU RIVER POND 5 DRAINAGE AREA	ALTERNATIVE SANITARY DRAINAGE LIMIT	FIGURE A-2

Table 1

Parameters	Current			Proposed		
	Design	Annual	Rare	Design	Annual	Rare
Res. Per Capita	350	300	300	280 [1]	200 [2]	200 [2]
Commercial	50000	17000	17000	28000	17000 [4]	17000 [4]
Institutional	50000	17000	17000	28000	17000 [4]	17000 [4]
Industrial	35000	10000	10000	35000 [4]	10000 [4]	10000 [4]
I/I dry	n/a	n/a	n/a	0.05	0.02*	0.02*
I/I wet	0.28	0.28*	0.5*	0.28	0.28*	0.53*
Total I/I	0.28	0.28*	0.5*	0.33	0.3	0.55 [3]
Harmon - Correction Factor	1	0.4-0.6	0.4-0.6	0.8	0.6	0.6
ICI Peak Factor	1.5	1	1	1.5/1 [5]	1	1

* or higher with the support of monitoring data

[1] 280 L/cap/day = 90th percentile based on statistical analysis of new development

[2] 200 L/cap/day = 70th percentile for new development, 60th percentile for old development

[3] 0.53 L/ha/day = interim value to be reviewed in 2017

[4] Values to be reviewed in 2017

[5] ICI Peak Factor = 1.5 if ICI in contributing area is >20%, 1.0 if ICI in contributing area is <20%

Notes:

1) Sewers in new subdivisions shall be designed to operate under free flow conditions during peak flow periods.

2) During a catastrophic failure at a wastewater pump station, the HGL in the sanitary sewer system shall be below the underside of footing for the "Annual Event" flow condition.

3) A minimum freeboard of 0.3 m is required under a "Rare Event" flow condition. For areas serviced by a pump station, assume the station is operating at its rated capacity (rated capacity to be confirmed by ESD staff).

4) Preferably, the elevation of the sanitary overflow conduit should be above the 100 yr stormwater elevation. The overflow elevation can be lowered to the 25 year storm event on a case-by-case basis.

IBI GROUP
400-333 Preston Street
Ottawa, Ontario K1S 5N4 Canada
tel 613 225 1311 fax 613 225 9868
ibigroup.com

REVISED RIVER ROAD COLLECTOR ANALYSIS
- EXISTING DEVELOPMENT USING MONITORED PARAMETERES FROM DESIGN GUIDELINES
- NEW DEVELOPMENT USING PROPOSED REVISIONS TO DESIGN GUIDELINES

SANITARY SEWER DESIGN SHEET

38269 - Riverside South Community Infrastructure Servicing Study
CITY OF OTTAWA

LOCATION				RESIDENTIAL																	ICI AREAS							INFILTRATION ALLOWANCE				TOTAL	PROPOSED SEWER DESIGN						
				TOTAL AREA (Ha)	LOW DENSITY			MED DENSITY			HIGH DENSITY				POPULATION		PEAKING FACTOR			PEAK FLOW (L/s)	AREA (Ha)						PEAK FLOW (L/s)	ROAD AREA (Ha)	AREA (Ha)		FLOW (L/s)	FLOW (L/s)	CAPACITY (L/s)	LENGTH (m)	DIA (mm)	SLOPE (%)	VELOCITY (full) (m/s)	AVAILABLE CAPACITY	
STREET	AREA ID	FROM MH	TO MH		AREA (Ha)	POP	CUM POP	AREA (Ha)	POP	CUM POP	AREA (Ha)	POP	CUM POP	TOTAL UNITS	IND	CUM	STANDARD	CORRECTED			COMMERCIAL		EMPLOYMENT		INSTITUTIONAL				IND	CUM									
																	PF	K	PF		IND	CUM	IND	CUM	IND	CUM												L/s	(%)
RIVER ROAD	2a + 2c(i) + 2c(ii) + 2d(i)	108	107	91.61	64.95	3202	3202	26.66	1721	1721	0.00	0	0	1718	4922	4922	3.25	0.80	2.60	41.49	1.19	1.19	0.00	0.00	1.01	1.01	1.07	4.48	98.28	98.28	32.43	74.99	103.03	1255	450	0.12	0.63	28.04	27.21%
RIVER ROAD	---	107	107a	0.00	0.00	0	0	0.00	0	0	0.00	0	0	0	0	0	3.20	0.60	1.92	0.00	0.00	1.19	0.00	0.00	0.00	1.01	1.07	0.00	0.00	0.00	0.00	84.50	155.42	254	525	0.12	0.70	70.92	45.63%
	2b FUTURE			12.21	10.22	502	3704	1.99	127	1848	0.00	0	0	0	629	5551		0.80	2.56	46.09								2.64	14.85	113.13	37.33								
RIVER ROAD	2b Existing (Phase 9)	107a	107b	43.20	43.20	2351	2351	0.00	0	0	0.00	0	0	N/A	2351	2351	3.06	0.60	1.83	14.97	0.00	1.19	0.00	0.00	2.46	3.47	2.27	0.00	43.20	43.20	12.10	111.45	141.88	405	525	0.10	0.63	30.43	21.45%
	---			0.00	0.00	0	3704	0.00	0	1848	0.00	0	0	0	0	5551		0.80	2.44	43.98								0.00	2.46	115.59	38.15								
RIVER ROAD	---	107b	107c	0.00	0.00	0	2351	0.00	0	0	0.00	0	0	0	0	2351	3.06	0.60	1.83	14.97	0.00	1.19	0.00	0.00	0.00	3.47	2.27	0.00	0.00	43.20	12.10	111.45	173.76	217	525	0.15	0.78	62.32	35.86%
				0.00	0.00	0	3704	0.00	0	1848	0.00	0	0	0	0	5551		0.80	2.44	43.98								0.00	0.00	115.59	38.15								
	---	107c	107d	0.00	0.00	0	2351	0.00	0	0	0.00	0	0	0	0	2351	3.06	0.60	1.83	14.97	0.00	1.19	0.00	0.00	0.00	3.47	2.27	0.00	0.00	43.20	12.10	113.00	141.88	107	525	0.10	0.63	28.88	20.36%
				0.00	0.00	0	3704	0.00	0	1848	0.00	0	0	0	0	5551		0.80	2.44	43.98								4.70	4.70	120.29	39.70								
	---	107d	106	0.00	0.00	0	2351	0.00	0	0	0.00	0	0	0	0	2351	3.06	0.60	1.83	14.97	0.00	1.19	0.00	0.00	0.00	3.47	2.27	0.00	0.00	43.20	12.10	113.00	126.90	278	525	0.08	0.57	13.90	10.95%
				0.00	0.00	0	3704	0.00	0	1848	0.00	0	0	0	0	5551		0.80	2.44	43.98								0.00	0.00	120.29	39.70								
	Ex3	106	103	17.90	10.04	413	2764	7.86	564	564	0.00	0	0	364	977	3328	3.01	0.60	1.80	20.84	5.35	6.54	0.00	0.00	0.00	3.47	4.87	0.00	17.90	61.10	17.11	127.54	141.88	835	525	0.10	0.63	14.34	10.11%
				0.00	0.00	0	3704	0.00	0	1848	0.00	0	0	0	0	5551		0.80	2.40	43.26								0.00	5.35	125.64	41.46								
	Ex2	103	102	16.42	16.42	573	3337	0.00	0	564	0.00	0	0	179	573	3901	2.98	0.60	1.79	24.21	0.00	6.54	0.00	0.00	0.00	3.47	4.87	5.11	21.53	82.63	23.14	136.55	141.88	1100	525	0.10	0.63	5.33	3.76%
				0.00	0.00	0	3704	0.00	0	1848	0.00	0	0	0	0	5551		0.80	2.38	42.87								0.00	0.00	125.64	41.46								
SPRATT SOUTH	2c - 2c(i) - 2c(ii)	114	113	20.32	18.37	905	905	1.95	125	125	0.00	0	0	335	1030	1030	3.79	0.80	3.03	10.12	0.00	0.00	0.00	0.00	7.68	7.68	3.73	5.93	33.94	33.94	11.20	25.05	98.65	695	450	0.11	0.601	73.59	74.60%
SPRATT SOUTH	2d - 2d(i)	113	112	31.65	21.26	1048	1953	10.40	665	790	0.00	0	0	604	1713	2743	3.48	0.80	2.78	24.71	0.00	0.00	0.00	0.00	14.95	22.63	11.00	5.45	52.06	85.99	28.38	64.09	148.80	1155	525	0.11	0.666	84.71	56.93%
SPRATT SOUTH	2e	112	111-a	17.48	0.00	0	1953	13.28	847	1637	4.19	479	479	605	1326	4069	3.33	0.80	2.66	35.09	2.55	2.55	0.00	0.00	0.00	22.63	12.24	6.14	26.17	112.16	37.01	84.34	155.42	470	525	0.12	0.696	71.08	45.73%
SPRATT SOUTH	---	111-a	111	0.00	0.00	0	1953	0.00	0	1637	0.00	0	479	0	0	4069	3.33	0.80	2.66	35.09	0.00	2.55	0.00	0.00	0.00	22.63	12.24	0.00	0.00	112.16	37.01	84.34	148.80	215	525	0.11	0.666	64.46	43.32%
SPRATT SOUTH	Ex4	111	110	14.93	13.31	90	2043	1.62	468	2105	0.00	0	479	223	558	4627	3.28	0.80	2.62	39.30	0.91	3.46	0.00	0.00	0.00	22.63	12.68	0.00	15.84	128.00	42.24	94.22	155.42	600	525	0.12	0.696	61.20	39.38%
SHORELINE DRIVE	3b	117	116	48.13	43.40	2138	2138	4.73	302	302	0.00	0	0	794	2440	2440	3.52	0.80	2.81	22.25	0.66	0.66	0.00	0.00	0.05	0.05	0.34	2.77	51.60	51.60	17.03	39.62	98.65	1270	450	0.11	0.601	59.03	59.84%
SHORELINE DRIVE	3c	116	115	47.51	27.40	1350	3488	15.47	989	1291	4.64	530	530	1113	2869	5309	3.22	0.80	2.58	44.33	0.00	0.66	0.00	0.00	11.13	11.17	5.75	10.02	68.67	120.26	39.69	89.77	122.63	990	450	0.17	0.747	32.87	26.80%
SHORELINE DRIVE	Ex5	115	110	20.60	14.47	480	3968	6.13	302	1593	0.00	0	530	276	782	6091	3.16	0.80	2.53	49.97	0.80	1.46	0.00	0.00	3.16	14.33	7.67	0.00	24.56	144.82	47.79	105.44	133.02	480	450	0.20	0.810	27.58	20.73%
SPRATT SOUTH	Ex6	110	109	25.47	20.32	822	6833	5.15	288	3986	0.00	0	1009	377	1110	11828	2.88	0.80	2.31	88.37	0.00	4.92	0.00	0.00	2.39	39.36	21.52	0.00	27.86	300.68	99.22	209.12	303.78	675	675	0.12	0.822	94.66	31.16%
CANYON WALK DRIVE	3d	121	120	46.05	35.39	1744	1744	10.66	679	679	0.00	0	0	828	2423	2423	3.52	0.80	2.82	22.11	0.60	0.60	0.00	0.00	3.72	3.72	2.10	5.41	55.78	55.78	18.41	42.62	115.20	820	450	0.15	0.702	72.58	63.01%
CANYON WALK DRIVE	3e	120	119	54.06	40.27	1984	3728	13.79	881	1560	0.00	0	0	987	2865	5288	3.22	0.80	2.58	44.18	0.00	0.60	0.00	0.00	3.91	7.63	4.00	9.21	67.19	122.97	40.58	88.76	190.35	925	525	0.18	0.852	101.59	53.37%
CANYON WALK DRIVE	3f-4a	119	118	17.44	0.00	0	3728	3.06	194	1754	14.38	1007	1007	577	1201	6489	3.14	0.80	2.51	52.80	6.01	6.61	0.00	0.00	5.28	12.92	9.49	16.75	45.49	168.46	55.59	117.88	195.57	880	525	0.19	0.875	77.69	39.73%
INTERNAL SOUTH	6a	123	122	49.84	31.53	1555	1555	18.31	1169	1169	0.00	0	0	973	2724	2724	3.48	0.80	2.78	24.56	1.18	1.18	0.00	0.00	5.33	5.33	3.17	6.44	62.80	62.80	20.72	48.45	167.87	600	525	0.14	0.751	119.42	71.14%
ARMSTRONG ROAD	4b	122	118	58.24	0.00	0	1555	0.00	0	1169	58.24	4070	4070	2005	4070	6794	3.12	0.80	2.50	54.94	24.34	25.53	0.00	0.00	0.00	5.33	15.00	24.91	107.49	170.29	56.20	126.13	230.96	1810	600	0.13	0.791	104.82	45.39%
CANYON WALK DRIVE	Ex1	118	124	45.64	22.12	896	6179	23.52	1687	4610	0.00	0	5077	983	2583	15866	2.75	0.80	2.20	113.27	1.55	33.69	0.00	0.00	0.00	18.25	25.24	0.00	47.19	385.94	127.36	265.87	449.81	860	750	0.15	0.986	183.94	40.89%
SPRATT ROAD	5c	130	129	25.52	20.06	989	989	5.46	348	348	0.00	0	0	454	1337	1337	3.72	0.80	2.97	12.88	0.00	0.00	0.00	0.00	2.38	2.38	1.16	4.86	32.77	32.77	10.81	24.85	248.09	420	600	0.15	0.850	223.24	89.98%
SPRATT ROAD	1a	129	128	10.26	7.00	346	1335	3.26	209	557	0.00	0	0	195	555	1892	3.60	0.80	2.88	17.68	0.00	0.00	0.00	0.00	0.00	2.38	1.16	7.76	18.02	50.79	16.76	35.60	339.63	450	675	0.15	0.919	304.04	89.52%
SPRATT ROAD	1b	128	127	18.80	4.11	202	1537	13.56	866	1423	1.13	129	129	492	1197	3089	3.43	0.80	2.75	27.48	0.00	0.00	0.00	0.00	2.82	5.20	2.53	5.34	26.97	77.76	25.66	55.67	339.63	490	675	0.15	0.919	283.96	83.61%
INTERNAL NORTH	5b	135	134	17.31	10.06	496	496	7.25	463	463	0.00	0	0	348	959	959	3.81	0.80	3.05	9.48	0.00	0.00	0.00	0.00	0.03	0.03	0.02	1.32	18.66	18.66	6.16	15.65	70.84	385	375	0.15	0.621	55.19	77.91%
INTERNAL NORTH	1d	134	127	21.95	12.43	611	1107	9.52	607	1070	0.00	0	0	444	1218	2177	3.56	0.80	2.85	20.08	2.66	2.66	0.00	0.00	0.01	0.04	1.31	4.33	28.95	47.61	15.71	37.10	70.84	550	375	0.15	0.621	33.75	47.64%
	BP-1	137	127	39.70	20.70	1173	1173	17.00	1019	1019	2.00	398	398	891	2590	2590	3.50	0.80	2.80	23.47	0.00	0.00	16.18	16.18	0.00	0.00	5.24	6.81	62.69	62.69	20.69	49.40	70.84	725	375	0.15	0.621	21.44	30.26%
SPRATT ROAD	1c	127	126	14.01	0.00	0	3817	8.98	574	4086	5.03	574	1101	541	1148	9004	3.00	0.80	2.40	70.03	0.74	3.40	0.00	16.18	6.60	11.84	12.65	6.42	27.77	215.82	71.22	153.89	449.81	795	750	0.15	0.986	295.92	65.79%
INTERNAL NORTH	5a	133	132	11.48	4.65	230	230	6.83	437	437	0.00	0	0	254	667	667	3.91	0.80	3.13	6.76	1.02	1.02	0.00	0.00	1.15	1.15	1.06	4.02	17.68	17.68	5.83	13.65	70.84	410	375	0.15	0.621	57.20	80.74%
INTERNAL NORTH	1e	132	126	34.06	22.08	1088	1318	11.98	766	1203	0.00	0	0	659	1854	2521	3.51	0.80	2.80	22.91	0.00	1.02	0.00	0.00	1.37	2.52	1.72	6.18	41.61	59.29	19.57	44.20	115.20	810	450	0.15	0.702	71.00	61.63%
	BP-2	138	126	0.11	0.00	0	0	0.11	7	7	0.00	0	0	3	7	7	4.00	0.80	3.20	0.07	0.00	0.00	15.00	15.00	0.00	0.00	4.86	1.48	16.59	16.59	5.48	10.41	70.84	440	375	0.15	0.621	60.43	85.31%
SPRATT ROAD	1g	126	125	14.19	1.66	83	5218	9.47	605	5901	3.05	348	1449	461	1036	12568	2.86	0.80	2.28	93.04	0.98	5.40	0.00	31.18	10.12	24.48	24.62	3.45	28.74	320.44	105.75	223.41	478.86	710	750	0.17	1.050	255.45	53.35%
SPRATT ROAD	1f	131	125	9.29	5.05	250	250	4.24	271	271	0.00	0	0	191	521	521	3.96	0.80	3.17	5.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.48	12.77	12.77	4.21	9.57	45.12	420	300	0.20	0.618	35.54	78.79%
	BP3	136	125	0.00	0.00	0	0	0.00	0	0	0.00	0	0	0	0	0	4.00	0.80	3.20	0.00	0.00	0.00	38.46	38.46	0.00	0.00	12.46	5.69	44.15	44.15	14.57	27.03	68.44	986	375	0.14	0.600	41.41	60.51%
SPRATT ROAD	1h	125	124	1.69	0.00	0	5468	1.69	108	6280	0.00	0	1449	45	108	13197	2.83	0.80	2.27	96.97	2.20	7.60	0.00	69.64	1.66	26.14	38.96	3.04	8.59	385.95	127.36	263.30	731.45	830	900	0.15	1.114	468.15	64.00%
SPRATT ROAD	Ex7	124	109	17.26	11.40	768	12415	3.00	250	11140	2.86	327	6853	516	1345	30408	2.47	0.80	1.98	194.84	0.64	41.93	0.00	69.64	0.00	44.39	64.51	0.00	17.90	789.79	260.63	519.98	1,103.33	515	1050	0.15	1.234	583.35	52.87%
CANYON WALK DRIVE	Ex8	109	102	56.40	54.40	2150	21398	2.00	134	15260	0.00	0	7862	728	2284	44520	2.31	0.80	1.85	266.83	0.00	46.85	0.00	69.64	0.00	83.75	86.03	5.45	61.85	1152.32	380.26	733.13	1,103.33	1100	1050	0.15	1.234	370.20	33.55%
SPRATT ROAD	BP-4	139	102	0.00	0.00	0	0	0.00	0	0	0.00	0	0	0	0	0	4.00	0.80	3.20	0.00	0.00	0.00	127.52	127.52	0.00	0.00	95.03	19.76	147.28	147.28	48.60	143.63	339.63	2790	675	0.15	0.919	196.00	57.71%
CROSSING	---	102	101	0.00			3337			564			0	0	0	3901	2.23	0.60	1.34	18.15	0.00	53.39	0.00	197.16	0.00	87.21	215.26	0.00	0.00	82.63	23.14	1016.86	1,348.97	145	1200	0.11	1.155	332.11	24.62%
							25101			17108			7862		0	50071		0.80	1.79	289.98								0.00	0.00	1425.24	470.33								

Design Parameters:

Residential			ICI Areas			Peak Factor
SF	3.2	p/p/u	COM	0.324	L/s/Ha	1.5
TH/SD	2.4	p/p/u	EMP	0.324	L/s/Ha	1
APT	1.9	p/p/u	INST	0.324	L/s/Ha	1.5

Notes:

1. Mannings coefficient (n) =	0.013	
2. Demand (per capita):	280 L/day	300 L/day
3. Infiltration allowance:	0.33 L/s/Ha	0.28 L/s/Ha
4. Residential Peaking Factor:	K = 0.80	K = 0.60
Harmon Formula = 1+(14/(4+P^0.5))		
where P = population in thousands		
5. Existing Sanitary Sewer Lines		

Designed: MB

Checked: MB

Dwg. Reference:

No.	Revision	Date
1a.	- Manual build of Stantec's *Riverside South Community Infrastructure Servicing Study* , dated June 5, 2017	2017-06-29
1b.	- New Sanitary parameters *(see Note 1)* and adjustments to Areas 2a, 2c, 2d	2017-06-29
1c.	- Correction Factor of K=0.6 & 0.28 L/s / 300L/day *(see Note 2)*	2017-06-29
1d.	- Increase in Area 2a split 50/50 between Low density and Medium Density *(see Note 3)*	2017-06-29

File Reference:	Date:	Sheet No:
38269-5.7.1	2017-05-09	1 of 1

NOTE 1: Spreadsheet is Stantec's original, but using proposed revisions to design guidelines
- Res. per capita = 280 L/d
- Commercial = 28,000 L/d/ha (0.324 L/s/ha)
- Instutional = 28,000 L/d/ha (0.324 L/s/ha)
- ~~Industrial = 35,000 L/d/ha~~
- Infiltration = 0.33 L/s/ha
- Peaking Factor correction, K = 0.80
- ICI Peaking Factor = 1.5 (>20% contributing area)

NOTE 2: MH106 to MH103, MH103 to MH102 and Area 2b *(Existing (Phase 9))* flows calculated using monitored parameters from design guidelines
- Res. per capita = 300 L/d
- Infiltration = 0.28 L/s/ha
- Peaking Factor correction, K = 0.60

NOTE 3:

Additions to Area 2a (50% Low Density / 50% Medium Density)					
Area		Low Density		Medium Density	
2d(i)	**7.63** ha	15.40	units / ha	27.0	units / ha
2c(i)	**25.20** ha	15.40	units / ha	27.0	units / ha
2c(ii)	**8.27** ha	15.40	units / ha	27.0	units / ha

J:\38269-RiversideSthPh15\5.7 Calculations\5.7.1 Sewers & Grading\Final Copy\CCS_38269_sanitary_FINAL_2017-06-29

IBI GROUP
400-333 Preston Street
Ottawa, Ontario K1S 5N4 Canada
tel 613 225 1311 fax 613 225 9868
ibigroup.com

SANITARY SEWER DESIGN SHEET

River Road
City of Ottawa
Riverside South Development Corporation

LOCATION				RESIDENTIAL											ICI AREAS							INFILTRATION ALLOWANCE			FIXED FLOW (L/s)		TOTAL FLOW	PROPOSED SEWER DESIGN						
				AREA w/ Units (Ha)	UNIT TYPES				AREA w/o Units (Ha)	POPULATION		PEAK FACTOR	CORR. FACTOR	PEAK FLOW (L/s)	AREA (Ha)						PEAK FLOW (L/s)	AREA (Ha)		FLOW				CAPACITY	LENGTH	DIA	SLOPE	VELOCITY (full)	AVAILABLE CAPACITY	
STREET	AREA ID	FROM MH	TO MH		SF	SD	TH	APT		IND	CUM				INSTITUTIONAL		COMMERCIAL		INDUSTRIAL			IND	CUM	(L/s)	IND	CUM	(L/s)	(L/s)	(m)	(mm)	(%)	(m/s)	L/s	(%)
															IND	CUM	IND	CUM	IND	CUM														
River Road	EXT - 7								22.71	1,835.0	1,835.0	3.61	0.80	17.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.71	22.71	7.49	0.00	0.00	24.69							
	28A	MH28A	MH29A	0.73	8					25.6	1,860.6	3.61	0.80	17.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.73	23.44	7.74	0.00	0.00	25.15	103.03	101.51	450	0.12	0.628	77.89	75.59%
Solarium Avenue	EXT - 4, 5, 6	STUB	MH29A	58.32	652		474			3,224.0	3,224.0	3.42	0.80	28.55	0.99	0.99	0.00	0.00	0.00	0.00	0.48	59.31	59.31	19.57	0.00	0.00	48.60	81.80	25.00	375	0.20	0.717	33.20	40.58%
River Road	29A	MH29A	MH30A	0.56	5					16.0	5,100.6	3.24	0.80	42.80	0.00	0.99	0.00	0.00	0.00	0.00	0.48	0.56	83.31	27.49	0.00	0.00	70.78	103.03	83.34	450	0.12	0.628	32.26	31.31%
	30A	MH30A	MH31A	0.49	3					9.6	5,110.2	3.24	0.80	42.88	0.00	0.99	0.00	0.00	0.00	0.00	0.48	0.49	83.80	27.65	0.00	0.00	71.01	103.03	93.99	450	0.12	0.628	32.02	31.08%
River Road	31A	MH31A	MH11A	0.25						0.0	5,110.2	3.24	0.80	42.88	0.00	0.99	0.00	0.00	0.00	0.00	0.48	0.25	84.05	27.74	0.00	0.00	71.09	103.03	80.00	450	0.12	0.628	31.94	31.00%
Atrium Ridge	EXT - 3	STUB	MH11A	1.34			40			96.0	96.0	4.00	0.80	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.34	1.34	0.44	0.00	0.00	1.44	41.91	25.04	200	1.50	1.292	40.47	96.57%
Street No. 1 West	12A	STUB	MH11A	2.84	40					128.0	128.0	4.00	0.80	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.84	2.84	0.94	0.00	0.00	2.26	24.19	22.70	200	0.50	0.746	21.93	90.64%
River Road	11A	MH11A	MH18A	0.34						0.0	5,334.2	3.22	0.80	44.51	0.00	0.99	0.00	0.00	0.00	0.00	0.48	0.34	88.57	29.23	0.00	0.00	74.22	103.03	100.00	450	0.12	0.628	28.81	27.96%
	18A	MH18A	MH4A	0.23						0.0	5,334.2	3.22	0.80	44.51	0.00	0.99	0.00	0.00	0.00	0.00	0.48	0.23	88.80	29.30	0.00	0.00	74.30	103.03	68.01	450	0.12	0.628	28.73	27.89%
Capricorn Circle	EXT - 2	STUB	MH4A	8.42	69		125			520.8	520.8	3.97	0.80	5.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.42	8.42	2.78	0.00	0.00	8.13	20.24	18.89	200	0.35	0.624	12.11	59.83%
Street 3 West	8A	STUB	MH4A	2.64			60			144.0	144.0	4.00	0.80	1.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.64	2.64	0.87	0.00	0.00	2.36	24.19	17.13	200	0.50	0.746	21.83	90.23%
River Road	4A	MH4A	MH3A	0.76	2					6.4	6,005.4	3.17	0.80	49.36	0.00	0.99	0.00	0.00	0.00	0.00	0.48	0.76	100.62	33.20	0.00	0.00	83.05	103.03	129.23	450	0.12	0.628	19.99	19.40%
Borbridge Avenue	EXT - 1	STUB	MH3A	2.08			57			136.8	136.8	4.00	0.80	1.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.08	2.08	0.69	0.00	0.00	2.11	19.36	20.00	200	0.32	0.597	17.25	89.12%
River Road	3A	MH3A	MH2A	0.31						0.0	6,142.2	3.16	0.80	50.34	0.00	0.99	0.00	0.00	0.00	0.00	0.48	0.31	103.01	33.99	0.00	0.00	84.81	155.42	97.77	525	0.12	0.696	70.61	45.43%
	2A	MH2A	*EX. MH160A*	0.38						0.0	6,142.2	3.16	0.80	50.34	0.00	0.99	0.00	0.00	0.00	0.00	0.48	0.38	103.39	34.12	0.00	0.00	84.94	155.42	118.68	525	0.12	0.696	70.48	45.35%
		EX MH106A	*EX MH 100A*	*0.19*						0.0	6,142.2	3.16	0.80	50.34	0.00	0.99	0.00	0.00	0.00	0.00	0.48	0.19	103.58	34.18	0.00	0.00	85.00	141.88	*58.85*	*525*	*0.10*	0.635	56.88	40.09%

Design Parameters:

Residential			ICI Areas			Peak Factor
SF	3.2	p/p/u	INST	28,000	L/Ha/day	1.5
TH/SD	2.4	p/p/u	COM	28,000	L/Ha/day	1.5
APT	1.9	p/p/u	IND	35,000	L/Ha/day	MOE Chart
Other	81	p/p/Ha				

Notes:
1. Mannings coefficient (n) = 0.013
2. Demand (per capita): 280 L/day
3. Infiltration allowance: 0.33 L/s/Ha
4. Residential Peaking Factor:
Harmon Formula = 1+(14/(4+P^0.5))
where P = population in thousands
Correction Factor = 0.8

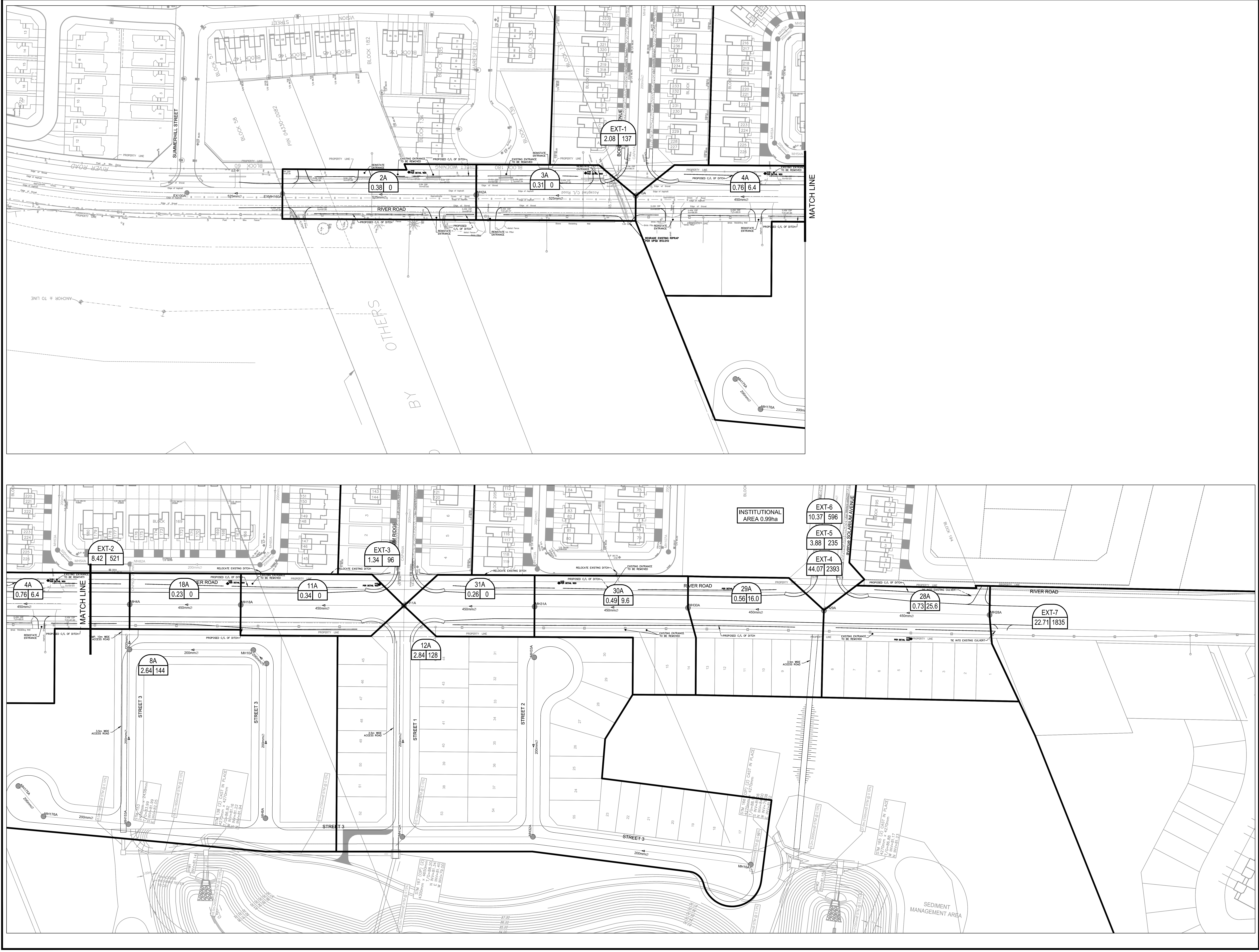
Designed: LME

Checked:

Dwg. Reference: 114373-501

No.	Revision	Date
1.	Submission No. 1	27/04/2018
2.	Submission No. 2	3/07/2018
3.	Submission No. 3	20/08/2018

File Reference:	Date:	Sheet No:
114373.5.7.1	2018-08-20	1 of 1



J:\114373_RiverRoad\5.9 Drawings\59civil\layouts\400 - Sanitary Drainage Area Plan.dwg Layout Name: SANITARY DRAINAGE AREA PLAN Plot Style: AIA STANDARD-FULL.CTB Plot Scale: 1:50.8 Plotted At: 8/20/2018 3:15 PM Last Saved By: CHRIS.CORMIER Last Saved At: Aug. 20, 18

NOTES:

1. ALL CULVERTS TO BE GALVANIZED CSP 68x13 CORR. x2.8mm THICK CLASS "B" BEDDING. ALL JOINTS TO BE WRAPPED WITH NON-WOVEN GEOTEXTILE, MINIMUM 1.0m WIDTH.

14			
13			
12			
11			
10			
9			
8			
7			
6			
5	REVISED AS PER CITY COMMENTS	LE	20-08-18
4	PRELIM. ISSUED TO CONTRACTOR	LE	16-08-18
3	ISSUED FOR TENDER	LE	06-07-18
2	REVISED AS PER CITY COMMENTS	LE	29-06-18
1	ISSUED FOR CITY REVIEW	LE	27-04-18
No.	REVISIONS	By	Date

IBI GROUP
400 – 333 Preston Street
Ottawa ON K1S 5N4 Canada
tel 613 225 1311 fax 613 225 9868
ibigroup.com

Project Title

RIVER ROAD
RECONSTRUCTION

L. M. ERION
13379508
20/08/18

N

Drawing Title

SANITARY DRAINAGE
AREA PLAN

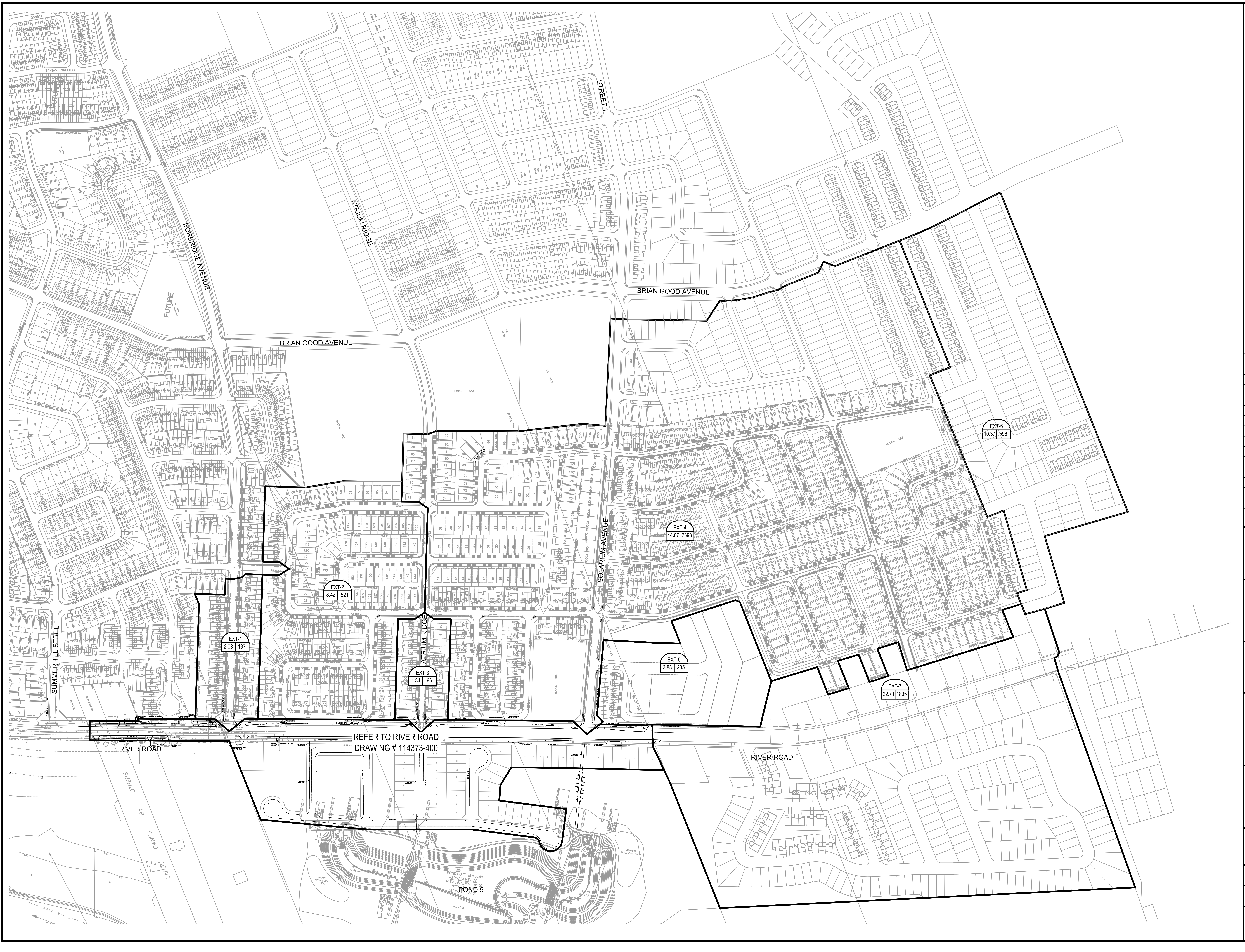
Scale
1:1000

Design	Date
LE	APR 2018

Drawn	Checked
CC	TB

Project No.	Drawing No.
114373	400

J:\114373_RiverRoad\5.9 Drawings\59civil\layouts\401 - Ext Sanitary Drainage Plan.dwg Layout Name: EXTERNAL SANITARY DRAINAGE AREA PLAN Plot Style: AIA STANDARD-FULL.CTB Plot Scale: 1:63.5 Plotted At: 8/20/2018 1:59 PM Last Saved By: CHRIS.CORMIER Last Saved At: Aug. 20, 18



NOTES:

1. ALL CULVERTS TO BE GALVANIZED CSP 68x13 CORR. x2.8mm THICK CLASS "B" BEDDING. ALL JOINTS TO BE WRAPPED WITH NON-WOVEN GEOTEXTILE, MINIMUM 1.0m WIDTH.

No.	REVISIONS	By	Date
14			
13			
12			
11			
10			
9			
8			
7			
6			
5	REVISED AS PER CITY COMMENTS	LE	20-08-18
4	PRELIM. ISSUED TO CONTRACTOR	LE	16-08-18
3	ISSUED FOR TENDER	LE	06-07-18
2	REVISED AS PER CITY COMMENTS	LE	29-06-18
1	ISSUED FOR CITY REVIEW	LE	27-04-18

IBI
IBI GROUP
400 – 333 Preston Street
Ottawa ON K1S 5N4 Canada
tel 613 225 1311 fax 613 225 9868
ibigroup.com

Project Title

RIVER ROAD
RECONSTRUCTION

L. M. ERION
13379508
20/08/18

N

Drawing Title

EXTERNAL SANITARY
DRAINAGE AREA PLAN

Scale
1:2500

Design
LE

Date
APR 2018

Drawn
CC

Checked
TB

Project No.
114373

Drawing No.
401

D07-

#

SANITARY SEWER DESIGN SHEET (PRELIMINARY)

NOVATECH
Engineers, Planners & Landscape Architects

Novatech Project #: 116037
Project Name: Wright Lands
Date Prepared: 7/23/2020
Date Revised:
Input By: Ben Sweet
Reviewed By: Sam Bahia
Drawing Reference: FIG 3.1, FIG 5.1

Legend:
- PROJECT SPECIFIC INFO
- USER DESIGN INPUT
- CUMILATIVE CELL
- CALCULATED DESIGN CELL OUTPUT
- CALCULATED ANNUAL CELL OUTPUT
- CALCULATED RARE CELL OUTPUT
- USER AS-BUILT INPUT

LOCATION				DEMAND														DESIGN CAPACITY							
				RESIDENTIAL FLOW											EXTRANOUS FLOW AREA METHOD		TOTAL DESIGN FLOW	PROPOSED SEWER PIPE SIZING / DESIGN							
STREET	AREA	FROM MH	TO MH	SINGLES	SEMIS/ TOWNS	APARTS	PARK AREA (ha)	POPULATION (in 1000's)	CUMULATIVE POPULATION (in 1000's)	PEAK FACTOR M	AVG POPULATION FLOW Q(q) (L/s)	PEAKED DESIGN POP FLOW Q(p) (L/s)	RESIDENTIAL DRAINAGE AREA (ha.)	CUMULATIVE RES DRAINAGE AREA (ha.)	CUMULATIVE EXTRANOUS DRAINAGE AREA (ha.)	DESIGN EXTRAN. FLOW Q(e) (L/s)	TOTAL DESIGN FLOW Q(D) (L/s)	LENGTH (m)	PIPE SIZE (mm) AND MATERIAL	PIPE ID ACTUAL (m)	ROUGH. (n)	DESIGN GRADE (%)	CAPACITY (L/s)	FULL FLOW VELOCITY (m/s)	Qpeak Design / Qcap
ONSITE SEWERS TO PROPOSED LIFT STATION																									
ALPHON LANDS (FUTURE DEVELOPMENT) [1]	EXT1	CAP	23	109	3		0.709	0.381	0.381	4.00	1.24	3.95	7.990	7.990	7.990	2.64	6.59	SEWERS BY OTHERS							
STREET 1	A01	23	21	3	4			0.021	0.402	4.00	1.30	4.17	0.410	8.400	8.400	2.77	6.94	51.6	250 PVC	0.254	0.013	0.25	31.0	0.61	22.4%
	A02	21	19	8	8			0.049	0.451	4.00	1.46	4.67	0.830	9.230	9.230	3.05	7.72	89.6	250 PVC	0.254	0.013	0.25	31.0	0.61	24.9%
	A03	19	17	2				0.007	0.458	3.99	1.48	4.74	0.170	9.400	9.400	3.10	7.84	13.8	250 PVC	0.254	0.013	0.25	31.0	0.61	25.3%
	A04	17	15	2				0.007	0.465	3.99	1.51	4.81	0.130	9.530	9.530	3.14	7.95	22.9	250 PVC	0.254	0.013	0.25	31.0	0.61	25.6%
	A05	15	13	3				0.010	0.475	3.99	1.54	4.91	0.210	9.740	9.740	3.21	8.12	35.8	250 PVC	0.254	0.013	0.25	31.0	0.61	26.2%
	A06	13	11	1				0.003	0.478	3.98	1.55	4.94	0.080	9.820	9.820	3.24	8.18	28.8	250 PVC	0.254	0.013	0.25	31.0	0.61	26.4%
ALPHON LANDS (FUTURE DEVELOPMENT) [1]	EXT2	CAP	57	30	3			0.110	0.110	4.00	0.36	1.14	2.310	2.310	2.310	0.76	1.90	SEWERS BY OTHERS							
STREET 1	A07	57	93	4	7			0.033	0.143	4.00	0.46	1.48	0.540	2.850	2.850	0.94	2.42	60.4	250 PVC	0.254	0.013	0.25	31.0	0.61	7.8%
	A08	93	11	1	2			0.009	0.151	4.00	0.49	1.57	0.210	3.060	3.060	1.01	2.58	34.5	250 PVC	0.254	0.013	0.25	31.0	0.61	8.3%
STREET 1	A09	11	9	3				0.010	0.640	3.92	2.07	6.50	0.200	13.080	13.080	4.32	10.81	39.3	250 PVC	0.254	0.013	0.25	31.0	0.61	34.9%
	A10	9	7		5			0.014	0.653	3.91	2.12	6.62	0.300	13.380	13.380	4.42	11.04	39.1	250 PVC	0.254	0.013	0.25	31.0	0.61	35.6%
	A11	7	3		1			0.003	0.656	3.91	2.13	6.65	0.060	13.440	13.440	4.44	11.09	38.8	250 PVC	0.254	0.013	0.25	31.0	0.61	35.7%
STREET 1 / LIFT STATION	A12	3	1					0.000	0.656	3.91	2.13	6.65	0.040	13.480	13.480	4.45	11.10	9.5	250 PVC	0.254	0.013	0.25	31.0	0.61	35.8%
	-	1	WW					0.000	0.656	3.91	2.13	6.65	0.000	13.480	13.480	4.45	11.10	34.3	250 PVC	0.254	0.013	0.25	31.0	0.61	35.8%
OFFSITE SEWERS TO EXISTING MH28A																									
LIFT STATION / RIVER ROAD	-	VC	101					0.000	0.656	3.91	2.13	6.65	0.000	13.480	13.480	4.45	11.10	20.3	250 PVC	0.254	0.013	0.25	31.0	0.61	35.8%
RIVER ROAD [2]	EXT3	CAP	101					1.179	1.179	3.75	3.82	11.47	9.230	9.230	9.230	3.05	14.52	SEWERS BY OTHERS							
RIVER ROAD [2]	-	101	EX MH28A					0.000	1.835	3.61	5.95	17.20	0.000	22.710	22.710	7.49	24.69	113.5	450 PVC	0.457	0.013	0.12	103.0	0.63	24.0%
TOTALS				**166**	**33**	**0**	**0.709**	**1.835**					**22.71**												

DEMAND EQUATION

Design Parameters:
1. Q(D), Q(A), Q(R) = Q(p) + Q(fd) + Q(ici) + Q(e)
2. Q(p) = (P x q x M x K / 86,400)
3. q Avg capita flow (L/per/day)= 280 L/per/day (design)
200 L/per/day (annual and rare)
4. M = Harmon Formula (maximum of 4.0)
5. K = 0.8 (design)
0.6 (annual and rare)
6. Park flow is considered equivalent to a single unit / ha
Park Demand = 1 Single Unit Equivalent / Park ha
7. Foundation Drains 0.45 L/s/unit
8. Q(ici) = ICI Area x ICI Flow x ICI Peak
9 Q(e) = 0.33 L/sec/ha (design)
0.30 L/sec/ha (annual)
0.55 L/sec/ha (rare)

Definitions:
Q(D) = Peak Design Flow (L/sec)
Q(A) = Peak Annual Flow (L/sec)
Q(R) = Peak Rare Flow (L/sec)
Q(e) = Extraneous Flow (L/sec)
Q(p) = Population Flow (L/sec)
K = Harmon Correction Factor
P = Residential Population
Typ Service Diameter (mm)
Typ Service Length (m)
I/I Pipe Rate (L/mm dia/m/hr) =
Q(fd) = Foundation Flow (L/sec)
Q(ici) = Industrial / Commercial / Institutional Flow (L/sec)

	Singles	Semis/Towns	Apts (2-BR)
P = Residential Population	3.4	2.7	2.1
Typ Service Diameter (mm)		135	
Typ Service Length (m)	15	15	
I/I Pipe Rate (L/mm dia/m/hr) =	0.007		

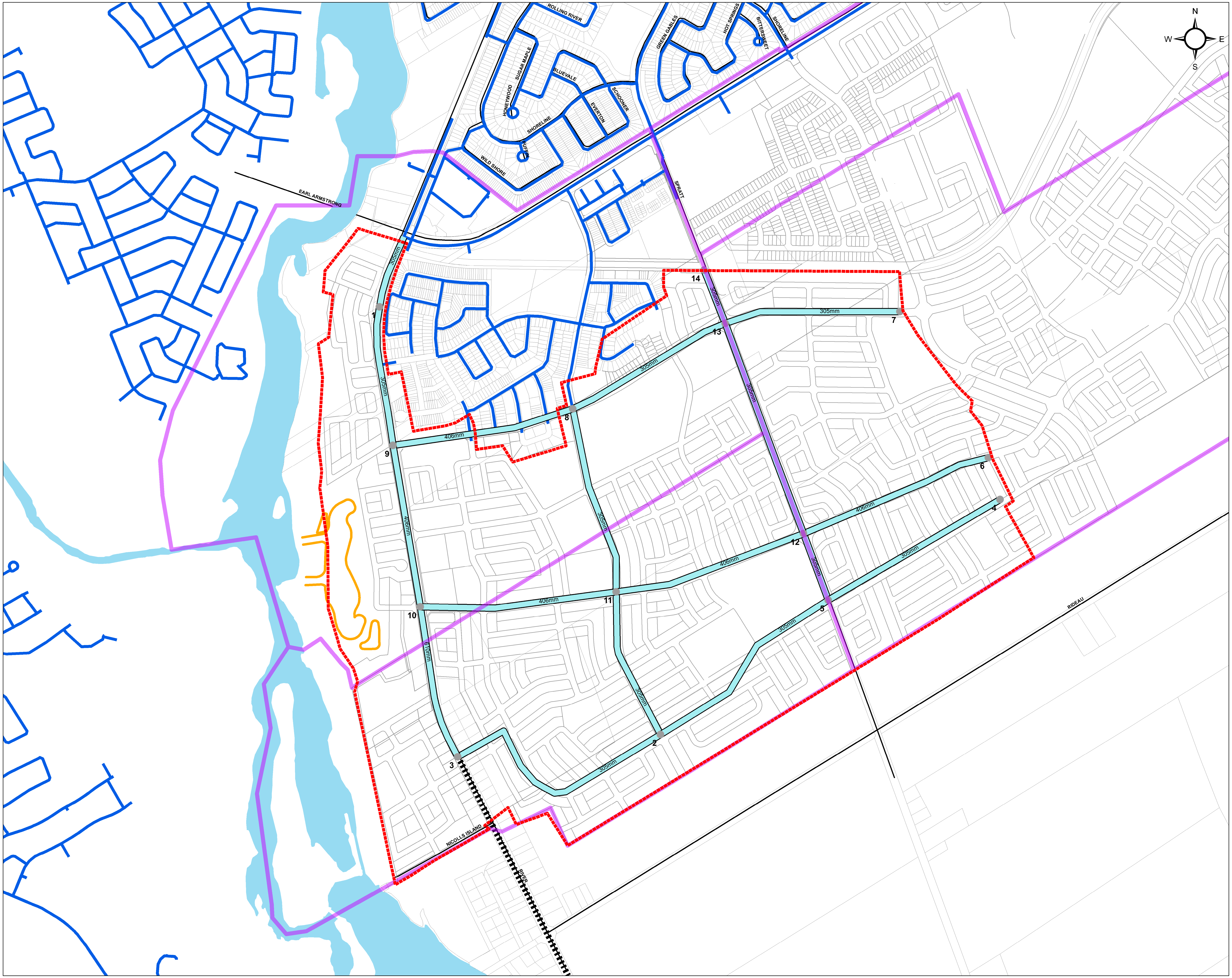
Institutional / Commercial / Industrial		Std ICI -->	Industrial	Commercial / Institutional
	Design =		35000	28000
	Annual / Rare =		10000	17000
ICI Peak *	Design =		1.0	1.5
	Annual / Rare =	1.0		

* ICI Peak = 1.0 Default, 1.5 if ICI in contributing area is >20% (design only)

NOTE(S)
[1] EXTERNAL FLOWS FROM ALPHON LANDS (FUTURE DEVELOPMENT) TO BE CONFIRMED AS PART OF DETAILED DESIGN.
[2] EXTERNAL FLOWS FROM RIVER ROAD SANITARY DRAINAGE AREA TO BE CONFIRMED AS PART OF DETAILED DESIGN. EXTERNAL FLOWS BASED FROM DESIGN BRIEF - RIVER ROAD RECONSTRUCTION SUMMERHILL STREET TO SOUTH OF SOLARIUM AVENUE (IBI, AUGUST 2018).

CAPACITY EQUATION
Q full= (1/n) A R^(2/3)So^(1/2)
Where : Q full = Capacity (L/s)
n = Manning coefficient of roughness (0.013)
A = Flow area (m^2)
R = Wetter perimeter (m)
So = Pipe Slope/gradient

Appendix E
Water Demand Calculations and Hydraulic Modeling



Stantec

STANTEC CONSULTING LTD.
400 1331 CLYDE AVENUE
OTTAWA, ON
TEL. 613.722.4420
WWW.STANTEC.COM

Legend

- Major Water
- Parcels
- Growth Polygons
- Rideau River Study Area
- Pond 5
- Streets
- Watermain Node
- Proposed Watermain
- Future Watermain to Manotick
- Existing Watermains

Client / Project:

CITY OF OTTAWA

RIVERSIDE SOUTH ISSU UPDATE

OTTAWA, ON

Title:

POTABLE WATER SERVICING PLAN

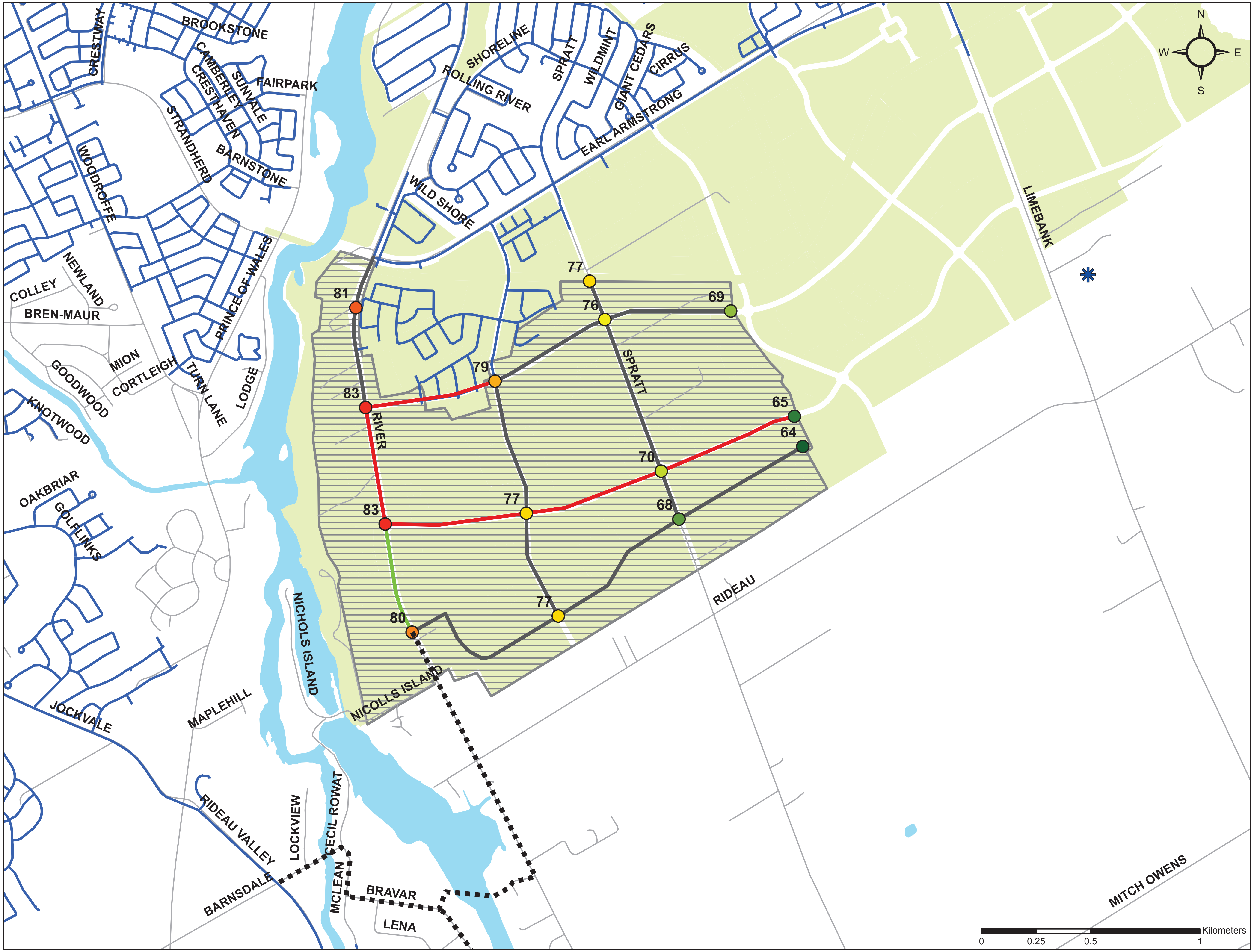
Project No.: **163401101**

Scale: 0 125 250 Meters

Drawing No.: **WAT-1**

Sheet: **7 of 7**

Revision: **0**



Stantec

STANTEC CONSULTING LTD.
400 1331 CLYDE AVENUE
OTTAWA, ON
TEL. 613.722.4420
WWW.STANTEC.COM

Legend

▭ Rideau River Study Area
🟩 Riveside South Area
✱ Future Elevated Tank Location
▪▪ Future Pipes to Manotick
— Existing Watermains

Proposed Pipes
Dia. (mm)
— 305
— 406
— 610

Model Nodes Maximum Pressure (psi)
● 64
● 65
● 68
● 69
● 70
● 76
● 77
● 79
● 80
● 81
● 83

Client / Project:

CITY OF OTTAWA

RIVERSIDE SOUTH ISSU UPDATE

OTTAWA, ON

Title:

Maximum Pressure During BSDY

Project No.:

163401101

Figure No.:

5-4

Boundary Conditions for Alphon Wright

Information Provided:

Date provided: September 2019

Scenario	Demand	
	L/min	L/s
Average Daily Demand	40.02	0.67
Maximum Daily Demand	100.08	1.67
Peak Hour	220.2	3.67
Fire Flow Demand #1	10000	167
Fire Flow Demand #2	13000	217

Location:

Results

Connection 1 - River Road

Demand Scenario	Existing Barrhaven PZ		Future Zone 3C	
	Head (m)	Pressure[1] (psi)	Head (m)	Pressure[1] (psi)
Maximum HGL	133.1	63.7	147.8	84.6
Peak Hour	125.7	53.1	145.6	81.5
Max Day plus Fire #1	122.0	47.9	142.7	77.3
Max Day plus Fire #2	119.5	44.4	140.3	73.9

[1] Ground Elevation = 88.3 m

Notes:

1) As per the Ontario Building Code in areas that may be occupied, the static pressure at any fixture shall not exceed 552 kPa (80 psi.) Pressure control measures to be considered are as follows, in order of preference:
    a) If possible, systems to be designed to residual pressures of 345 to 552 kPa (50 to 80 psi) in all occupied areas outside of the public right-of-way without special pressure control equipment.
    b) Pressure reducing valves to be installed immediately downstream of the isolation valve in the home/ building, located downstream of the meter so it is owner maintained.

2) Two connections off the 610 mm watermain is not permitted. A connection from a secondary watermain on River Road or from a future local watermain east of River Road is required.

Disclaimer

The boundary condition information is based on current operation of the city water distribution system. The computer model simulation is based on the best information available at the time. The operation of the water distribution system can change on a regular basis, resulting in a variation in boundary conditions. The physical properties of watermains deteriorate over time, as such must be assumed in the absence of actual field test data. The variation in physical watermain properties can therefore alter the results of the computer model simulation. Fire Flow analysis is a reflection of available flow in the watermain; there may be additional restrictions that occur between the watermain and the hydrant that the model cannot take into account.

Ben Sweet

From: Sam Bahia
Sent: Thursday, November 14, 2019 3:54 PM
To: Ben Sweet; Michael Dias
Subject: Fwd: 116037 - Alphon Wright RSS
Attachments: AlphonWright_Boundary Conditions_24Sept2019.docx; ATT00001.htm; 116037-WM Connections.pdf; ATT00002.htm; MWL_FDR_Stub.pdf; ATT00003.htm

Thanks
Sam Bahia, P.Eng., Project Manager | Land Development
NOVATECH
Tel: 613.254.9643 x 285
The information contained in this email message is confidential and is for exclusive use of the addressee.

Begin forwarded message:

From: "Sharif, Golam" <sharif.sharif@ottawa.ca>
Date: September 26, 2019 at 2:47:25 PM EDT
To: Bradley Reed <b.reed@novatech-eng.com>
Cc: Sam Bahia <s.bahia@novatech-eng.com>
Subject: RE: 116037 - Alphon Wright RSS

Hi Bradley,

Here is the boundary condition. There are few comments from the water resource:

The City will not permit two connections off the future 610 mm Manotick Watermain Link (MWL) as proposed by Novatech to service the Alphon-Wright lands in Riverside South (refer to 116037-WM Connections.pdf). I am proposing one connection from the 610 mm watermain (refer to MWL_FDR_Stub.pdf) and another connection from the local 152 mm watermain on River Road at Solarium Avenue (refer to word document). The developer is required to fund the extension of local watermain.

Julie Lyons (City PM for the watermain) and JLR needs to know this since the original MWL functional design did not include the stub.

If you have any question please let me know. Thanks.

Sharif

From: Bradley Reed <b.reed@novatech-eng.com>
Sent: September 10, 2019 2:14 PM
To: Sharif, Golam <sharif.sharif@ottawa.ca>
Cc: Sam Bahia <s.bahia@novatech-eng.com>
Subject: RE: 116037 - Alphon Wright RSS

Hello Sharif,

I have attached the FUS sheets for worst case, both for 1 story and 2 story. The calculations consider lots 1-22, as well as lots 31-33.

Thanks,

Bradley Reed, E.I.T.
NOVATECH Engineers, Planners & Landscape Architects
240 Michael Cowpland Drive, Suite 200, Ottawa, ON, K2M 1P6 | Tel: 613.254.9643 | Fax: 613.254.5867

From: Sharif, Golam <sharif.sharif@ottawa.ca>
Sent: Monday, September 9, 2019 2:21 PM
To: Bradley Reed <b.reed@novatech-eng.com>
Cc: Sam Bahia <s.bahia@novatech-eng.com>
Subject: RE: 116037 - Alphon Wright RSS

Good Afternoon Bradley,

The consultant still needs to provide the FUS calculation and then refer to the technical bulletins to cap of 10,000 L/min explaining how it met that cap.

I have discussed with internally, also with John Sevigny to confirm and this is the process. So please provide the FUS calculation, so that I can forward them to our water resources group. Thanks.

Sharif

From: Bradley Reed <b.reed@novatech-eng.com>
Sent: September 06, 2019 3:41 PM
To: Sharif, Golam <sharif.sharif@ottawa.ca>
Cc: Sam Bahia <s.bahia@novatech-eng.com>
Subject: RE: 116037 - Alphon Wright RSS

Hello Sharif,

The development only consists of one story towns and singles, in which a 10m separation is met (see attachment for reference). An FUS sheet is not necessary at this time as the cap of 10,000 L/min will be met (Referring to ISDTB2014-02).

Thank you,

Bradley Reed, E.I.T.
NOVATECH Engineers, Planners & Landscape Architects
240 Michael Cowpland Drive, Suite 200, Ottawa, ON, K2M 1P6 | Tel: 613.254.9643 | Fax: 613.254.5867

From: Sharif, Golam <sharif.sharif@ottawa.ca>
Sent: Friday, September 6, 2019 1:35 PM
To: Bradley Reed <b.reed@novatech-eng.com>
Subject: RE: 116037 - Alphon Wright RSS

Hi Bradley,

Where is the FUS calculation sheet please? Thanks.

Sharif

From: Bradley Reed <b.reed@novatech-eng.com>
Sent: September 06, 2019 12:17 PM
To: Sharif, Golam <sharif.sharif@ottawa.ca>
Subject: RE: 116037 - Alphon Wright RSS

Hello Sharif,

Thank you for the response. The following information can also be found in the provided attachments.

i. The connection will be made to the River Road Manotick Watermain Link Extension.
ii. Residential development with required fire flows: 167 L/s and 217 L/s.
iii. Average daily demand: 0.667 L/s.
iv. Maximum daily demand: 1.668 L/s.
v. Maximum hourly daily demand: 3.670 L/s.
iv. Hydrant location will follow City design guidelines and the spacing will be between 90-120m.

Thank you,

Bradley Reed, E.I.T.
NOVATECH Engineers, Planners & Landscape Architects
240 Michael Cowpland Drive, Suite 200, Ottawa, ON, K2M 1P6 | Tel: 613.254.9643 | Fax: 613.254.5867

From: Sharif, Golam <sharif.sharif@ottawa.ca>
Sent: Friday, September 6, 2019 10:21 AM
To: Bradley Reed <b.reed@novatech-eng.com>
Subject: RE: 116037 - Alphon Wright RSS

Good Morning Bradley,

Could you please provide the FUS calculation for fire flow. And could you please fill out the information as below, (it help the water department):

1. Water Boundary condition requests must include the location of the service and the expected loads required by the proposed development. Please provide the following information:
    i. Location of service
    ii. Type of development and the amount of fire flow required (as per FUS, 1999).
    iii. Average daily demand: ___ l/s.
    iv. Maximum daily demand: ___l/s.
    v. Maximum hourly daily demand: ___ l/s.
    vi. Hydrant location and spacing to meet City's Water Design guidelines.

Thanks.

Sharif

From: Bradley Reed <b.reed@novatech-eng.com>
Sent: September 04, 2019 3:00 PM
To: Sharif, Golam <sharif.sharif@ottawa.ca>
Subject: 116037 - Alphon Wright RSS

Hello Sharif,

Attached you will find a high-level water demand table and concept plan outlining the location of the desired watermain connection for Alphon Wright. The site consists of:

- 27 singles (3.4 people/unit)
- 27 towns (2.7 people/unit)
- Fire demand of 10,000 Ipm and 13,000 Ipm
- 1 or 2 watermain connections to River Road and Manotick WM link extension (610mm feedermain)

Could you please provide us with watermain boundary conditions for the noted development at your earliest convenience. If any additional information is required do not hesitate to ask.

Thanks,

Bradley Reed, E.I.T.
NOVATECH Engineers, Planners & Landscape Architects
240 Michael Cowpland Drive, Suite 200, Ottawa, ON, K2M 1P6 | Tel: 613.254.9643 | Fax: 613.254.5867

'

'
'

'
'

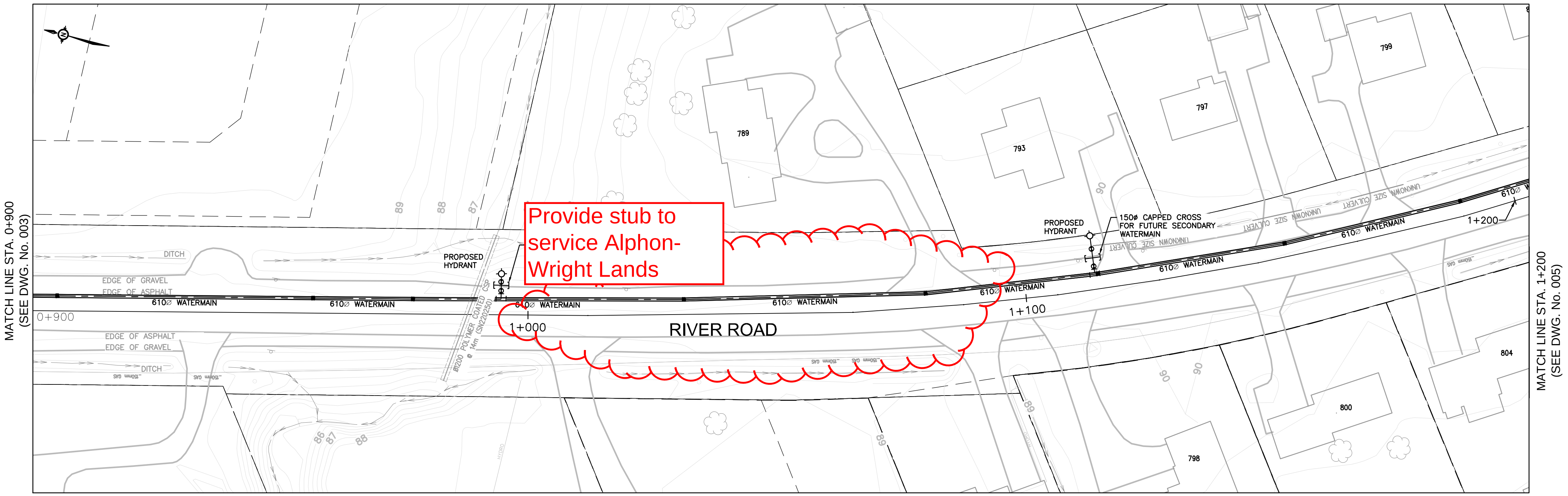
'
'

'

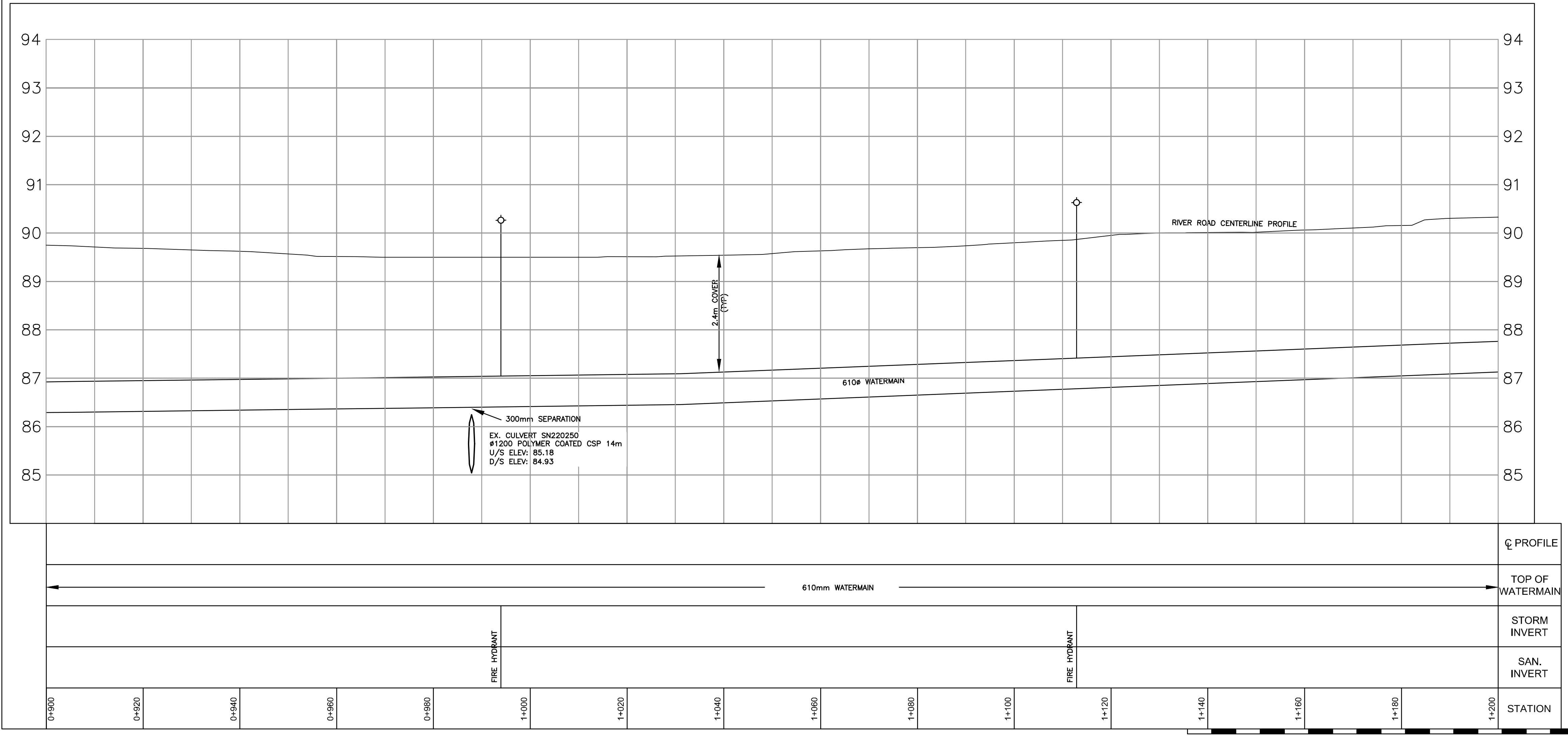
DRAWING FRAME: 790mm x 534mm City of Ottawa 2008

Consultant Drawing Number

L: \proj\2124040\06 Design\01 Drawings\03 Working Drawings\2124040 Functional Design.dwg



Provide stub to service Alphon-Wright Lands



MANOTICK WATERMAIN
LINK FUNCTIONAL DESIGN

RIVER ROAD
PLAN / PROFILE

WAYNE NEWELL
General Manager

JOHN BOUGADIS
Senior Project Manager

MORRISON HERSHFIELD

Ottawa

Contract No.

Dwg. No. 004

Sheet 04 of 10

Asset No.

Asset Group

Des. VP

Chk'd. TD

Dwn. SW

Chk'd.

Utility Circ. No.

Index No.

Const. Inspector

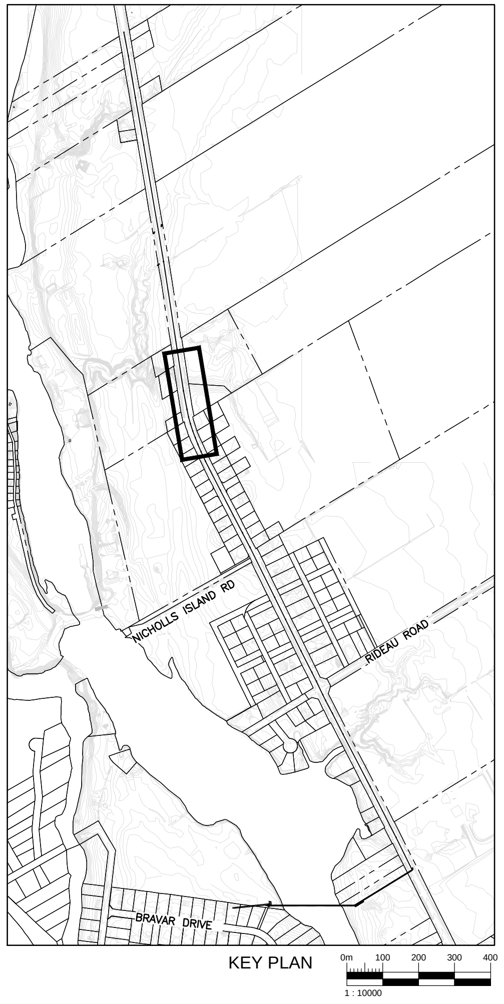
Scale:
HORIZONTAL
0m 10 20 40
0m 2 4
VERTICAL

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
1	FUNCTIONAL DESIGN	E.E.	19/11/15
2	FUNCTIONAL DESIGN	E.E.	23/12/15
3	FUNCTIONAL DESIGN	E.E.	04/03/16

PRELIMINARY
NOT FOR CONSTRUCTION



KEY PLAN

NOTE:

1. MINIMUM 2.4m COVER REQUIRED. ALLOW FOR DIFFERENCE IN ELEVATION BETWEEN CENTERLINE AND EDGE OF ASPHALT.

Project: Alphon-Wright RSS **Reference:** City of Ottawa Water Distribtuion Guidelines, 2010

Proj. No.: 116037

Design: SB

Basic Residential Water Demand

Type of Units	=				
No of. Units	=				
Total Population	=	164.7			
Flow/capita	=	350	L/day/person		
Domestic Flow Daily	=	57645	L/day	(# Units x # People x Residential Flow)	
	=	0.667	L/s	Less than 50m³	YES
Max Daily	=	144112.5	L/day	(2.5 x Domestic)	
	=	1.668	L/s		
Max Hour	=	13210	L/hour	(2.2 x Max Daily / 24)	
	=	3.670	L/s		
Fire Demand 1	=	10000	L/min	TB2014-01 Cap	
	=	167	L/s		
Fire Demand 2	=	13000	L/min	TB2014-01 Towns	
	=	217	L/s		

Attachment B1 - Wood, Ordinary Non-Combustible

FUS - Fire Flow Calculations

As per 1999 Fire Underwriter's Survey Guidelines

NOVATECH
Engineers, Planners & Landscape Architects

Novatech Project #: 116037
Project Name: Wright Property
Date: 9/9/2019
Input By: BCS
Reviewed By: BHB

Legend 🟨
▨

Building Description: Lots 1-22 - Single Family, Lots 31-33 - Townhouses and Semis
Wood frame

Step			Input		Value Used	Total Fire Flow (L/min)
	Base Fire Flow					
1	**Construction Material**			**Multiplier**		
	Coefficient related to type of construction **C**	Wood frame	Yes	1.5	1.5	
		Ordinary construction		1		
		Non-combustible construction		0.8		
		Modified Fire resistive construction (2 hrs)		0.6		
		Fire resistive construction (> 3 hrs)		0.6		
2	**Floor Area**					
	A	Building Footprint (m^2)	4991			
		Number of Floors/Storeys	1			
		Area of structure considered (m^2)			**4,991**	
	F	**Base fire flow without reductions**				**23,000**
		F = 220 **C** (**A**)$^{0.5}$				
	Reductions or Surcharges					
3	**Occupancy hazard reduction or surcharge**			**Reduction/Surcharge**		
	(1)	Non-combustible		-25%	-15%	**19,550**
		Limited combustible	Yes	-15%		
		Combustible		0%		
		Free burning		15%		
		Rapid burning		25%		
4	**Sprinkler Reduction**			**Reduction**		
	(2)	Adequately Designed System (NFPA 13)	No	-30%		**0**
		Standard Water Supply	No	-10%		
		Fully Supervised System	No	-10%		
				Cumulative Total	**0%**	
5	**Exposure Surcharge (cumulative %)**				**Surcharge**	
	(3)	North Side	> 45.1m		0%	**6,843**
		East Side	> 45.1m		0%	
		South Side	20.1 - 30 m		10%	
		West Side	0 - 3 m		25%	
				Cumulative Total	**35%**	
	Results					
6	**(1) + (2) + (3)**	**Total Required Fire Flow, rounded to nearest 1000L/min**			**L/min**	**26,000**
		(2,000 L/min < Fire Flow < 45,000 L/min)		or	L/s	**433**
				or	USGPM	6,869
7	**Storage Volume**	Required Duration of Fire Flow (hours)			Hours	6
		Required Volume of Fire Flow (m^3)			m^3	9360

FUS - Fire Flow Calculations

As per 1999 Fire Underwriter's Survey Guidelines

NOVATECH
Engineers, Planners & Landscape Architects

Novatech Project #: 116037
Project Name: Wright Property
Date: 9/9/2019
Input By: BCS
Reviewed By: BHB

Legend 🟨 ▨

Building Description: Lots 1-22 - Single Family, Lots 31-33 - Townhouses and Semis
Wood frame

Step			Input		Value Used	Total Fire Flow (L/min)
		Base Fire Flow				
1	**Construction Material**			**Multiplier**		
	Coefficient related to type of construction **C**	Wood frame	Yes	1.5	1.5	
		Ordinary construction		1		
		Non-combustible construction		0.8		
		Modified Fire resistive construction (2 hrs)		0.6		
		Fire resistive construction (> 3 hrs)		0.6		
2	**Floor Area**					
	A	Building Footprint (m^2)	4991			
		Number of Floors/Storeys	2			
		Area of structure considered (m^2)			**9,982**	
	F	**Base fire flow without reductions** F = 220 C (A)$^{0.5}$				**33,000**
		Reductions or Surcharges				
3	**Occupancy hazard reduction or surcharge**			**Reduction/Surcharge**		
	(1)	Non-combustible		-25%	-15%	**28,050**
		Limited combustible	Yes	-15%		
		Combustible		0%		
		Free burning		15%		
		Rapid burning		25%		
4	**Sprinkler Reduction**			**Reduction**		
	(2)	Adequately Designed System (NFPA 13)	No	-30%		**0**
		Standard Water Supply	No	-10%		
		Fully Supervised System	No	-10%		
				Cumulative Total	**0%**	
5	**Exposure Surcharge (cumulative %)**				**Surcharge**	
	(3)	North Side	> 45.1m		0%	**9,818**
		East Side	> 45.1m		0%	
		South Side	20.1 - 30 m		10%	
		West Side	0 - 3 m		25%	
				Cumulative Total	**35%**	
		Results				
6	**(1) + (2) + (3)**	**Total Required Fire Flow, rounded to nearest 1000L/min**			**L/min**	**38,000**
		(2,000 L/min < Fire Flow < 45,000 L/min)		or	L/s	**633**
				or	USGPM	10,040
7	**Storage Volume**	Required Duration of Fire Flow (hours)			Hours	9
		Required Volume of Fire Flow (m^3)			m^3	20520

Novatech Project #: 116037
Project Name: Wright Lands
Date: 2020/07/23
Date Revised:

Engineers, Planners & Landscape Architects

OVERALL WATER DEMAND

PHASE	RESIDENTIAL						AVE. DAY DEMAND (L/s) RES.	MAX. DAY DEMAND (L/s) RES.	PEAK HOUR DEMAND (L/s) RES.
	NUMBER OF UNITS					POP'N (pers)			
	SINGLE DETACHED	SEMI-DETACHED	ROW TOWNHOME	MULTI-RESIDENTIAL	PARK				
Wright Lands (Subject Site)	27	0	27	0	0	165	0.67	1.67	3.67
Alphon Lands (Future Development)	139	0	6	0	1	492	1.99	4.98	8.97
	166	**0**	**33**	**0**	**1**	**657**	**2.66**	**6.65**	**12.64**

ASSUMPTIONS:

RESIDENTIAL POPULATION DENSITY:	- Single Dwelling		3.4 people/unit
	- Semi-Detached		2.7 people/unit
	- Row Townhome		2.7 people/unit
	- Multi-Residential		2.1 people/unit
	- Park demands, equivalent to Single Detached		
AVERAGE DAY DEMAND:	- Residential		350 L / c / d
MAXIMUM DAY DEMAND:	- Residential		2.50 * average day
PEAK HOUR DEMAND:	- Residential		2.20 * maximum day
FIRE FLOW DEMAND:	- Low Density Residential	10,000 L/min. =	167 L/s

Novatech Project #: 116037
Project Name: Wright Lands
Date: 2020/07/23
Date Revised:

Engineers, Planners & Landscape Architects

JUNCTION DEMAND

JUNCTION ID	RESIDENTIAL					AVE. DAY DEMAND (L/s)	MAX. DAY DEMAND (L/s)	PEAK HOUR DEMAND (L/s)	FIRE FLOW DEMAND (L/s)
	NUMBER OF UNITS				POP'N (pers)				
	SINGLE DWELLING	ROW TOWNHOME	MULTI-RESIDENTIAL	PARK					
J1					0	0.00	0.00	0.00	
J2					0	0.00	0.00	0.00	
J3	6	9			45	0.18	0.45	1.00	167
J4					0	0.00	0.00	0.00	
J5	4	6			30	0.12	0.30	0.66	167
J6					0	0.00	0.00	0.00	
J7	10	3			42	0.17	0.43	0.94	167
J8	7	9			48	0.19	0.49	1.07	167
J9					0	0.00	0.00	0.00	
TOTAL	**27**	**27**	**0**	**0**	**165**	**0.67**	**1.67**	**3.67**	

ASSUMPTIONS:

RESIDENTIAL POPULATION DENSITY:	- Single Dwelling		3.4 people/unit
	- Semi-Detached		2.7 people/unit
	- Row Townhome		2.7 people/unit
	- Multi-Residential		2.1 people/unit
	- Park demands, equivalent to Single Dwelling		
AVERAGE DAY DEMAND:	- Residential		350 L / c / d
MAXIMUM DAY DEMAND:	- Residential		2.50 * average day
PEAK HOUR DEMAND:	- Residential		2.20 * maximum day
FIRE FLOW DEMAND:	- Low Density Residential	10,000 L/min. =	167 L/s

Novatech Project #: 116037
Project Name: Wright Lands
Date: 2020/07/23
Date Revised:

NOVATECH
Engineers, Planners & Landscape Architects

EXISTING CONDITIONS - MAX PRESSURES DURING BSDY CONDITIONS

JUNCTION ID	ELEVATION (m)	STATIC DEMAND (L/s)	STATIC HEAD (m)	STATIC PRESSURE (m)	STATIC PRESSURE (psi)
J1	89.80	0.00	133.55	43.75	62
J2	89.40	0.00	133.55	44.15	63
J3	87.96	0.18	133.55	45.59	65
J4	87.84	0.00	133.55	45.71	65
J5	87.61	0.19	133.55	45.94	65
J6	87.76	0.00	133.55	45.79	65
J7	87.48	0.17	133.55	46.07	66
J8	87.61	0.19	133.55	45.94	65
J9	87.91	0.00	133.55	45.64	65

FUTURE CONDITIONS - MAX PRESSURES DURING BSDY CONDITIONS

JUNCTION ID	ELEVATION (m)	STATIC DEMAND (L/s)	STATIC HEAD (m)	STATIC PRESSURE (m)	STATIC PRESSURE (psi)
J1	89.80	0.00	147.90	58.10	83
J2	89.40	0.00	147.90	58.50	83
J3	87.96	0.18	147.90	59.94	85
J4	87.84	0.00	147.90	60.06	85
J5	87.76	0.12	147.90	60.14	86
J6	87.76	0.00	147.90	60.14	86
J7	87.48	0.17	147.90	60.42	86
J8	87.61	0.19	147.90	60.29	86
J9	87.91	0.00	147.90	59.99	85

Novatech Project #: 116037
Project Name: Wright Lands
Date: 2020/07/23
Date Revised:

NOVATECH
Engineers, Planners & Landscape Architects

EXISTING CONDITIONS - MIN PRESSURES DURING PKHR CONDITIONS

JUNCTION ID	ELEVATION (m)	STATIC DEMAND (L/s)	STATIC HEAD (m)	STATIC PRESSURE (m)	STATIC PRESSURE (psi)
J1	89.80	0.00	125.70	35.90	51
J2	89.40	0.00	125.70	36.30	52
J3	87.76	0.00	125.69	37.93	54
J4	87.48	0.94	125.68	38.20	54
J5	87.61	1.07	125.68	38.07	54
J6	87.91	0.00	125.68	37.77	54
J7	87.48	0.94	125.68	38.20	54
J8	87.61	1.07	125.68	38.07	54
J9	87.91	0.00	125.68	37.77	54

FUTURE CONDITIONS - MIN PRESSURES DURING PKHR CONDITIONS

JUNCTION ID	ELEVATION (m)	STATIC DEMAND (L/s)	STATIC HEAD (m)	STATIC PRESSURE (m)	STATIC PRESSURE (psi)
J1	89.80	0.00	145.60	55.80	79
J2	89.40	0.00	145.60	56.20	80
J3	87.96	1.00	145.59	57.63	82
J4	87.84	0.00	145.59	57.75	82
J5	87.76	0.66	145.59	57.83	82
J6	87.76	0.00	145.59	57.83	82
J7	87.48	0.94	145.58	58.10	83
J8	87.61	1.07	145.58	57.97	82
J9	87.91	0.00	145.58	57.67	82

Novatech Project #: 116037
Project Name: Wright Lands
Date: 2020/07/23
Date Revised:

Engineers, Planners & Landscape Architects

EXISTING CONDITIONS - AVAILABLE FLOW AT 20psi DURING MXDY+FF CONDITIONS

JUNCTION ID	ELEVATION (m)	STATIC DEMAND (L/s)	STATIC HEAD (m)	STATIC PRESSURE (m)	STATIC PRESSURE (psi)	FIRE FLOW DEMAND (L/s)	FIRE FLOW DEMAND (L/min)	AVAILABLE FLOW (L/min)
J3	87.96	0.45	130.63	42.67	61	167	10,000	10,890
J5	87.76	0.30	130.63	42.87	61	167	10,000	8,220
J7	87.48	0.43	130.63	43.15	61	167	10,000	7,866
J8	87.61	0.49	130.63	43.02	61	167	10,000	6,318

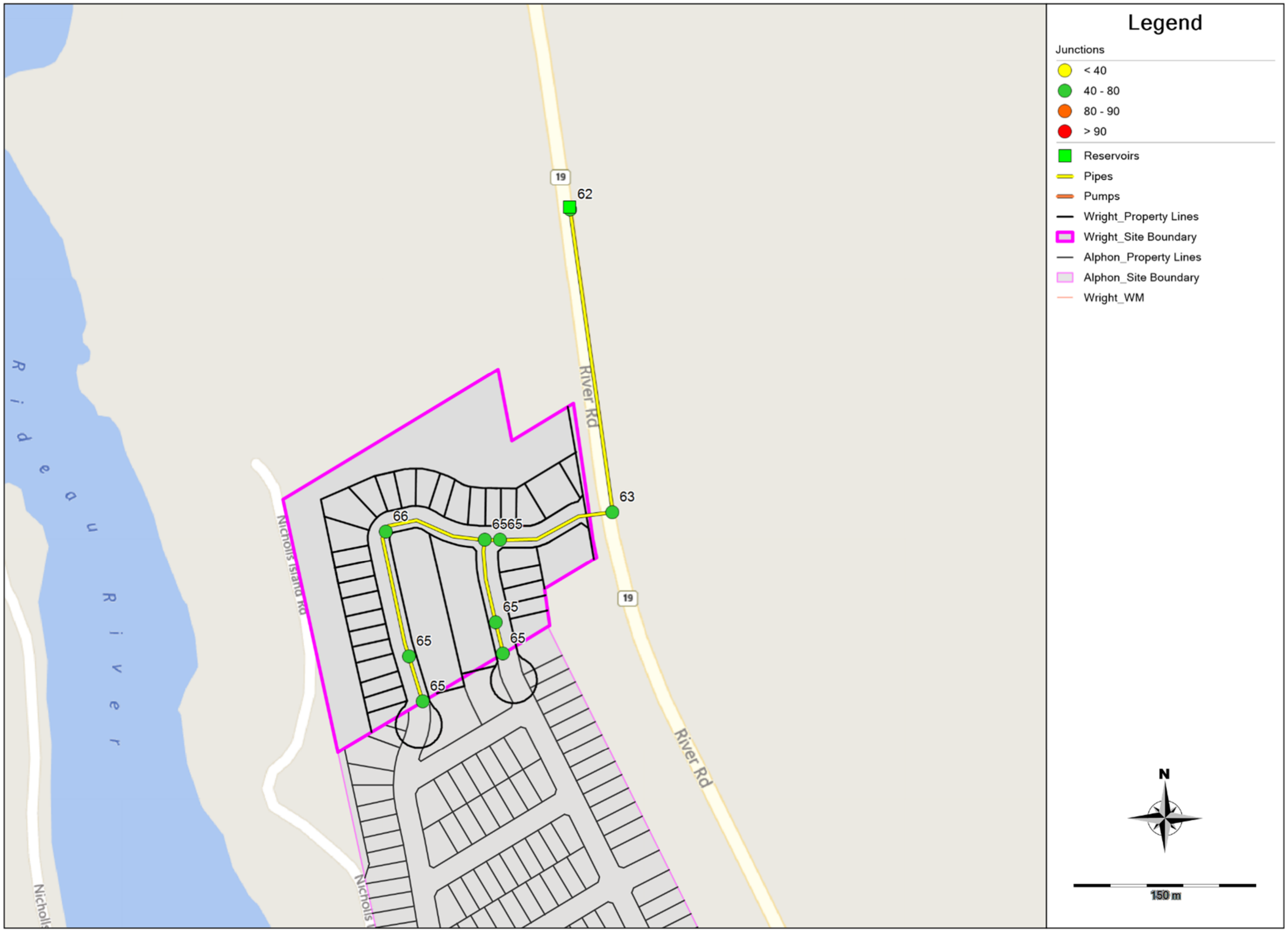
FUTURE CONDITIONS - AVAILABLE FLOW AT 20psi DURING MXDY+FF CONDITIONS

JUNCTION ID	ELEVATION (m)	STATIC DEMAND (L/s)	STATIC HEAD (m)	STATIC PRESSURE (m)	STATIC PRESSURE (psi)	FIRE FLOW DEMAND (L/s)	FIRE FLOW DEMAND (L/min)	AVAILABLE FLOW (L/min)
J3	87.96	0.45	147.06	59.10	84	167	10,000	15,414
J5	87.76	0.30	147.06	59.30	84	167	10,000	11,646
J7	87.48	0.43	147.06	59.58	85	167	10,000	11,136
J8	87.61	0.49	147.06	59.45	85	167	10,000	8,976

NOVATECH
Engineers, Planners & Landscape Architects

Wright Lands
Job No. 116037
PCSWMM Model Schematic – EXISTING CONDITIONS

Maximum Pressures During BSDY Conditions

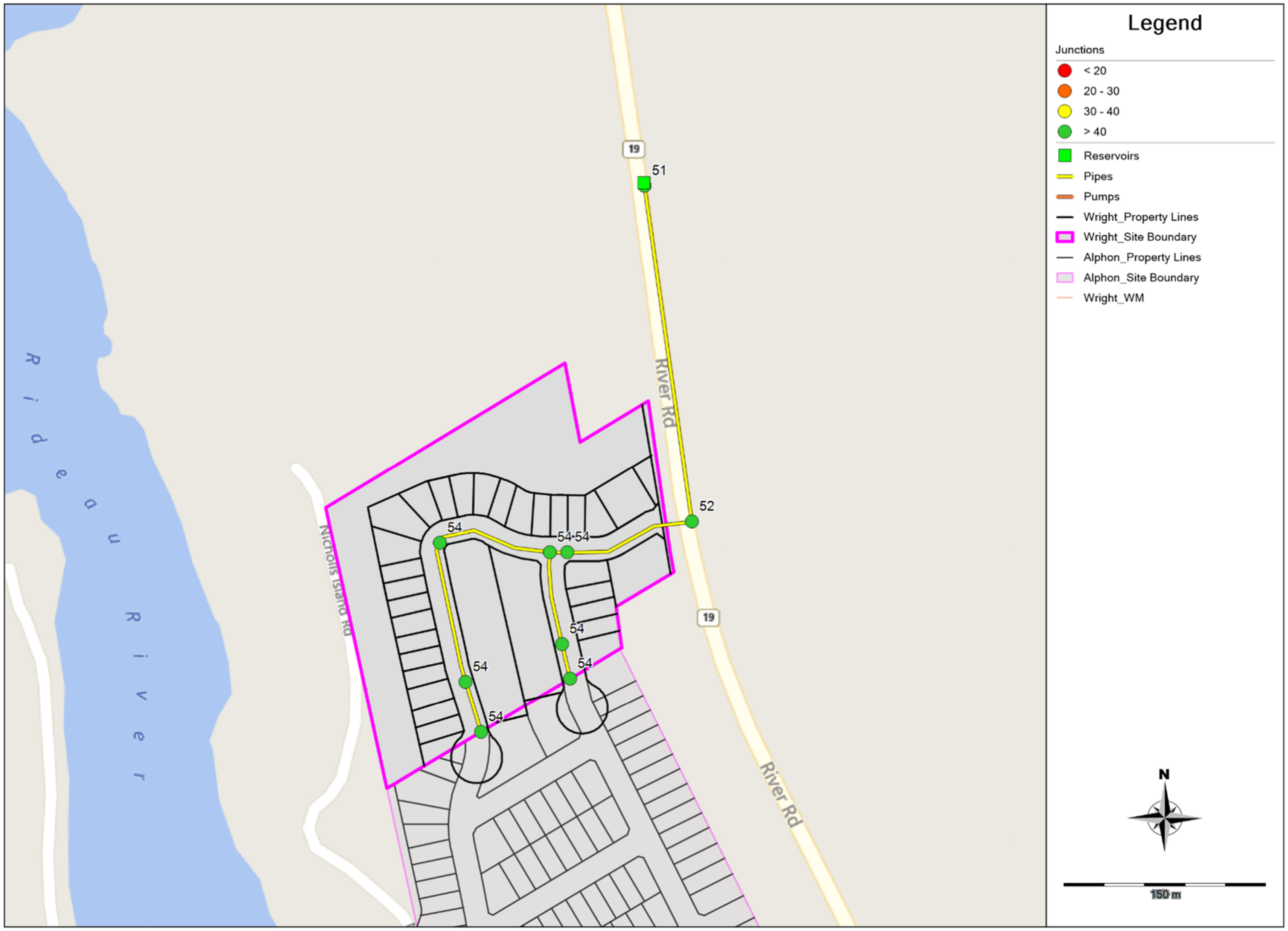


Date: 2020/07/23
M:\2016\116037\DATA\Calculations\Sewer Calcs\Water\Model Schematic_Existing.docx

Wright Lands
Job No. 116037
PCSWMM Model Schematic – EXISTING CONDITIONS

NOVATECH
Engineers, Planners & Landscape Architects

Minimum Pressures During PKHR Conditions

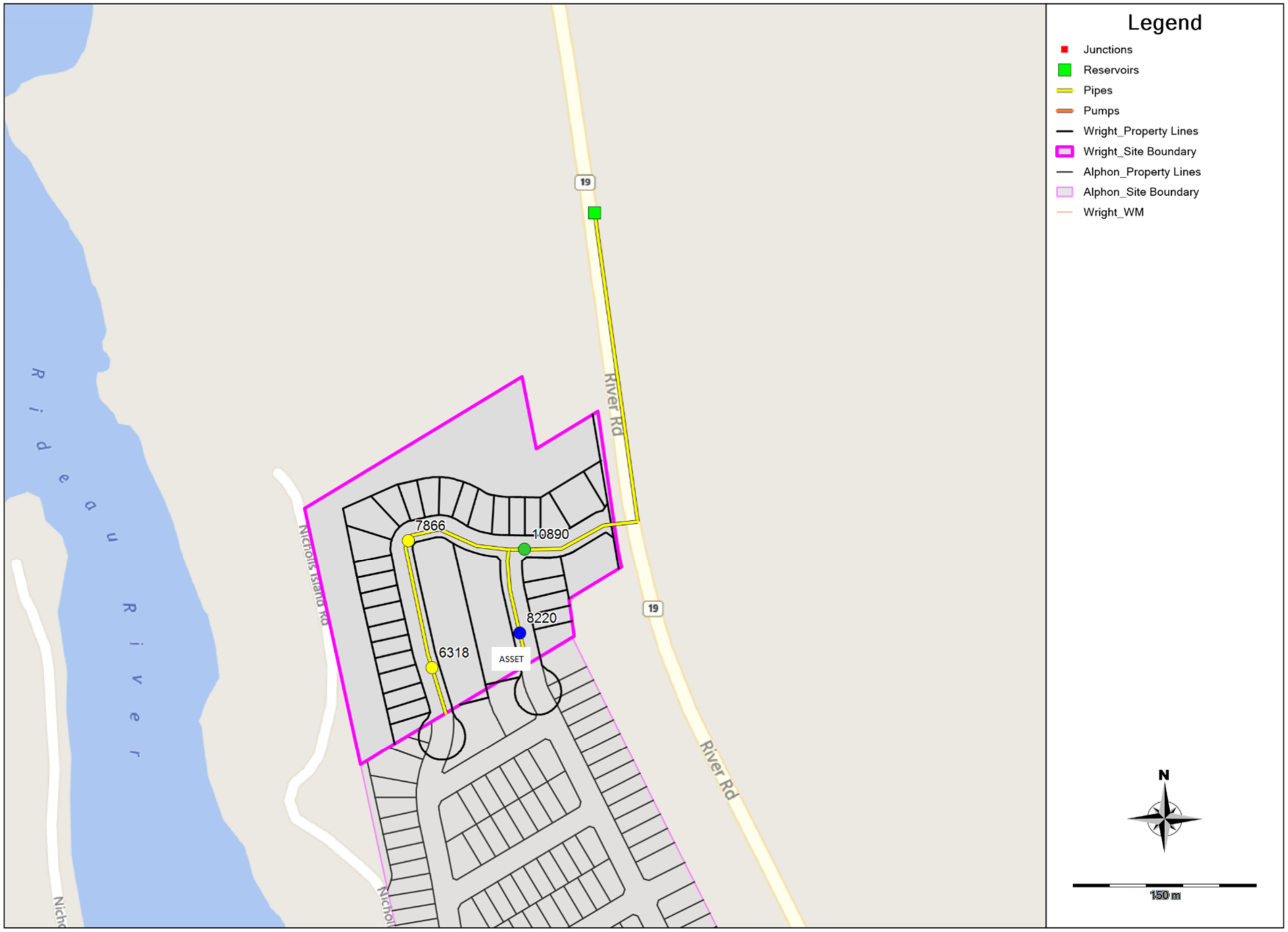


Date: 2020/07/23
M:\2016\116037\DATA\Calculations\Sewer Calcs\Water\Model Schematic_Existing.docx

NOVATECH
Engineers, Planners & Landscape Architects

Wright Lands
Job No. 116037
PCSWMM Model Schematic – EXISTING CONDITIONS

Available Flow at 20psi During MXDY+FF Conditions



p

Date: 2020/07/23
M:\2016\116037\DATA\Calculations\Sewer Calcs\Water\Model Schematic_Existing.docx

1. Background

On behalf of the City of Ottawa, the National Research Council of Canada (NRC) evaluated the City's hydrant spacing guidelines in relation to Required Fire Flow (RFF) as calculated using the Fire Underwriters Survey (FUS) methodology. This work lead to the development of a procedure to be used to establish the appropriate sizing of, and hydrant spacing on, dead-end watermains. This procedure may also be used as an optional watermain network design method to optimize watermain sizing based on RFF and standard hydrant spacing.

The procedure is partially based on the NFPA 1: Fire Code (NFPA1) and the City of Ottawa existing hydrant classification practice (refer to **Attachment A** at the end of this appendix for relevant excerpts of the Fire Code).

2. Rationale for Guideline

Given a Required Fire Flow (RFF) for a certain asset/structure/building, proper planning must ensure that there is a sufficient number of hydrants at sufficient proximities to actually provide the RFF. Both the capacity of the hydrants and their proximity to the asset/structure/building must be considered. Pressure losses (due to friction) in firehoses are proportional to the firehose length. Therefore, the actual fire flow delivered by the nozzle at the end of a very long firehose will be less compared to a short firehose connected to the same hydrant. Table 1 provides conservative values for hydrant fire flow capacity adjusted for firehose length.

3. Hydrant Capacity Requirement

For the purposes of this guidelines, the aggregate fire flow capacity of all contributing fire hydrants within 150 m of a building/asset/structure[1], measured in accordance with Table 1, shall be not less than the RFF.

4. Standard Practice

For the vast majority of developments, hydrant spacing as indicated in Section 4.5, Table 4.9, Ottawa Design Guidelines – Water Distribution, are sufficient to meet the RFF. This has been verified by evaluating approved development plans representing a

---

[1] Although NFPA 1 considers hydrant contribution at distances of up to 1000ft (305 m), Ottawa Fire Services (OFS) would need two pumpers to deliver flow from such a distance (one pumper midway – acting as a booster). Moreover, OFS cautioned that some redundancy is advisable to account for accessibility limitations in emergency situations, wind effects, etc. Therefore 150 m was considered as the maximum contributing distance

range of land uses and configurations. However, in some instances involving dead-end watermains, standard spacing requirements may not be sufficient to meet RFF.

Standard design practice involves systematic checking of design fire flows at every node in hydraulic models of proposed water distribution systems. Normally the entire design fire flow is applied to each node in succession. Nodes are typically at water main junctions rather than actual hydrant locations. This significantly simplifies the design process and the current software packages that are normally used for this purpose have been developed based on this practice. The "point load assumption" produces a conservative design.

Table 1. Maximum flow to be considered from a given hydrant

Hydrant Class	Distance to asset/structure/building (m)[a]	Contribution to required fire flow (L/min)[b]
AA	≤ 75	5,700
	> 75 and ≤ 150	3,800
A	≤ 75	3,800
	> 75 and ≤ 150	2,850
B	≤ 75	1,900
	> 75 and ≤ 150	1,500
C	≤ 75	800
	> 75 and ≤ 150	800

[a] Distance of contributing hydrant from the structure, measured in accordance with NFPA 1 (Appendix A).

[b] Maximum flow contribution to be considered for a given asset/structure/building, at a residual pressure of 20 psi, measured at the location of the main, at ground level.

4. Intended Application of Guideline

The intent of this procedure is to:

- Determine the appropriate sizing of dead end watermains and associated hydrant requirements.
- Provide an optional approach to local watermain network sizing that will assist the designer in determining the minimum pipe sizing needed to meet RFF.

The procedure permits the designer to: (a) reconcile available hydrant flow with computed RFFs, and (b) allow the distribution of RFFs along multiple hydrants, rather than consider RFF to be a point flow. The application of this protocol may result in reduced watermain diameters compared to those determined based on a traditional design approach. Caution is required in the application of the procedure to ensure that the transmission function of any watermains identified in a Master Servicing Study is not compromised. Normally, watermains 300mm in diameter and larger that are identified in such studies would not be considered for resizing.

5. Application Procedure

5.1 Rated hydrants

The procedure described here would apply to an existing watermain network with existing hydrants (i.e., re-development or infill in existing neighborhoods):

- Identify critical zones within the (re)development area, e.g., high RFF, dead ends, small diameter watermains, low C factor, and/or high geographic elevation zones.
- For the critical zones use Table 1 to examine if there are sufficient hydrants to deliver the RFF (following procedure described in 5.3).
- If hydrant capacity is insufficient, then consider either:
    - adding hydrants as appropriate;
    - determine if the existing hydrants can be upgraded to higher rating; or
    - upgrade existing watermains.

5.2 Un-rated hydrants

There are currently about 24,800 hydrants in the City of Ottawa, of which about 78% are rated. Of the rated hydrants, 96% are AA (Blue), 3% are A (Green). Many of the un-rated hydrants are located in old parts of the City, often installed on water mains with minimum diameter of 6" (150 mm), and would be likely to have a low rating.

Based on a review of hydrants that have been installed as part of recent urban development, approximately 99% of those which were rated are rated AA, and only 1% are rated A.

5.2.1 Un-rated Existing Hydrants

In cases where fire flow is to be evaluated in areas with an established water distribution network and with existing fire hydrants (i.e., re-development or infill in existing neighborhoods), all un-rated hydrants should be tested and rated in accordance with NFPA standard 291. The procedure described in Section 5.1 can then be followed to complete the design.

5.2.2 Planned hydrants

Planned hydrants cannot be tested for rating because they have not been installed yet. Moreover, the rating of a hydrant is an intrinsic property of the hydrant and can therefore not be directly evaluated by simulation. Based on the statistics cited previously, it can be assumed for design purposes that all planned hydrants are AA. However, there could be a situation where the proposed network might not have sufficient capacity to supply 5,700 L/min to a AA-rated hydrant in a specific area. Hydraulic analysis is required to confirm that the distribution network is capable of providing the hydrants with the fire flows in Table 1.

5.3 Hydrant Placement and Watermain Size Optimization

Ottawa design guidelines for watermain sizing and hydrant placement (Section 4) stipulate that the RFF be added to the average hourly rate of a peak day demand. This fire flow is added to hydraulic nodes in the vicinity of the planned development, while ensuring that the residual pressure is at least 140 kPa (measured at the location of the main, at ground level).[2] The following procedure is used to optimize watermain sizing and hydrant placement based on the RFF.

- Place hydrants throughout the development area according to the current Ottawa design guidelines.
- Size water mains and locate hydrants according to standard design procedures. Assume all hydrants are AA-rated.
- Identify the most critical zones in the development area, e.g. highest required fire flows, dead ends, longest distances between junctions, and/or highest elevation. Within these critical zones identify critical structures, i.e. those with highest RFF or greatest distance from proposed hydrant locations. Identify the closest hydrants to these buildings.
- For each critical structure, distribute the RFF according to Table 1 (i.e., assign a flow of 5,700 L/min to all hydrants with a distance of less or equal to 75 m from the test property and 3,800 L/min to all hydrants with a distance of more than 75 m but less or equal to 150 m from the test property) These hydrants are to be represented as hydrant-nodes in the network model, where the hydrant lateral would connect to the proposed water main.

---

[2] At the time when this protocol was proposed, the City of Ottawa had in effect Technical Bulletin ISDTB 2014-02, whereby RFF may be capped at 10,000 L/min for single detached dwellings (with a minimum 10 m separation between the backs of adjacent units and for side-by-side town and row houses that comply with the OBC Div. B, subsection 3.1.10 requirement (compartments of no more than 600 m^2 area).

- For each critical structure, run a single fire flow simulation ensuring that the RFF is provided by hydrants within 150 m distance from the test property, with a minimum residual pressure of 140 kPa.
- If the required residual pressure cannot be achieved, consider either re-sizing of pipes, and/or re-spacing of hydrants.

The above procedure is optional except for dead-end watermains servicing cul-de-sacs because (a) based on standard spacing requirements, there would often be insufficient fire flow provided and (b) the watermain would otherwise could be sized larger than necessary and lead to excessive water age and on-going flushing requirements.

Irrespective of the above, if the RFF is equal to or less than 10,000 L/min, then:

- where the distance between two adjacent hydraulic nodes is greater than the inter-hydrant spacing allowed in the guideline, a hydraulic node should be added halfway between the two nodes, and proceed with fire flow simulations to verify watermain sizing, ensuring that the simulation considers RFF at the new hydraulic node.

Attachment A—Excerpts from NFPA 1 Fire Code (2015 Edition)

18.5 Fire Hydrants.

18.5.1 Fire Hydrant Locations and Distribution. Fire hydrants shall be provided in accordance with Section 18.5 for all new buildings, or buildings relocated into the jurisdiction unless otherwise permitted by 18.5.1.1 or 18.5.1.2.

18.5.1.4* The distances specified in Section 18.5 shall be measured along fire department access roads in accordance with 18.2.3.

18.5.1.5 Where fire department access roads are provided with median dividers incapable of being crossed by fire apparatus, or where fire department access roads have traffic counts of more than 30,000 vehicles per day, hydrants shall be placed on both sides of the fire department access road on an alternating basis, and the distances specified by Section 18.5 shall be measured independently of the hydrants on the opposite side of the fire department access road.

18.5.1.6 Fire hydrants shall be located not more than 12 ft (3.7 m) from the fire department access road.

18.5.2 Detached One- and Two-Family Dwellings. Fire hydrants shall be provided for detached one- and two-family dwellings in accordance with both of the following:

(1) The maximum distance to a fire hydrant from the closest point on the building shall not exceed 600 ft (183 m).

(2) The maximum distance between fire hydrants shall not exceed 800 ft (244 m).

18.5.3 Buildings Other than Detached One- and Two-Family Dwellings. Fire hydrants shall be provided for buildings other than detached one- and two-family dwellings in accordance with both of the following:

(1) The maximum distance to a fire hydrant from the closest point on the building shall not exceed 400 ft (122 m).

(2) The maximum distance between fire hydrants shall not exceed 500 ft (152 m).

18.5.4 Minimum Number of Fire Hydrants for Fire Flow.

18.5.4.1 The minimum number of fire hydrants needed to deliver the required fire flow for new buildings in accordance with Section 18.4 shall be determined in accordance with Section 18.5.4.

18.5.4.2 The aggregate fire flow capacity of all fire hydrants within 1000 ft (305 m) of the building, measured in accordance with 18.5.1.4 and 18.5.1.5, shall be not less than the required fire flow determined in accordance with Section 18.4.

18.5.4.3* The maximum fire flow capacity for which a fire hydrant shall be credited shall be as specified by Table 18.5.4.3. Capacities exceeding the values specified in Table 18.5.4.3 shall be permitted when local fire department operations have the ability to accommodate such values as determined by the fire department.

Table 18.5.4.3 Maximum fire flow hydrant capacity

Distance to buildings[a]		**Maximum capacity**[b]	
(ft)	(m)	(gpm)	(L/min)
≤ 250	≤ 76	1500	5678
> 250 and ≤ 500	> 76 and ≤ 152	1000	3785
> 500 and ≤ 1000	> 152 and ≤ 305	750	2839

[a] Measured in accordance with 18.5.1.4 and 18.5.1.5.

[b] Minimum 20 psi (139.9 kPa) residual pressure.

18.5.4.4 Fire hydrants required by **18.5.2** and **18.5.3** shall be included in the minimum number of fire hydrants for fire flow required by **18.5.4**.

The City of Ottawa design guidelines on hydrant classification conform to the NFPA Standard #291, which recommends the following:

5.1 Classification of Hydrants. Hydrants should be classified in accordance with their rated capacities [at 20 psi (1.4 bar) residual pressure or other designated value as follows:

(1) Class AA — Rated capacity of 1500 gpm (5700L/min) or greater

(2) Class A — Rated capacity of 1000–1499 gpm (3800– 5699 L/min)

(3) Class B — Rated capacity of 500–999 gpm (1900–3799 L/min)

(4) Class C — Rated capacity of less than 500 gpm (1900 L/min)

Appendix F
Geotechnical Investigation (soft copy)

REPORT

Geotechnical Investigation

Proposed Residential Development
Nicolls Island Road - Parcel - 'A'
Riverside South
Ottawa, Ontario

Submitted to:

Nicolls Island Holdings Inc. c/o Regional Group
1737 Woodward Drive North
Ottawa, Ontario
K2C 0P9

Submitted by:

Golder Associates Ltd.
1931 Robertson Road,
Ottawa, Ontario
K2H 5B7,

1534482

August 2020

Distribution List

1 e-copy - The Regional Group

1 e-copy - Golder

Table of Contents

FIGURES

APPENDICES

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was retained by Nicolls Island Holdings Inc. (The Regional Group) to conduct a geotechnical investigation for the proposed residential development to be located west of River Road and about 500 metres north of Nicolls Island Road in Ottawa, Ontario. The site is to be developed as shown on Figure 1, and consists of residential dwellings and a pumping station structure to be located on the northeast extent of the site.

The current geotechnical investigation included an assessment of the general subsurface conditions at the site by means of eleven boreholes and selected geotechnical laboratory testing. Based on an interpretation of the factual information obtained, a general description of the subsurface conditions is presented. These interpreted subsurface conditions and available project details were used to prepare engineering guidelines on the geotechnical design aspects of the project, including construction considerations which could influence design decisions.

A site reconnaissance was performed to determine the state oferosion along the northern and western slopes that border the site, as well as to confirm the top of the slopes for the limit of hazard land recommendations.

The reader is referred to the “Important Information and Limitations of This Report” which follows the text but forms an integral part of this document.

2.0 DESCRIPTION OF PROJECT AND SITE

Based on information provided by The Regional Group, plans have been developed for a residential subdivision on a site located west of River Road and about 500 metres north of Nicolls Island Road in Ottawa, Ontario.

The site is about 210 by 260 metres in plan dimension, although somewhat irregular in shape as shown on Figure 1. The property is generally bounded to the east by existing residences along River Road, to the west by the RCMP Campground (which is located along the east bank of the Rideau River), to the north by undeveloped land and to the south by undeveloped land. The site is generally flat, with a gentle slope from east to west, and has slopes along the north and west boundaries.

A slope, approximately six metres in height, separates the site from the adjacent lower-lying RCMP Campground to the west, while the north boundary slope ranges between about 4 and 8 metres in height. The northern watercourse flows from east to west along the north boundary of the site within a shallow valley.

The site is currently undeveloped and consists of agricultural land with treelines along the north, east and west boundaries. A line of trees also extends along a linear drainage feature through the middle portion of the site in a north – south direction.

Based on a review of the published geological mapping, the subsurface conditions at the site are expected to consist of a deposit of silty clay overlaying glacial till, which in turn is underlain by bedrock. The available geological mapping suggests that the bedrock surface is in the order of 10 to 15 metres depth below the existing ground surface and consists of dolostone of the Oxford Formation.

3.0 INVESTIGATION PROCEDURES

The field work for the current geotechnical investigation was carried out between July 20 and 21, 2016. During that time, six boreholes (numbered 16-1 to 16-6) were advanced within the project limit. These boreholes were advanced to depths ranging from about 5.8 to 8.3 metres below the existing ground surface.

Additional investigation was also carried out between June 5 and 6, 2019, during which time a total of five boreholes (numbered 19-01 to 19-05) were advanced at approximate locations shown on Figure 1. Borehole 19-01 was advanced to a depth of 13.5 metres within the area of the proposed pumping station, while boreholes 19-02 to 19-05 were advanced to depths ranging between about 3.8 and 4.0 metres below the existing ground surface.

All the boreholes of the current investigations were advanced using a track-mounted, continuous flight hollow-stem auger drill rig, supplied and operated by CCC Geotechnical and Environmental Drilling Company of Ottawa, Ontario.

Standard Penetration Tests (SPT) were carried out within the overburden at regular intervals of depth in general conformance with ASTM D 1586. Soil samples were recovered using 35 millimetres inside diameter split-spoon sampling equipment or grab samples from the sides of selected boreholes. In-situ vane testing was carried out, where possible, in the silty clay deposit to measure the undrained shear strength of this soil unit.

Standpipe piezometers were sealed into boreholes 16-1, 16-5 and 19-01 to allow subsequent measurements of the groundwater level across the site. The groundwater levels in the standpipe piezometers installed in boreholes 16-1 and 16-5, and borehole 19-01 were measured on July 21, 2016 and July 26, 2019, respectively.

The boreholes were backfilled with bentonite pellets, mixed with soil cuttings and the site conditions were restored following completion of work.

The field work was supervised by Golder staff who located the boreholes, directed the drilling operations and in situ testing, logged the subsurface conditions encountered in the boreholes, and took custody of the soil samples retrieved.

Upon completion of the drilling operations, samples of the soils encountered in the boreholes were transported to our laboratory for further examination and for geotechnical laboratory testing, which included natural water content measurements, grain size distribution and Atterberg Limits testing on selected soil samples.

One sample of soil from borehole 16-03 was submitted to Eurofins Environment Testing for basic chemical analysis related to potential sulphate attack on buried concrete elements and corrosion of buried ferrous elements.

The borehole locations were marked in the field and surveyed by Golder personnel. The borehole coordinates and ground surface elevations were measured using a Trimble R8 GPS survey unit. The geodetic reference system used for the survey is the North American Datum of 1983 (NAD83). The borehole coordinates are based on the Modified Transverse Mercator (MTM Zone 9) coordinate system. The elevations are referenced to Geodetic datum (CGVD28).

In addition, Golder previously carried out a due diligence study for the site and the results were provided in the following draft report:

- Report to The Regional Group titled "*Preliminary Geotechnical Assessment, Due Diligence Study, Nicolls Island Road – Parcel 'A', Riverside South, Ottawa, Ontario*" dated August 2015 (Report Number 1534482-4000).

4.0 SUBSURFACE CONDITIONS

4.1 General

Information on the subsurface conditions is presented as follows:

- Record of Borehole Sheets from the current investigation are provided in Appendix A.
- The results of the laboratory testing are provided in Appendix B.
- The results of chemical testing are provided in Appendix C.

Results of the water content measurements are provided on the respective Record of Borehole Sheets.

The subsurface conditions on the site generally consist of topsoil, or silty sand to sandy silt underlain by a weathered silty clay crust. The weathered silty clay crust is underlain by a layer of glacial till over bedrock.

The following sections present a more detailed overview of the subsurface conditions encountered during the field investigation.

4.2 Topsoil

Topsoil was encountered at the ground surface in all boreholes 19-01 to 19-05, as well as in boreholes 16-4 and 16-6. The thickness of the topsoil ranged from about 120 to 300 millimetres. The topsoil generally consisted of moist, dark brown, silt and sand to sandy silt and contains organic matter, roots and rootlets.

4.3 Fill

Fill was encountered below the topsoil in borehole 19-01 and generally consists of silty clay with some sand. The fill extends to a depth of 3.5 m below the existing ground surface.

The results of SPT testing carried out within the fill in this borehole gave SPT ‘N’ values ranging from 2 to 4 blows per 0.3 metres of penetration indicating a stiff to very stiff consistency.

4.4 Sandy Silt to Silty Sand

A deposit of sandy silt to silty sand was encountered below the topsoil in boreholes 19-02 and 16-6, as well as at the ground surface in boreholes 16-1, 16-2, 16-3, and 16-5. The sandy silt to silty sand extended to depths varying between 200 and 600 millimetres below the existing ground surface.

SPT testing carried out within the layer gave SPT ‘N’ values ranging from 6 to 11 blows per 0.3 metres, indicating a loose to compact state of compactness.

4.5 Silty Clay to Clay

The topsoil, sandy silt to silty sand or fill, where encountered, were underlain by a deposit of silty clay to clay (referred hereafter as “silty clay”) at all borehole locations. The upper portion of the silty clay has been weathered to a grey brown crust. This weathered crust is typically stiffer, less sensitive, and exhibits a higher apparent pre-consolidation pressure than the underlain unweathered silty clay.

The weathered crust was fully penetrated in boreholes 19-01, and 16-01 to 16-06, to depths ranging between about 3.8 and 6.1 metres below the existing ground surface, while in boreholes 19-02 to 19-05, the weathered crust was proven to the borehole termination depths ranging between 3.8 and 4 metres below the existing ground surface.

SPT testing carried out within the weathered silty clay crust gave SPT 'N' values ranging from 2 to 14 blows per 0.3 metres of penetration, indicating a generally stiff to very stiff consistency.

Beneath the weathered crust, the clay is grey in colour. The unweathered clay was fully penetrated in borehole 19-01 to a depth of 9.8 metres below the ground surface, while in other boreholes, where encountered, the grey silty clay was proven to borehole termination depths ranging from about 5.8 to 8.3 metres below the existing ground surface. A thin layer, 100 millimetres thick, of sand and gravel was encountered within the silty clay deposit in borehole 16-4, at a depth of about 5.6 metres below the existing ground surface.

SPT testing carried out within the grey silty clay layer gave SPT 'N' values ranging from weight of hammer (WH) to 5 blows per 0.3 metres of penetration.

In-situ vane shear testing carried out within the grey silty clay deposit gave undrained shear strength (S_u) values ranging from 31 to more than 96 kilopascals, but more typically in the range of 42 to 75 kilopascals, indicating a firm to very stiff consistency.

In-situ vane testing was also carried out on remolded grey silty clay samples and gave S_u values varying between 6 to 18 kilopascals. Based on the ratio of the in-situ shear strength to the remolded shear strength ranging from 3 to 8, the grey silty clay is classified as medium sensitive to sensitive according to Canadian Foundation Engineering Manual (CFEM, 2006) classification.

The results of Atterberg limit testing carried out on eight samples of the weathered and unweathered silty clay deposit gave plasticity index values ranging from about 24 to 44 percent and liquid limit values ranging from about 40 to 68 percent, indicating a soil of intermediate to high plasticity. Results of the Atterberg limit testing are provided on Figure B-4 in Appendix B.

The results of shrinkage limit testing carried out on two samples from the silty clay deposit gave a shrinkage value of about 15 percent and a shrinkage ratio of about 1.9. The results of shrinkage limit testing are provided in Appendix B.

The measured natural water content of 27 samples of the weathered silty clay ranged from about 9 to 67 percent and the results are provided on the corresponding Record of Borehole sheets.

The result of grain size distribution testing on two samples of the silty clay from the current investigation are provided on Figures B-1 and B-2 in Appendix B.

4.6 Glacial Till

A deposit of glacial till was encountered beneath the silty clay in boreholes 19-01 and 16-1, at depths of 9.8 and 5.3 metres, respectively. The glacial till generally consists of a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of sandy silt. This layer was not fully penetrated in either of the boreholes, except borehole 19-01 that was terminated on inferred bedrock at a depth of about 13.5 metres below the existing ground surface.

SPT testing carried out within the glacial till gave SPT 'N' values ranging from about 10 to 24 blows per 0.3 metres of penetration, indicating a compact state of packing.

The measured natural water content of three samples of the glacial till were between about 10 and 12 percent.

The grain size distribution testing on one sample of the glacial till from the current investigation is provided on Figure B-3 in Appendix B.

4.7 Groundwater

Standard piezometers were installed into boreholes 16-1, 16-5 and 19-01 for subsequent groundwater level measurements. The following table summarizes the depths and the elevations of the groundwater level measured in the standard piezometers installed at the site.

Borehole No.	Geologic Unit of Screened Interval	Ground Elevation (m)	Groundwater Level Depth (mbgs)	Groundwater Elevation (m)	Date of Measurement
19-01	Till	88.5	5.0	83.5	June 26, 2019
16-1	Till & Silty Clay	85.5	5.7	79.8	August 2, 2016
16-5	Silty Clay	86.7	2.9	83.8	August 2, 2016

It should be noted that groundwater levels are expected to fluctuate seasonally. Higher groundwater levels are expected during wet periods of the year, such as spring.

4.8 Corrosion Testing

One soil sample from borehole 16-3 was submitted to Eurofins Environment Testing for chemical analysis related to potential corrosion of exposed buried steel and potential sulphate attack on buried concrete elements (corrosion and sulphate attack). The test results are provided in Appendix C and are summarized below.

Borehole No.	Sample Depth (m)	Chloride (%)	Sulphate (%)	pH	Resistivity (ohm-cm)
BH 16-3 / Sa 3	1.5 – 2.1	0.002	< 0.01	7.6	8,330

5.0 DISCUSSION

5.1 General

This section of the report provides engineering guidelines on the geotechnical design aspects of the project based on our interpretation of the available information described herein and project requirements. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the factual information for construction, and make their own interpretation of the factual data as it affects their proposed construction techniques, schedule, safety, and equipment capabilities.

Reference should be made to the “Important Information and Limitations of This Report” which follows the text but forms an integral part of this document

5.2 Site Grading

In general, the subsurface conditions on this site consist of weathered silty clay overlaying a relatively thick firm to stiff deposit of grey (unweathered) silty clay underlain by glacial till. The groundwater level ranged from about 2.9 to 5.7 metres below existing ground surface. The unweathered silty clay deposits have limited capacity to support additional stress, such as could be imposed by:

- The foundation loads of buildings/houses.
- The weight of grade raise fill placed on the site.
- The effects of groundwater level lowering (which reduces the buoyant forces that act between the soil particles), which could result from servicing and development of the site.

An increase in stress, if excessive (i.e., increasing the magnitude of stress above, or even close to, the silty clay's preconsolidation pressure), could lead to significant consolidation settlement. Due to the low hydraulic conductivity of the silty clay and the need to expel water for settlement to occur, the settlement would be long-term in nature, possibly taking many months or years to complete. Grade raises on areas underlain by compressible silty clay will therefore need to be restricted, based on leaving sufficient remaining capacity for the silty clay to also support foundation loads and the effects of groundwater level lowering, without being overstressed. If the grade is raised excessively, then significant consolidation settlement will occur.

It is conventional practice to allow the stress increase on the silty clay to be about 80 percent of the difference between the existing natural stress level and the preconsolidation pressure (i.e., of the overconsolidation). This margin (of 20 percent) is left between the final stress level and the preconsolidation pressure because the effects of 'secondary compression' can cause large settlements even at stress levels just slightly below the preconsolidation pressure. The margin also allows for some uncertainty in the actual value of the preconsolidation pressure, the groundwater levels, the unit weight of the fill, etc.

Based on the subsurface conditions encountered during the investigations, the site can be subdivided into two areas based on the amount of permissible grade raise, indicated as Area A and Area B as shown on Figure 1. The following table provides the maximum permissible grade raises for each of the assessment areas indicated on Figure 1. It should be noted that only Area A has been shown on Figure 1, and Area B refers to the rest of the site.

The analyses carried out for this assessment assumes that the unit weight of the grade raise fill would be less than or equal to 19.0 kilonewtons per cubic metre (weathered brown silty clay or clear stone). It has also been assumed that the groundwater level would be lowered to about 0.5 metres above the weathered/grey silty clay interface.

The results of the analyses indicate the following permissible grade raises:

Assessment Area	Maximum Permissible Grade Raise with Conventional Backfill (metres)
A	1.5
B	2.7

These grade raise limitations have generally been assessed based on leaving sufficient remaining capacity in the silty clay deposits such that strip footings up to 0.6 metres in width can be designed using a maximum allowable bearing pressure of at least 75 kilopascals, consistent with design in accordance with Part 9 of the Ontario Building Code.

The maximum permissible grade raises for Areas A and B were calculated based on the following criteria:

- The houses will have conventional depth basements, with founding levels in the range of 2 to 2.4 metres below finished grade.
- Any fill required for site grading (above original grade) and the backfill within the garages (and porches) would have a unit weight of *no* more than 19.0 kilonewtons per cubic metre. Silty clay (such as present on this site) would be suitable for exterior fill. Granular fills and crushed stone typically have higher unit weights and, if these materials are to be used, the maximum permissible grade raises would be reduced and would need to be re-evaluated.

The above permissible grade raises are based on some simplifying generalizations regarding the grading design and subsurface conditions on this site. It is possible that slightly higher permissible grade raises could be accommodated in some areas based on a refinement of the analyses once more specific information is available on:

- The lot grading
- The shape of the house footprint and the proximity of surrounding houses/foundations
- The footing levels and foundation embedment

Where the above noted grade raise restrictions cannot be achieved, an alternative method of increasing the permissible grade raise for the houses might be using lighter backfill materials within the garages and porches, and around the foundations of the entire house using Geofoam (EPS) lightweight fill or preloading/surcharging Area A and allowing the consolidation settlements to occur over a period of 9 to 15 months (estimate).

As a general guideline regarding the site grading, the preparation for filling of the site should include stripping the topsoil for predictable performance of structures and services. The topsoil is not suitable as engineered fill and should be stockpiled separately for re-use in landscaping applications only

It must, however, be noted that the above assessments are preliminary in nature, and based on a very specific set of parameters. The impact on any grade raise above the aforementioned permissible grade raise values will need to be evaluated, on a house-by-house basis, once the detailed site grading design is complete.

5.3 Material Reuse

The native soils encountered at the site are not considered to be generally suitable for reuse as structural/engineered fill. Within foundation areas, imported engineered fill should be used.

The native sandy silt to silty sand, and silty clay may be suitable for use as controlled fill beneath pavement areas, provided they are not too wet to place and compact. These materials can also be reused in non-structural areas (i.e., landscaping).

5.4 Foundations

It is considered that the proposed residential development will be supported on spread footings founded on or within the surficial weathered silty clay deposit.

As discussed in the preceding section, the unweathered silty clay present at depth has limited capacity to accept the combined load from site grading fill and foundation loads. The allowable bearing pressures for spread footing foundations are therefore based on limiting the stress increases on the “softer” compressible, unweathered grey silty clay at depth to an acceptable level so that foundation settlements do not become excessive. Four important parameters in calculating the stress increase on the unweathered silty clay are:

- The thickness of soil below the underside of the footings and above unweathered silty clay
- The size (dimensions) of the footings
- The amount of surcharge in the vicinity of the foundations due to landscape fill, underslab fill, floor loads, etc.
- The effects of groundwater lowering caused by this or other construction

Provided that the grade raises are restricted to those indicated in Section 5.2, spread footing foundations up to 0.6 metres in width and pad footings up to 2.0 metres square can be designed using a maximum allowable bearing pressure of 75 kilopascals. As such, the house footings may be sized in accordance with Part 9 of the Ontario Building Code (OBC).

The post construction total and differential settlements of footings sized using the above maximum allowable bearing pressure should be less than about 25 and 15 millimetres, respectively, provided that the subgrade at or below founding level is not disturbed during construction.

The tolerance of the house foundations to accept those settlements could be improved by providing nominal levels of reinforcing steel in the top and bottom of the foundation walls. Houses without projecting garages, but rather garages that are more interior with the overall house foundation/footprint would also be more tolerant to these settlements.

The maximum allowable bearing pressure provided for footings founded within the silty clay correspond to settlement resulting from consolidation of these deposits. Consolidation of the clayey soils is a process which takes months or longer and, as such, results from sustained loading. Therefore, the foundation loads to be used in conjunction with the allowable bearing pressure should be the full dead load plus sustained live load.

The proposed grading may also result in some of the footing levels being above the surface of the native inorganic subgrade soil (following removal of the topsoil and any surficial fill material). Where this is the case, the subgrade should be raised to the footing elevation using engineered fill consisting of 19 millimetre crushed clear stone having a unit weight not exceeding about 19.0 kilonewtons per cubic metre (i.e., similar to the native soil). The use of clear stone is recommended so as to avoid possible settlements associated with the use of heavier material. The engineered fill should be placed to occupy the full house footprint and the full zone of influence/support for the foundations. That zone is considered to extend down and out from the outside edge of the perimeter foundations at a slope of 1H:1V (horizontal:vertical). The engineered fill should be placed in maximum 300 millimetre thick lifts and be compacted to at least 95 percent of the material’s standard Proctor maximum dry density (SPMDD) using suitable vibratory compaction equipment. To avoid settlements resulting from loss of soil into the voids in the clear stone, it should be fully encapsulated in a geotextile. The geotextile should be placed on the bottom, sides, and over the top of the clear stone. A Class II non-woven geotextile should be used, with a Filtration Opening Size (FOS) not exceeding 150 microns, in accordance with Ontario Provincial Standard Specifications (OPSS) 1860. Footings founded on or within properly placed engineered fill can also be designed using a maximum allowable bearing pressure of 75 kilopascals.

5.5 Seismic Design

The seismic design provisions of the 2012 OBC depend, in part, on the shear wave velocity of the upper 30 metres of soil and/or bedrock below founding level. The OBC also permits the Site Class to be specified based solely on the stratigraphy and in situ testing data, rather than from direct measurement of the shear wave velocity. Based on this methodology, it is considered that a Site Class of E would be applicable to the design of low-rise structures at this site.

It should be noted that the seismic Site Class is not directly applicable to structures designed in accordance with Part 9 of the OBC (i.e., conventional housing); however, this assessment is provided to address City of Ottawa requirements that relate to housing on Site Class E sites. It should also be noted that a more favourable Site Class value could likely be assigned for the site, if seismic shear wave velocity testing is carried out.

5.6 Frost Protection

The soils at this site are considered to be highly frost susceptible. Therefore, all exterior perimeter foundation elements or foundation elements in unheated areas should be provided with a minimum of 1.5 metres of earth cover for frost protection purposes. Isolated and/or unheated exterior footings adjacent to surfaces which are cleared of snow cover during winter months should be provided with a minimum of 1.8 metres of earth cover. Houses with conventional depth basements would satisfy these requirements.

5.7 Basement and Garage Floor Slabs

In preparation for the construction of the basement floor slabs, all loose, wet, and disturbed material should be removed from beneath the floor slabs. Provision should be made for at least 200 millimetres of 19 millimetre crushed clear stone to form the base of the basement floor slabs.

To prevent hydrostatic pressure build up beneath the basement floor slabs, it is suggested that the granular base material be positively drained. This could be achieved by providing a hydraulic link between the underslab fill material and the exterior drainage system.

The backfill material inside the garage should have a unit weight no greater than 19.0 kilonewtons per cubic metre (i.e., clear crushed stone). The garage backfill should be placed in maximum 300 millimetre thick lifts and be compacted to at least 95 percent of the material’s SPMDD using suitable compaction equipment. The granular base for the garage floor slab should consist of at least 150 millimetres of Granular A compacted to at least 95 percent of the material’s SPMDD using suitable compaction equipment.

5.8 Basement Walls and Foundation Wall Backfill

The soils at this site are highly frost susceptible and should not be used as backfill directly against exterior, unheated or well insulated foundation elements. To avoid problems with frost adhesion and heaving, these foundation elements should be backfilled with non-frost susceptible sand or sand and gravel conforming to the requirements for OPSS Granular B Type I or, alternatively, a bond break such as the Platon system sheeting could be placed against the foundation walls.

Drainage of the basement wall backfill should be provided by means of a perforated pipe subdrain in a surround of 19 millimetre clear stone, fully wrapped in geotextile, which leads by gravity drainage to an adjacent storm sewer or sump pit. Conventional damp proofing of the basement walls is appropriate with the above design approach.

Where design of basement walls in accordance with Part 4 of the 2012 Ontario Building Code is required, walls backfilled with granular material and effectively drained as described above should be designed to resist lateral earth pressures calculated using a triangular distribution of the stress with a base magnitude of $K_o\gamma H$, where:

K_o = The lateral earth pressure coefficient in the ‘at rest’ state, use 0.5;

γ = The unit weight of the granular backfill, use 21.5 kilonewtons per cubic metre; and,

H = The height of the basement wall in metres.

If Platon System sheeting or similar water barrier product is used against the foundation walls, then hydrostatic groundwater pressures should also be considered in the calculation of the lateral earth pressures.

5.9 Excavations

Excavations for basements, watermain, sewers, and service connections will be primarily through the weathered silty clay crust and may extend into the grey silty clay (at least for the site services). No unusual problems are anticipated in excavating the weathered or grey silty clay using conventional hydraulic excavating equipment.

In accordance with the Occupational Health and Safety Act (OHSA) of Ontario, the weathered silty clay crust and firm to stiff grey silty clay would be generally classified as a Type 3 soil, since these soils have a firm to very stiff consistency. Accordingly, excavations may be made with unsupported side slopes at 1 horizontal to 1 vertical, or flatter. Excavation side slopes below the groundwater level in the silty clay would need to be cut back at 3 horizontal to 1 vertical (i.e., Type 4 soils).

Alternatively, for site service installations, trench excavations could also be carried out using steeper side slopes with all manual labour carried out within a fully braced, steel trench box for worker safety. It is expected that open-cut methods and/or braced trench box support will generally be feasible.

Stockpiling of soil beside the excavations should be avoided; the weight of the stockpiled soil could lead to basal instability of braced excavations or slope instability of unsupported excavations. Stockpiles should be setback from the top of the slope a minimum distance equal to twice the depth of the excavation.

Where the subgrade for houses is found to be wet and sensitive to disturbance, consideration should be given to placing a mud slab of lean concrete over the subgrade (following inspection and approval by geotechnical personnel) or a 150 millimetre thick layer of OPSS Granular A underlain by a non-woven geotextile to protect the subgrade from construction traffic.

The groundwater depth encountered at this site ranges between about 2.9 and 5.8 metres below existing ground surface; therefore, excavations for the foundation construction will not extend below the groundwater level. However, the excavations for the site services might extend below the groundwater level. In this case, the groundwater inflow into the excavations should feasibly be handled by pumping from sumps within the excavations. Groundwater inflow from the silty clay is expected to be low to moderate; however, the actual rate of groundwater inflow will depend on many factors including the contractor’s schedule and rate of excavation, the size of the excavation, the number of working areas being excavated at one time, and the time of year at which the excavation is made. Also, there may be instances where significant volumes of precipitation, surface runoff and/or groundwater collects in an open excavation, and must be pumped out.

Under current regulations, a Permit-To-Take-Water (PTTW) is required from the Ministry of the Environment and Climate Change (MOECC) if a volume of water greater than 400,000 litres per day is pumped from the excavations. If the volume of water to be pumped will be less than 400,000 litres per day, but more than 50,000 litres per day, the water taking will not require a PTTW, but will need to be registered in the Environmental Activity and Sector Registry (EASR) as a prescribed activity. Based on the groundwater information collected during the current investigation, it is considered unlikely that a PTTW would be required during construction for this project. However, registration in the EASR may be required. The requirement for registration (i.e., if more than 50,000 litres per day is being pumped) and can be assessed at the time of construction. Registration is a quick process that is not expected to significantly disrupt the construction schedule.

5.10 Site Servicing

At least 150 millimetres of OPSS Granular A should be used as pipe bedding for sewer and water pipes. Where unavoidable disturbance to the subgrade surface does occur, it may be necessary to place a sub-bedding layer consisting of compacted OPSS Granular B Type II beneath the Granular A or to thicken the Granular A bedding. This will be particularly likely where the trench floor level is within silt, but also in the unweathered silty clay. The bedding material should, in all cases, extend to the spring line of the pipe and should be compacted to at least 95 percent of the material’s SPMDD. The use of crushed clear stone as a bedding layer should not be permitted anywhere on this project since fine particles from the sandy backfill materials or silty soils on the trench walls could potentially migrate into the voids in the clear crushed stone and cause loss of lateral pipe support.

Cover material, from spring line of the pipe to at least 300 millimetres above the top of pipe, should consist of OPSS Granular A or Granular B Type I with a maximum particle size of 25 millimetres. The cover material should be compacted to at least 95 percent of the material’s SPMDD.

It should generally be possible to re-use the drier weathered silty clay as trench backfill.

However, the high moisture content of the deeper unweathered silty clay deposit makes this soil difficult to handle and compact. If these materials are excavated during installation of the site services, they should be wasted or should only be used as backfill in the lower portion of the trenches to limit the amount of long-term settlement of the roadway surface. If the unweathered silty clay is used in trenches under roadways, long term settlement of the pavement surface should be expected. Some significant padding of the roadways may be required prior to final paving. In that case, it would also be prudent to delay final paving for as long as practical. Where the trench will be covered with hard surfaced areas, the type of native material placed in the frost zone (between subgrade level and 1.8 metres depth) should match the soil exposed on the trench walls for frost heave compatibility.

Trench backfill should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the material’s SPMDD using suitable compaction equipment.

Impervious dykes or cut-offs should be constructed at 100 metre intervals in the service trenches where these extend 2 metres or deeper below existing grades, to reduce groundwater lowering at the site due to the “french drain” effect of the granular bedding and surround for the service pipes. It is important that these barriers extend from trench wall to trench wall and that they fully penetrate the granular materials to the trench bottom. The dykes should be at least 1.5 metres wide and could be constructed using relatively dry (i.e., compactable) grey brown silty clay from the weathered zone.

5.11 Pavement Design

The following provides guidelines for the subdivision pavements.

5.11.1 Profile Grade

It is anticipated that some filling will be carried out to achieve profile grade within the development. Raising the grade within the development is acceptable from a geotechnical point of view provided that the restrictions for grade raise fill as discussed in Section 5.2 are considered.

5.11.2 Subgrade Preparation

In preparation for pavement construction, all topsoil and any unsuitable fill (i.e., fill containing organic matter) should be excavated from the pavement areas for predictable pavement performance.

Those portions of the fill not containing organic matter may be left in place provided that some long term settlement of the pavement surface can be tolerated. However, the surface of the fill material at subgrade level should be proof rolled with a heavy smooth drum roller under the supervision of qualified geotechnical personnel to compact the surface of the existing fill and to identify soft areas requiring sub-excavation and replacement with more suitable fill.

Areas requiring grade raising to proposed subgrade level should be filled using acceptable (compactable and inorganic) earth borrow (OPSS.MUNI 206/212) or Select Subgrade Material (SP F-3147). The native weathered silty clay at the site might be suitable for this purpose but that would need to be confirmed by the geotechnical engineer at the time of construction. Subgrade fill should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the material’s SPMDD using suitable compaction equipment.

5.11.3 Granular Pavement Materials

The granular base and subbase for new construction should consist of Granular A and Granular B Type II (City of Ottawa F-3147), respectfully.

5.11.4 Pavement Design

The pavement structure for car parking areas should consist of:

Pavement Component	Thickness (mm)
Asphaltic Concrete	50
OPSS Granular A Base	150
OPSS Granular B Type II Subbase	400

The pavement structure for access roadways and truck traffic areas should consist of:

Pavement Component	Thickness (mm)
Asphaltic Concrete	90
OPSS Granular A Base	150
OPSS Granular B Type II Subbase	600

The granular base and subbase materials should be uniformly compacted to at least 100 percent of the material’s SPMDD using suitable vibratory compaction equipment. The asphaltic concrete should be compacted in accordance with Table 10 of OPSS 310.

The composition of the asphaltic concrete pavement in car parking areas should be as follows:

- Superpave 12.5 Surface Course – 50 millimetres

The composition of the asphaltic concrete pavement in access roadways and truck traffic areas should be as follows:

- Superpave 12.5 Surface Course – 40 millimetres
- Superpave 19.0 Binder Course – 50 millimetres

The asphaltic concrete should meet the requirements of City of Ottawa specification F-3106. As such, the Performance Graded Asphalt Cement (PGAC) should consist of PG 54-34 and both mixes should be based on Traffic Category B for roadways.

The above pavement designs are based on the assumption that the pavement subgrade has been acceptably prepared (i.e., where the trench backfill and grade raise fill have been adequately compacted to the required densities and the subgrade surface not disturbed by construction operations or precipitation). Depending on the actual conditions of the pavement subgrade at the time of construction, it could be necessary to increase the thickness of the subbase and/or to place a woven geotextile beneath the granular materials.

5.11.5 Pavement Structure Compaction

Adequate compaction of the granular roadway materials will be essential to the continued acceptable performance of the roadway. Compaction should be carried out in conformance with procedures outlined in OPSS 501 “Construction Specification for Compacting” with compacted densities of the various materials being in accordance with Subsection 501.08.02 Method A. The granular base and subbase material should be uniformly compacted to at least 100 percent of the material’s SPMDD using suitable vibratory compaction equipment. Compaction of the asphaltic concrete should be carried out in accordance with OPSS 310, Table 10.

The placement and compaction of any engineered fill, as well as sewer and watermain bedding and backfill, should be inspected to ensure that the materials used conform to the specifications from both a grading and compaction viewpoint. In addition, compaction testing and sampling of the asphaltic concrete used on site should be carried out to make sure that the materials used, and level of compaction achieved during construction meet the project requirements.

5.12 Corrosion and Cement Type

A soil sample from borehole 16-3 was submitted to Eurofins Environment Testing for basic chemical analysis related to potential sulphate attack on buried concrete elements and corrosion of buried ferrous elements. The results of this testing are provided in Appendix C.

The results indicate that concrete made with Type GU Portland cement should be acceptable for substructures. The results also indicate a potential for corrosion of exposed ferrous metal, which should be considered during the design of substructures.

5.13 Pools, Decks and Additions

The following guidelines are provided to address some typical requirements of the City of Ottawa.

5.13.1 Above Ground and In Ground Pools

No special geotechnical considerations are necessary for the installation of in-ground pools, provided that the pool (including piping) does not extend deeper than the house footing level. A geotechnical assessment will be required if the pool extends deeper than the house foundations.

Due to the additional loads that would be imposed by the construction of above-ground pools, these should be located no closer than 2 metres from the outside wall of the house. In addition, the installation of an above-ground pool should not be permitted to alter the existing grades within 2 metres of the house. Provided these restrictions are adhered to, no further geotechnical assessment should be required for above-ground pools.

5.13.2 Decks

It is considered that, in general, no particular geotechnical evaluation/assessment will be necessary for future decks, added by the homeowners, except where:

- The deck will be attached to the house; and/or,
- The deck will be heavily loaded and require spread footing or drilled pier foundations (i.e., where the deck will be designed in accordance with Part 9 of the OBC and require a building permit).

5.13.3 Additions

Any proposed addition to a house (regardless of size) will require a geotechnical assessment. The geotechnical assessment must consider the proposed grading, foundation types and sizes, depths of foundations, and design bearing pressures. Written approval from a geotechnical engineer should be required by the City of Ottawa prior to the building permit being issued.

5.14 Trees

The clay soils on this site are potentially sensitive to water depletion by trees of high water demand during periods of dry weather. When trees draw water from clay soil, the clay undergoes shrinkage, which can result in settlement of adjacent structures. Some restrictions could therefore need to be imposed on the planting of trees of higher water demand in close proximity to the foundations of houses or other structures founded at shallow depth.

The grain size distribution test result carried out on one sample of weathered silty clay indicates that the percentage of the soil particles finer than 0.475 millimetres in diameter is 100 percent. The results of Atterberg limit testing carried out on three samples of the weathered silty clay from shallow depth (i.e., presumably near or below the underside of the footings) gave an average plasticity index and liquid limit values of 30 and 48 percent, respectively.

The results of the shrinkage test are provided in Appendix B and indicate that the weathered silty clay at this site has a shrinkage limit of about 15 and a shrinkage ratio of about 1.9.

Based on the results of the laboratory testing, the plasticity index of the clay soil encountered within the residential development is generally below 40 percent.

Therefore, it should be acceptable to reduce the set-back distances for small size (mature tree height up to 7.5 metres) and medium size (mature tree height 7.5 to 14 metres) trees to 4.5 metres from the foundations within the residential development. However, in accordance with current City guidelines, the following conditions must also be met:

- The underside of footing elevation must be 2.1 metres or greater below the lowest finished grade;
- Available soil volume must be provided for small and medium trees as per the guidelines;
- Tree species must be very low to moderate Potential Subsistence Risk;
- The foundation walls should be reinforced at least nominally, to provide ductility; and
- The grading must promote drainage towards the tree root zone.

The required set-backs can be evaluated once further details are available on the site grading design. For example, where the grading will result in structures founded on engineered fill, the restrictions may not apply.

5.15 Pumping Station

A proposed pumping station including a wet well and associated structures will be located on the northeast corner of the site, approximately near borehole 19-01, as shown on Figure 1. Based on the preliminary information provided, it is understood that the wet well structure would be 2.4 m in diameter and have a founding elevation of about 79.8 metres above sea level (masl) (i.e., about 8.7 metres below the existing ground surface).

The ground conditions at the proposed pumping station consist of 3.5 metres of silty clay fill underlain by a native deposit of stiff to very stiff silty clay extending to a depth of about 9.8 metres below the existing ground surface, which in turn is underlain by glacial till. Auger refusal was encountered at a depth of about 13.5 metres below the existing ground surface. The groundwater at borehole 19-01 was encountered at a depth of about 5 metres below the existing ground surface (i.e., elevation 83.5 masl).

The geotechnical assessments and associated detailed design of the pumping station will be provided later (i.e., in the detailed design stage), once the detailed information on pumping station subsurface structure and the proposed method of construction are available and provided.

5.16 Slope Stability Assessment

5.16.1 Site Reconnaissance

The site is bounded to the northeast and southeast by residential buildings, to the north by a watercourse flowing through a forested valley, and to the east by River Road. The southern boundary is established through vacant agricultural lands and to the west lies a campground backing onto the Rideau River. The slopes under assessment extend along the western and northern boundaries of the site.

The survey of the existing slopes at the site was carried out by Annis, O’Sullivan, Vollebekk Limited (AOV) on July 2016 and later completed by two additional cross-sections by Golder (June 2019). The approximate locations of the surveyed slope cross-sections (labelled A-A’ to K-K’) are shown on Figure 1.

A reconnaissance of the northern and western slopes was conducted on May 31, 2019. At the time of the site visit, these slopes were mostly covered with grass, vegetation and tall and mature trees. The purpose of the site visits was to observe the state of the erosion at the toe the slopes. At the time of the site visit, the northern watercourse was gently flowing from east to west, with a water elevation of less than 0.3 metres along most of the observed length. A linear drainage feature in a south to north direction is present within the middle portion of the site, with evidence of water flow during periods of heavy rainfall.

The northern slope is approximately 250 metres in length between cross-sections A-A’ and G-G’ and inclined from steeper than 1H:1V to 2H:1V, on average. This slope extends from a watercourse crossing at the northwest corner of the site to River Road in the east. The floodplain along the south riverbank is variable in width ranging from less than one metre to about 15 metre. The watercourse is tight against the riverbank in several locations such as at or near cross-sections A-A’, B-B’, D-D’, east of F-F’ and G-G’, where signs of significant active erosion were observed along the northern slopes with several indications of recent shallow and surficial slope failures (see photographs in Appendix D). These surficial failures occurred as a result of toe erosion. The northern slopes range from about 4.5 to 8 metres in height. The approximate top of slope location is highlighted on Figures 1 and 2. The shallow linear drainage feature in the middle of the site was found to be free of water at the time our visit, and without any indication of active erosion.

The western slope is approximately 225 metres in length and stretches between north of cross-section H-H’ to south of cross-section K-K’, reaching from the southwestern site boundary to the watercourse crossing in the northwest corner of the site. The slope varies in height from about 5 to 6 metres and is less steep compared to the northern slope. The toe of the slope extends along the ditch of a road for the campground, with no visible indication of water flow. The slope is inclined between about 1.5H:1V and 4H:1V. No sign of erosion was observed along the western slopes facing the campground.

Photographic records of the northern watercourse bank slope, as well as the western slope adjacent to the campground, are provided in Appendix D.

5.16.2 Slope Stability Analysis

Ontario Ministry of Natural Resources (MNR) guidelines were referenced to assess the stability condition of the slopes along the northern (and western) extent of the site. According to these guidelines, any land which is sloped or inclined more steeply than about 11 degrees from horizontal (5H:1V) and has a grade difference of more than 2 metres across it has the potential for instability. Therefore, the stability assessment of these slopes would be required. Limit equilibrium slope stability analyses were carried out for the slope stability assessment.

For this assessment, five cross-sections along the northern slope were selected as “critical” cross-sections; that is cross-sections A-A’, C-C’, D-D’, F-F’ and G-G’. In view of the relative uniformity of the slope geometry over the western slope of the site, only two reprehensive cross-sections I-I’ and K-K’ were selected for detailed analyses. These cross-sections were selected on the basis of being the highest slopes, having the steepest inclinations, and having active erosion at the toe of the slope, which is considered to be the most critical of the conditions along the slope.

In general, slope failures occur when the forces (or rotational moments) generated by the weight of the soil in a slope and external loads exceed the shear strength of the soil. The six main parameters involved in the engineering analysis of the stability of a slope are:

- The geometry of the slope;
- The subsurface stratigraphy within the slope (i.e., the composition of the various soil layers within the slope and their depth, thickness, and orientation);
- The groundwater conditions (i.e., the groundwater levels and the hydraulic gradient/flow conditions);
- The strength parameters for the soils;
- The unit weights (i.e., densities) of the soils within the slope; and
- External loads on the slope, such as from foundations of structures, filling above the slope, or earthquakes.

The geometries of the slopes used in the analyses were based on the surveyed data obtained for the site.

The subsurface stratigraphy used in the analyses was based on the results of the subsurface investigation completed for the site. The interpreted subsurface conditions consist of fill or sandy silt to silty sand overlying a deposit of very stiff weathered silty clay crust, overlying unweathered silty clay, which in turn is underlain by glacial till.

The selected soil stratigraphy and strength parameters used in the analyses are given in the table below.

Soil Type	Bulk Unit Weight, γ (kN/m^3)	Shear Strength Parameters		
		Undrained Shear Strength, c_u (kPa)	Effective Angle of Internal Friction, φ' (degrees)	Effective Cohesion, c' (kPa)
Silty Clay (Fill)	17.5	45	28	7.5
Sandy Silty to Silty Sand	17.5	N/A	34	0
Silty Clay (Weathered Crust)	17.5	75	36	7.5
Silty Clay	16.5	75	32	7.5
Glacial Till	21	N/A	36	0

The soil parameters given in the above table were based on the results of the laboratory testing and previous experience with similar soils in eastern Ontario.

The groundwater level within the slopes was assumed in the analyses based on the results of groundwater measurements. The groundwater was found to be approximately near or above the weathered crust and underlying unweathered silty clay.

The stability of the slopes was evaluated for:

- Drained (i.e., long-term, static) conditions, for which effective stress soil parameters were used;
- Undrained (i.e., short-term, static) conditions, for which total stress soil parameters were considered; and,
- Seismic conditions (i.e., the dynamic loading conditions during an earthquake), for which a horizontal seismic coefficient of 0.14 was used for the analyses. This value is based on the peak horizontal ground acceleration for the site as specified in the 2015 NBC with half that value being used, per standard practice.

The stability of the slopes was evaluated using 2-dimensional limit equilibrium methods and the commercially available SLOPE/W software. The Morgenstern-Price method was used to compute the factor of safety.
The factor of safety is defined as the ratio of the magnitude of the forces/moments tending to resist failure to the magnitude of the forces/moments tending to cause failure. Theoretically, a slope with a factor of safety of less than 1.0 will fail and one with a factor of safety of 1.0 or greater will stand. However, because the modeling is not exact and natural variations exist for all of the parameters affecting slope stability, a factor of safety of 1.5 is used to define a stable slope (for static loading conditions), and/or to define the ‘safe’ set-back distance from an unstable slope.

For seismic loading conditions, a factor of safety of 1.1 is typically used.

A summary of the slope stability analyses for the different loading scenarios explained above are presented below:

Location	**Cross-Section**	**Factor of Safety**		
		Static Condition (Drained)	**Static Condition (Undrained)**	**Seismic Condition**
Northern Slope	A-A’	1.84	3.38	2.53
	C-C’	2.33	3.63	2.34
	D-D’	2.20	3.52	2.50
	F-F’	1.94	2.83	1.96
	G-G’	2.08	2.97	2.11
Western Slope	I-I’	2.67	3.85	2.47
	K-K’	2.45	4.14	2.79

The results of the stability analyses carried out for the drained (i.e., static) conditions indicate that the factor of safety against global instability of the northern and western slopes is generally between 1.8 and 2.3, which can be considered stable. Similarly, an acceptable factor of safety against instability were obtained in undrained condition analyses.

The factor of safety against global instability of the western slope for both drained and undrained conditions and under static loaning were also acceptable.

The factor of safety against instability under *seismic* loading for both northern and western slopes were greater than 1.1 and therefore these slopes are also considered to be stable during a design earthquake event.

Results of the slope stability analyses are graphically provided on Figures E-1 to E-21 in Appendix E.

5.16.3 Limits of Hazard Lands

In view of the active erosion along the northern watercourse banks, the slope surface and the adjacent table land would be classified as Hazard Lands in accordance with Ministry of Natural Resources and Forestry (MNRF) guidelines, and provincial planning policies. These lands would therefore be unsuitable for development with either private development or significant infrastructure.

In accordance with the MNRF guidelines, a set-back distance is required from the slope crest for development such that the factor of safety against global instability meets or exceeds 1.5 (under static conditions) and 1.1 (under seismic conditions).

The set-back distance from the slope crest to the Limit of Hazard Lands is required to include three components, as appropriate, namely:

- A “*Stable Slope Allowance*”, which is determined as the limit beyond which there is an acceptable factor of safety (i.e., greater than about 1.5 static or 1.1 seismic) against the table land being impacted by a slope failure.

- An "*Erosion Allowance*", to account for future movement of the slope toe, in the table land direction, as a result of erosion along the slope toe/ northern watercourse bank. The magnitude of the Erosion Allowance depends upon the type of soil being eroded at the slope toe, the severity of the erosion, and the watercourse characteristics.
- An "*Access Allowance*" of 6 metres, to allow a corridor by which equipment could travel to access and repair a future slope failure. This Access Allowance is included in the determination of the Limit of Hazard Lands wherever the development could restrict future slope access.

The *Stable Slope Allowance* was assessed by carrying out further stability analyses to determine if a set-back distance from the slope crest (which there is a factor of safety of at least 1.5 against instability) would be required. Based on the results of the slope stability assessment, the slopes along the northern and western boundaries of the site are stable and therefore a *Stable Slope Allowance* is not required.

Based on the provided preliminary grading plan, the filling on top of the table land and along the northern slope would start about 15 metres behind the top of slope crest, with a grading slope ranging from 2% to 7% away toward the table land (i.e., to form the backyard of the proposed dwellings along this slope). The total thickness of the filling would be about 0.5 to 2 metres at distances varying from about 35 to 45 metres behind the slope crest. In consideration of the height of the watercourse bank along the northern slope (i.e., 4.5 to 8 metres), and considerable distance of the proposed grade raise fill from the slope crest, the effect of grade raise filling on the stability of the northern watercourse bank would be negligible and therefore was not considered in the analyses.

In consideration of the MNRF guideline, an *Erosion Allowance* needs to be applied wherever there is active erosion, or the potential for active erosion based on the flow velocities. *Erosion Allowances* of 9.0 metres are required for the northern slope. An *Erosion Allowance* of 2 metres would also be required for the western slope where no sign of active erosion was identified during our site assessments.

The *Access Allowance* included in the MNRF procedures for defining the Limit of Hazard Lands is intended to provide a corridor of sufficient width across the table land that equipment could access the site of a future slope failure to undertake a repair. The MNRF documents do not provide specific guidance on those situations where the *Access Allowance* need be applied. However, as a general guideline, an *Access Allowance* of 6 metres should be included wherever the development plans would preclude equipment access to the slope.

The following table provides a summary of the various "set-back" components that are applicable for determining the total set-back for this site. The total set-backs (or the limit of hazard lands) are shown on Figure 1.

Location	**Cross-Section**	**Stable Slope Allowance (metres)**	**Erosion Allowance (metres)**	**Access Allowance (metres)**	**Total Set-Back (1) (metres)**
Northern Slope	A-A' to G-G'	N/A	9	6	15
Western Slope	H-H' to K-K'	N/A	2	6	8

Note: (1) Referenced from the slope crest (see Figures 1 and 2).

The above Limit of Hazard Lands assessment is based on erosion protection not being installed along the northern watercourse bank (i.e., slope toe). If erosion protection were to be installed then, at least for those specific sections of bank and slope where erosion protection measures were installed, an *Erosion Allowance* need not be included or can significantly be reduced, in the determination of the Limit of Hazard Lands. Furthermore, if erosion protection were to be considered, other studies and regulatory approvals might be required, such as with respect to natural environmental impacts.

Based on the preliminary site plan of the proposed development, the linear drainage feature (as previously described above) will be located within the entire length of Lot No. 7, as can be seen on Figure 1. As a result, a large portion of Lot No. 7 and parts of Lots. No. 6 and 8 would be located inside of the total set-backs provided in this report (i.e., 15 metres). It is our understanding that this drainage feature will be backfilled (with depths of filling ranging from 2 to 3.5 metres) to push back the top of the slope crest and associated total set-back towards the north and behind the property limit by 15 to 20 m. The proposed backfilling area is also shown on Figure 1. Culvert and outlet structures will also be installed along the linear drainage feature to maintain the flow and accommodate stormwater. No geotechnical concern with regards to the alterations to the existing slope and linear drainage feature is anticipated from a slope stability perspective; however, Golder should be retained to assess the stability of the new slope when the actual depth and extent of the backfilling, along with the final slope inclination, are decided in the detailed design stage.

Based on the preliminary grading plan it is anticipated that an emergency overland flow route for the site will also be located in the rear yards at Lots No. 10 and 11. Any outlet discharging the flow over the slope must be adequately protected against surface erosion by providing a layer of riprap (or any equivalent solution) over the slope to reduce the surface erosion. The erosion mitigation measures should, therefore, be reviewed by Golder at these locations as part of detailed design.

The following additional points should be noted:

- The set-back to the Limit of Hazard lands provided above has been evaluated based on the thickness and extent of the preliminary filling/grading plan as well as the proposed layout for the residential development as shown on Figure 1.
- If modification/disturbance to the slope is proposed where required to accommodate underground services or planned landscaping, the results of this assessment will need to be re-assessed.
- Provided the slope is not disturbed by construction and that the above set-backs are respected, it is not considered that stabilization measures will be required. The slope would ideally be left undisturbed, or at least any disturbance should be minimized or restricted to limited parts of the slope.
- The soils that form the slopes are vulnerable to erosion. Surface water as part of the development should not be directed to flow over the slope, unless a proper erosion protection measure is provided.

6.0 ADDITIONAL CONSIDERATIONS

The soils at this site are sensitive to disturbance from ponded water, construction traffic, and frost.

All footing and subgrade areas should be inspected by experienced geotechnical personnel prior to filling or concreting to ensure that soil having adequate bearing capacity has been reached and that the bearing surfaces have been properly prepared. The placement and compaction of any engineered fill as well as sewer bedding and backfill should be inspected to ensure that the materials used conform to the specifications from both a grading and compaction point of view.

At the time of the writing of this report, only preliminary details for the proposed subdivision were available. Golder Associates should be retained to review the final drawings and specifications for this project prior to construction to ensure that the guidelines in this report have been adequately interpreted.

The groundwater level monitoring devices (i.e., standpipe piezometers or wells) installed at the site will require decommissioning at the time of construction in accordance with Ontario Regulation 128/03. However, it is expected that most of the wells can be more economically abandoned as part of the construction contract. If that is not the case or is not considered feasible, abandonment of the monitoring devices can be carried out separately.

7.0 CLOSURE

We trust that this report meets your current needs. If you have any questions, or if we may be of further assistance, please do not hesitate to contact the undersigned.

Golder Associates Ltd.

AGhirian

Ali Ghirian, P.Eng.
Geotechnical Engineer

LICENSED PROFESSIONAL ENGINEER
A. Ghirian
A. GHIRIAN
100501824
August 06, 2020
PROVINCE OF ONTARIO

Michael Snow

Michael Snow, P.Eng.
Principal, Senior Geotechnical Engineer

RK/AG/MSS/PS/hwd
n:\active\2015\3 proj\1534482 regional nichols lock prop ontario\08_reports\2020 geotech report\final aug 2020\1534482-r-rev0-geotech investigation wright lands-august 06, 2020.docx

Golder and the G logo are trademarks of Golder Associates Corporation

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client, **Nicolls Island Holdings Inc. c/o Regional Group.** The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder cannot be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then the client may authorize the use of this report for such purpose by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process, provided this report is not noted to be a draft or preliminary report, and is specifically relevant to the project for which the application is being made. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client cannot rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder cannot be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. **The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report.** The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

KEY MAP

SCALE 1:50,000

LEGEND

⌖	APPROXIMATE BOREHOLE LOCATION	🟪	BACKFILLED AREA
⯐	PROPOSED BOREHOLE LOCATION	☐	PROPERTY PARCEL
—	ROADWAY	▨	WETLAND
—	TOPOGRAPHIC CONTOUR, metres	🟦	WATERBODY
—x—	FENCE	🟥	STUDY AREA
—	WATERCOURSE	▧	AREA A
— —	NEW TOP OF SLOPE		
— —	NEW FINAL SETBACK		
—	TOP OF SLOPE		
—	15 m OFFSET FROM TOP OF SLOPE		
— —	LIMIT OF HAZARD		
A ↑ A'	SLOPE CROSS-SECTION LOCATION		

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. NEW TOP OF SLOPE AND NEW FINAL SETBACK, AND BACKFILLED AREA DIGITIZED FROM CLIENT PLAN, 116037-CP11, MARCH 14, 2019.
2. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2014
3. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, GARMIN, USGS, INTERMAP, INCREMENT P, NRCAN, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), ESRI KOREA, ESRI (THAILAND), NGCC, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
4. BASE PLAN PROVIDED IN ELECTRONIC FORMAT FROM THE REGIONAL GROUP, MAY 2019
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: MTM ZONE 9 VERTICAL DATUM: CGVD28

0 15 30 60
1:1,500 METRES

CLIENT
THE REGIONAL GROUP

PROJECT
NICOLLS ISLAND ROAD
GEOTECHNICAL INVESTIGATION
PARCEL 'A', OTTAWA, ONTARIO

TITLE
SITE PLAN AND LOCATION OF CROSS-SECTIONS

CONSULTANT
GOLDER

YYYY-MM-DD	2020-03-19
DESIGNED	AG
PREPARED	ABD/BR
REVIEWED	AG
APPROVED	MSS

PROJECT NO.	PHASE	REV.	FIGURE
1534482	20000	A	1

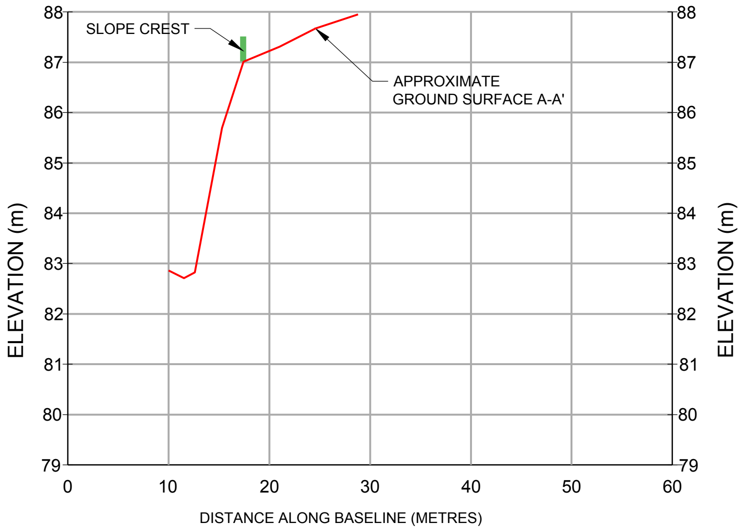
Path: N:\Active\Spatial_IM\The_Regional_Group\Nicolls_Island_Road\99_PROJ\1534482_Regional_Nicolls_Island_Road\40_PROD\Ph20000_Geotech\1534482-20000-BG-0001.mxd

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:
25mm 0

LEGEND

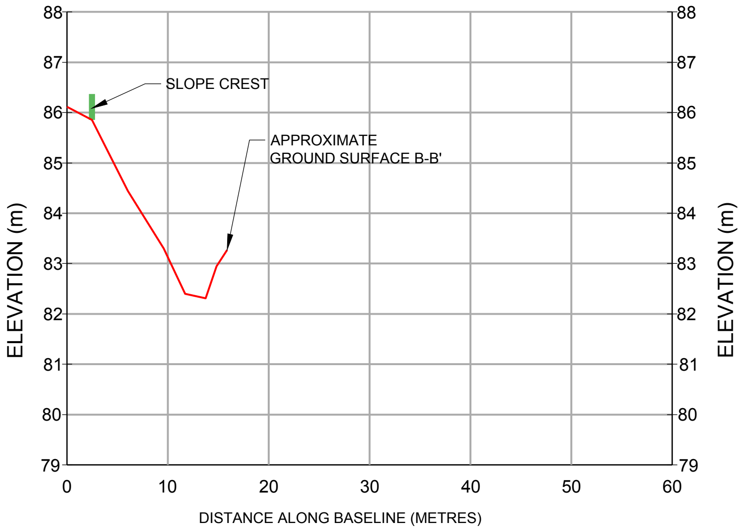
🟥 GROUND SURFACE

🟩 SLOPE CREST



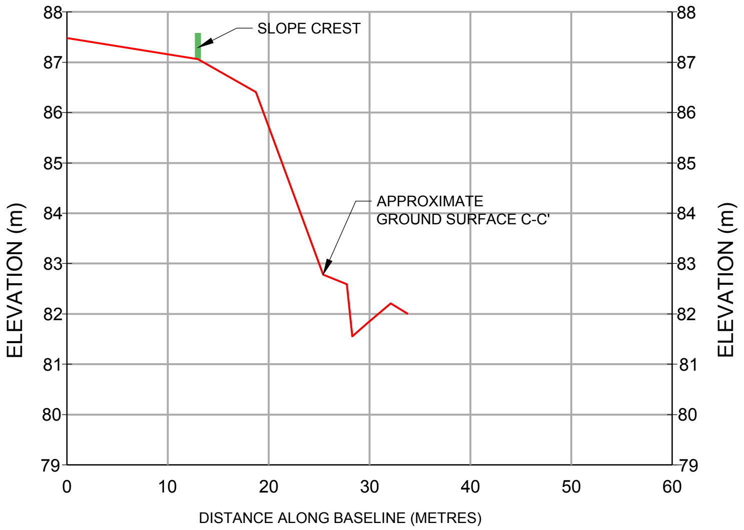
PROFILE A-A'

1:200 m



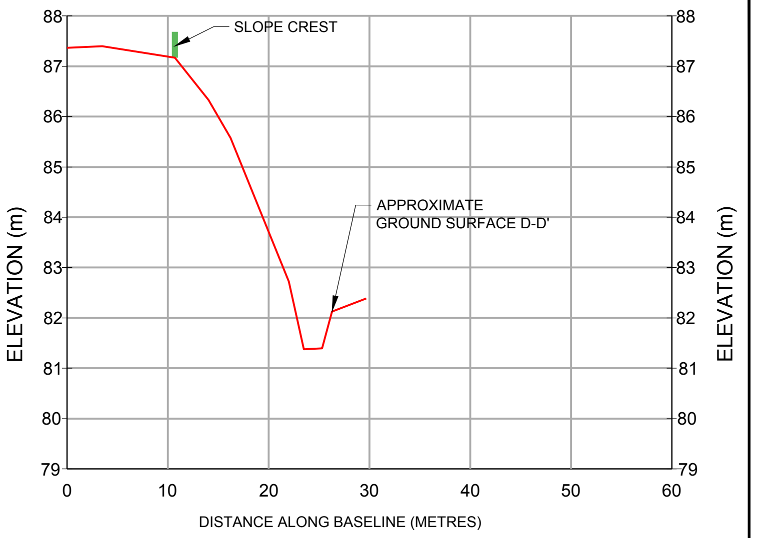
PROFILE B-B'

1:200 m



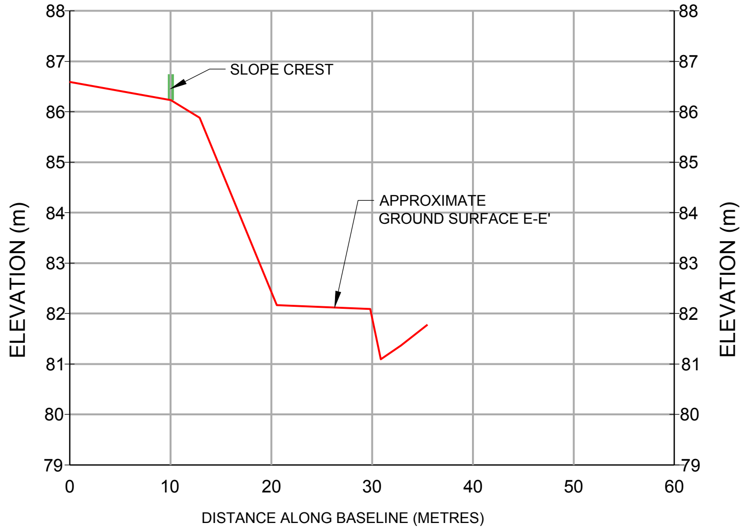
PROFILE C-C'

1:200 m



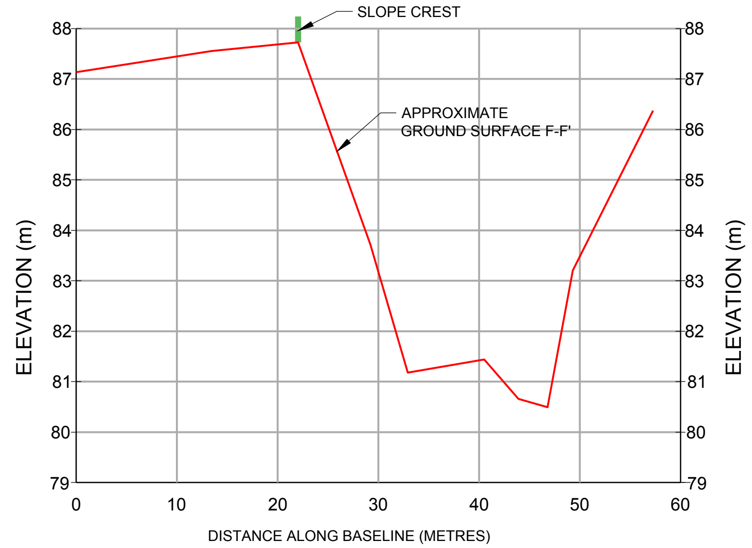
PROFILE D-D'

1:200 m



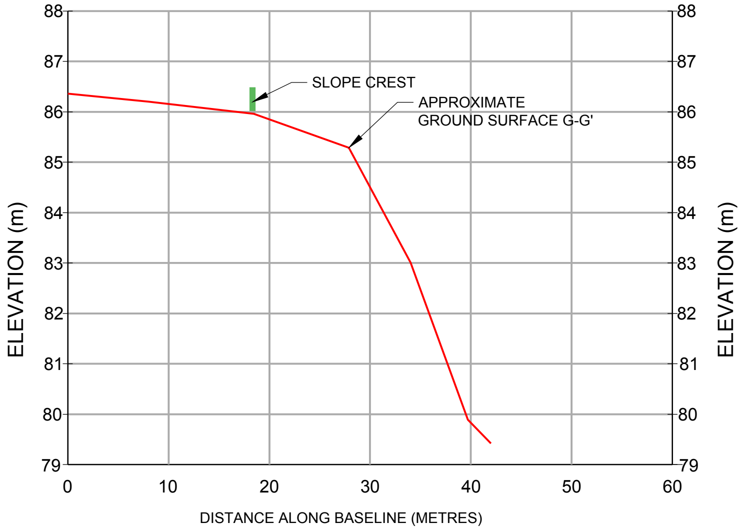
PROFILE E-E'

1:200 m



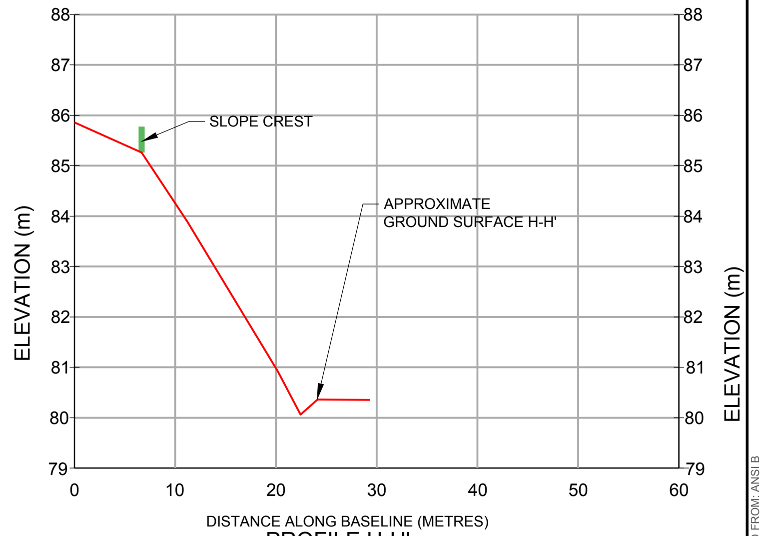
PROFILE F-F'

1:200 m



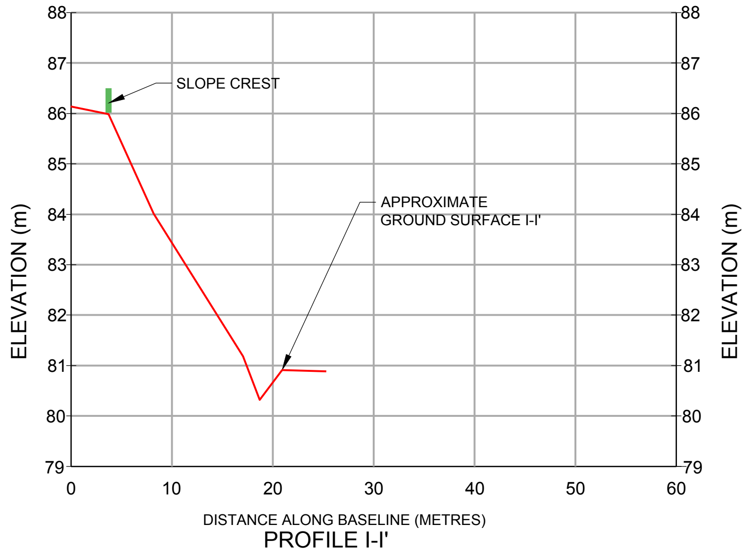
PROFILE G-G'

1:200 m



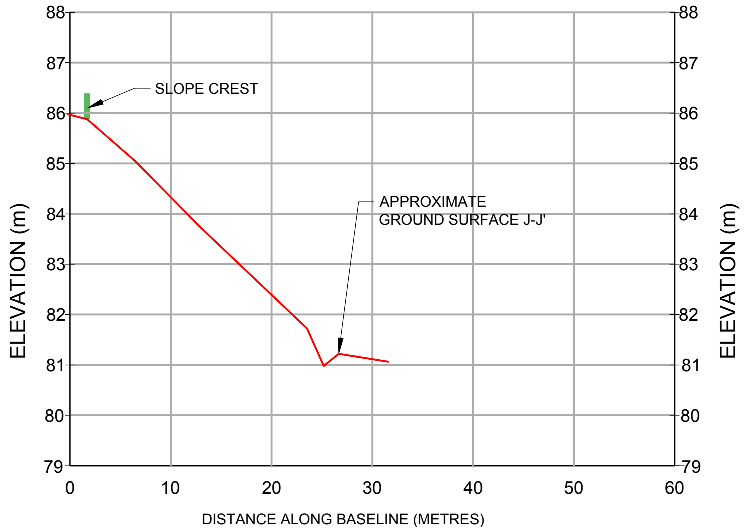
PROFILE H-H'

1:200 m



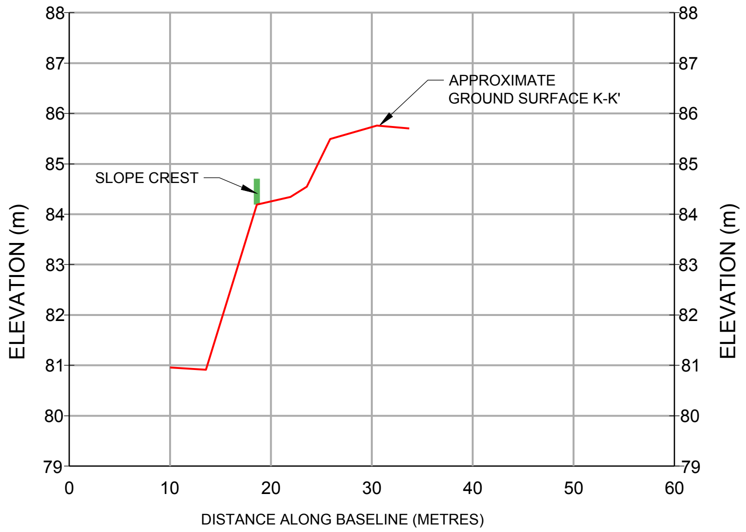
PROFILE I-I'

1:200 m



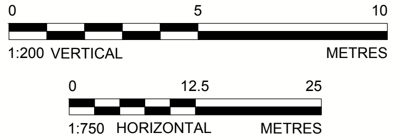
PROFILE J-J'

1:200 m



PROFILE K-K'

1:200 m



CLIENT
THE REGIONAL GROUP

PROJECT
NICOLLS ISLAND ROAD
GEOTECHNICAL INVESTIGATION
PARCEL 'A', OTTAWA, ONTARIO

TITLE
CROSS-SECTIONS

CONSULTANT

GOLDER

YYYY-MM-DD	2019-03-28
DESIGNED	AG
PREPARED	ABD
REVIEWED	AG
APPROVED	MSS

PROJECT NO.	CONTROL	REV.	FIGURE
1534482	20000	0	2

APPENDIX A

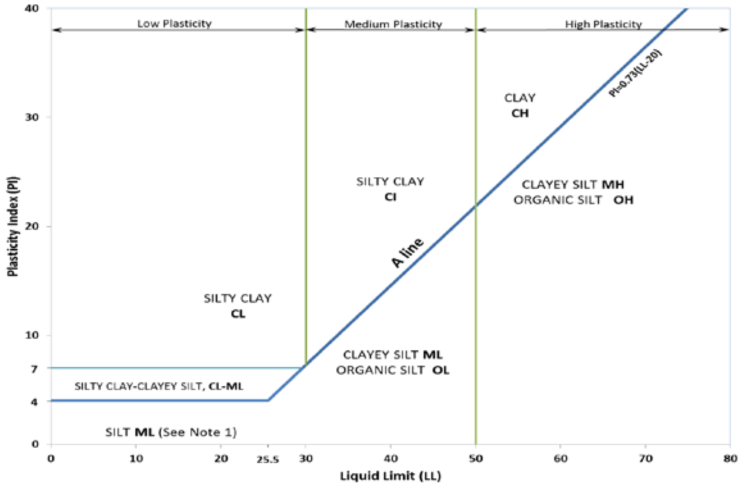
Record of Borehole Sheets

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
				Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
				Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% **(see Note 2)**	CL	SILTY CLAY
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.

Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.

For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.

For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.

A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)
An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH:	Sampler advanced by hydraulic pressure
PM:	Sampler advanced by manual pressure
WH:	Sampler advanced by static weight of hammer
WR:	Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.
2. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\,\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$
2 shear strength = (compressive strength)/2

---

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of rock material weathering.

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, as measured along the centerline axis of the core, relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid segments.

DISCONTINUITY DATA

Fracture Index

A count of the number of naturally occuring discontinuities (physical separations) in the rock core. Mechanically induced breaks caused by drilling are not included.

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^{o} angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN	Joint
FLT	Fault
SH	Shear
VN	Vein
FR	Fracture
SY	Stylolite
BD	Bedding
FO	Foliation
CO	Contact
AXJ	Axial Joint
KV	Karstic Void
MB	Mechanical Break
PL	Planar
CU	Curved
UN	Undulating
IR	Irregular
K	Slickensided
PO	Polished
SM	Smooth
SR	Slightly Rough
RO	Rough
VR	Very Rough

PROJECT: 1534482

RECORD OF BOREHOLE: 19-01

SHEET 1 OF 2

LOCATION: N 5011640.9 ;E 445126.2

BORING DATE: June 6, 2019

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

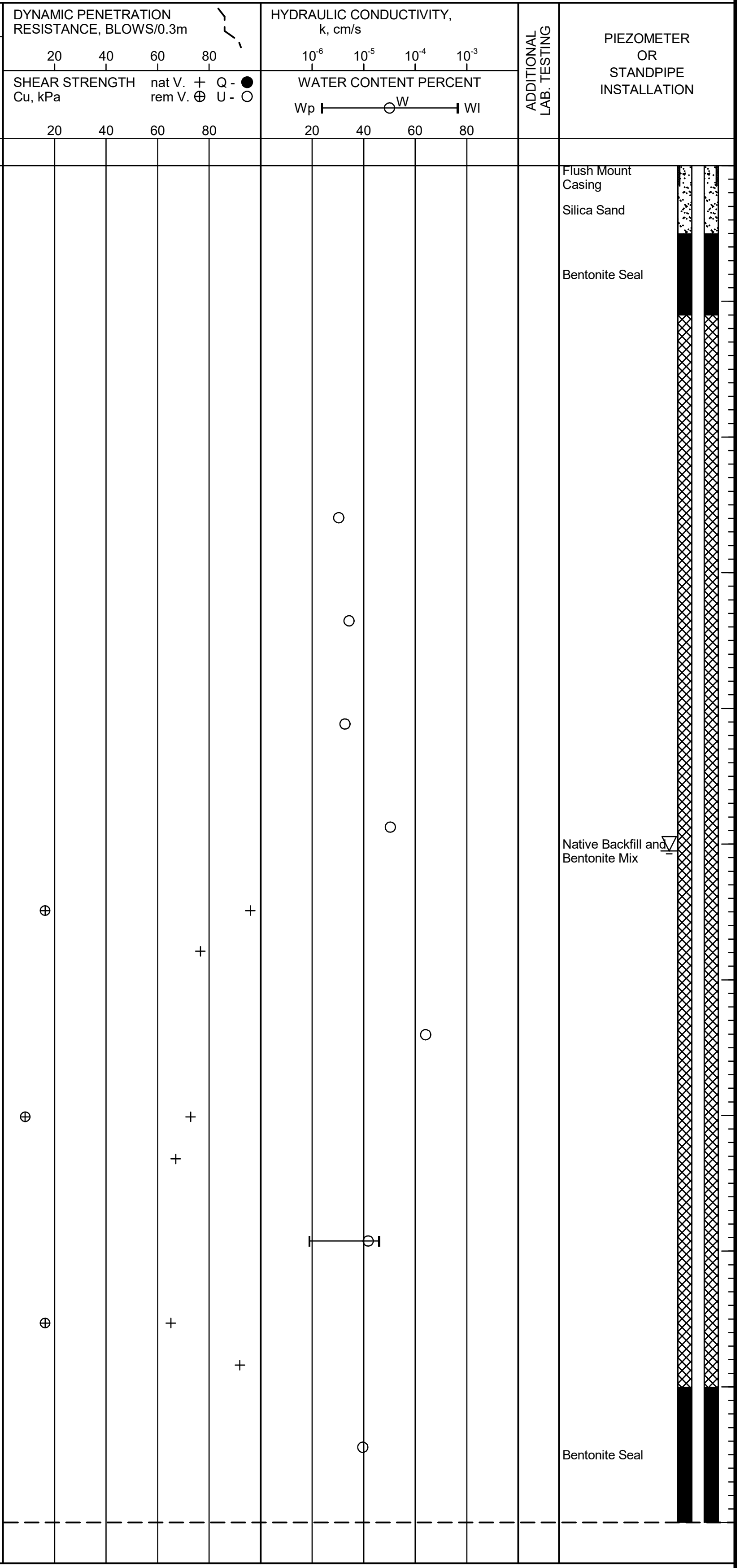
PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger
200 mm Diam. (Hollow Stem)

DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	88.46
TOPSOIL - (ML) sandy SILT; dark brown, contains organics	0.00
FILL - (CL) SILTY CLAY, some sand; grey brown, contains organics and bricks; cohesive, w>~PL, stiff	0.12
(CI/CH) SILTY CLAY; grey brown, fissured, contains silty fine sand seams (WEATHERED CRUST); cohesive, w>~PL, stiff to very stiff	84.95 3.51
(CI/CH) SILTY CLAY; grey; cohesive, w>PL, stiff	82.97 5.49
(CI, CL-ML) SILTY CLAY to CLAYEY SILT; grey, layered; cohesive, w>PL, stiff to very stiff	80.84 7.62
	78.71 9.75

CONTINUED NEXT PAGE

NUMBER	TYPE	BLOWS/0.30m
1	SS	2
2	SS	4
3	SS	2
4	SS	3
5	SS	3
6	SS	2
7	SS	WH
8	SS	3
9	SS	1
10	SS	11



DEPTH SCALE 1 : 50

LOGGED: PAH

CHECKED: AL

PROJECT: 1534482

RECORD OF BOREHOLE: 19-01

SHEET 2 OF 2

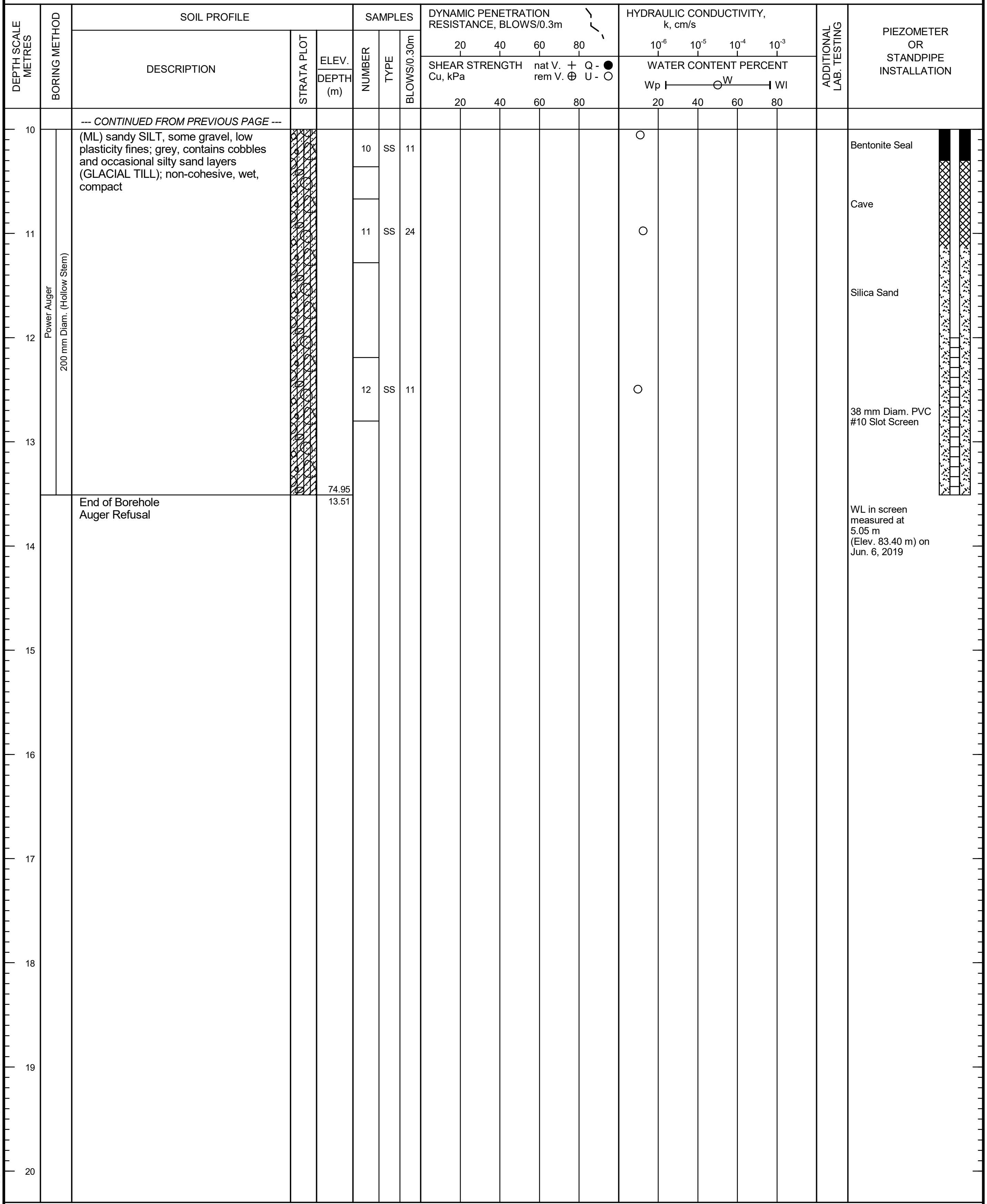
LOCATION: N 5011640.9 ;E 445126.2

BORING DATE: June 6, 2019

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm



--- CONTINUED FROM PREVIOUS PAGE ---

Depth (m)	Description	Elev. / Depth (m)	Sample Number	Type	Blows/0.30m
10	(ML) sandy SILT, some gravel, low plasticity fines; grey, contains cobbles and occasional silty sand layers (GLACIAL TILL); non-cohesive, wet, compact		10	SS	11
11			11	SS	24
12			12	SS	11
13.51	End of Borehole Auger Refusal	74.95 13.51			

Piezometer or Standpipe Installation:

Bentonite Seal

Cave

Silica Sand

38 mm Diam. PVC
#10 Slot Screen

WL in screen
measured at
5.05 m
(Elev. 83.40 m) on
Jun. 6, 2019

MIS-BHS 001 1534482.GPJ GAL-MIS.GDT 20-2-27 ZS

DEPTH SCALE

1 : 50

GOLDER

LOGGED: PAH

CHECKED: AL

PROJECT: 1534482

RECORD OF BOREHOLE: 19-02

SHEET 1 OF 1

LOCATION: N 5011595.6 ;E 445032.9

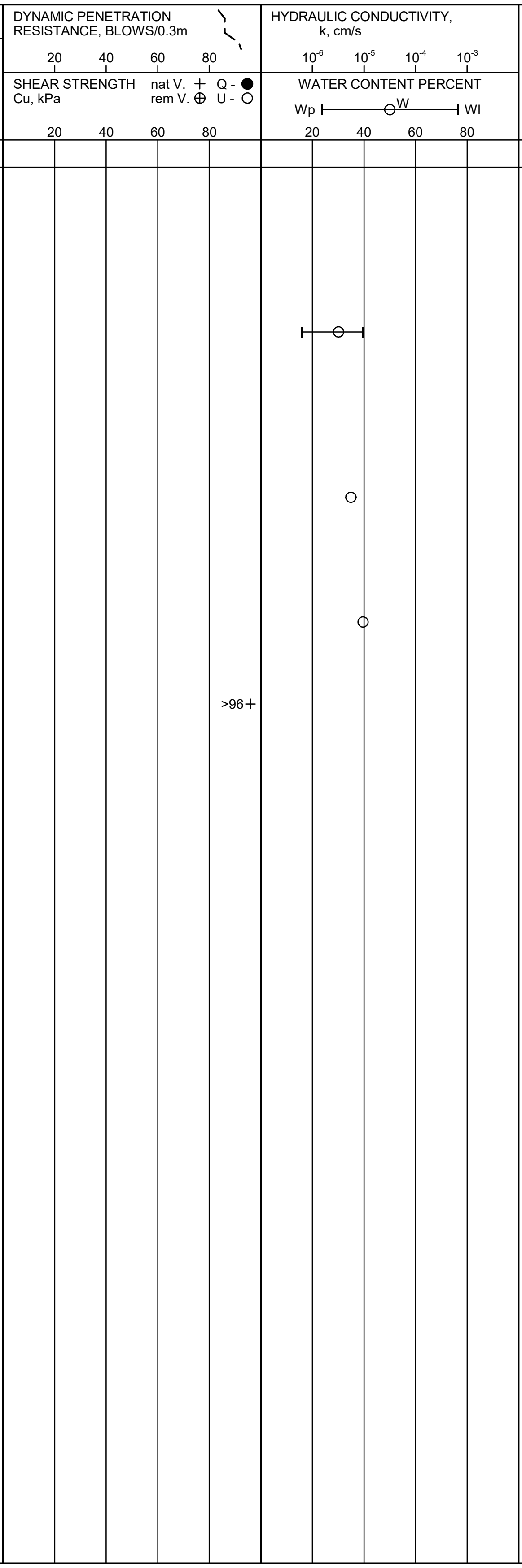
BORING DATE: June 5, 2019

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		87.38					
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) SILTY SAND, fine; dark brown, contains organic matter		0.00					
		(SM) SILTY SAND, fine; brown; non-cohesive, moist, loose		87.18 0.20					
		(CI/CH) SILTY CLAY; grey brown, fissured, contains silty fine sand seams (WEATHERED CRUST); cohesive, w>~PL, very stiff		86.92 0.46					
1					1	SS	5		
2					2	SS	8		
3					3	SS	6		
4		End of Borehole		83.42 3.96					



DEPTH SCALE

1 : 50

GOLDER

LOGGED: PAH

CHECKED: AL

PROJECT: 1534482

RECORD OF BOREHOLE: 19-03

SHEET 1 OF 1

LOCATION: N 5011568.5 ;E 444961.9

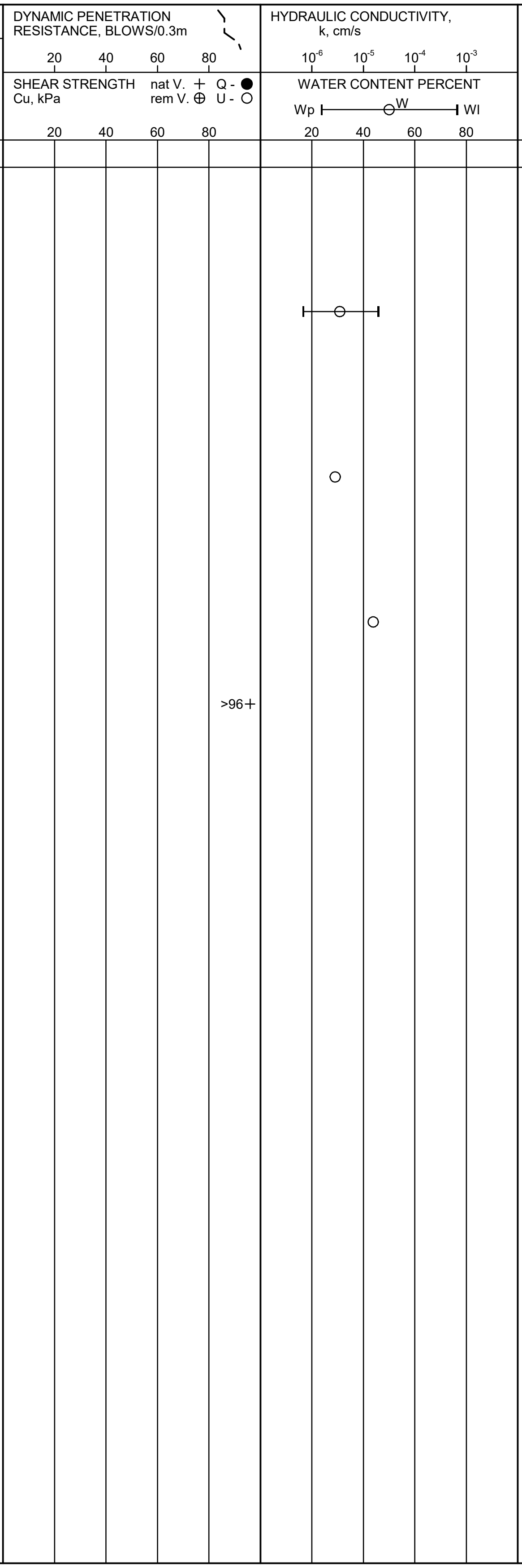
BORING DATE: June 5, 2019

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		87.10					
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (CL) SILTY CLAY; dark brown, contains organic matter		0.00 86.90 0.20					
		(CI/CH) SILTY CLAY; grey brown, fissured, contains silty fine sand seams (WEATHERED CRUST); cohesive, w>~PL, very stiff							
1					1	SS	6		
2					2	SS	4		
3					3	SS	5		
4		End of Borehole		83.14 3.96					
5									
6									
7									
8									
9									
10									



DEPTH SCALE
1 : 50

GOLDER

LOGGED: PAH
CHECKED: AL

PROJECT: 1534482

RECORD OF BOREHOLE: 19-04

SHEET 1 OF 1

LOCATION: N 5011487.0 ;E 444979.9

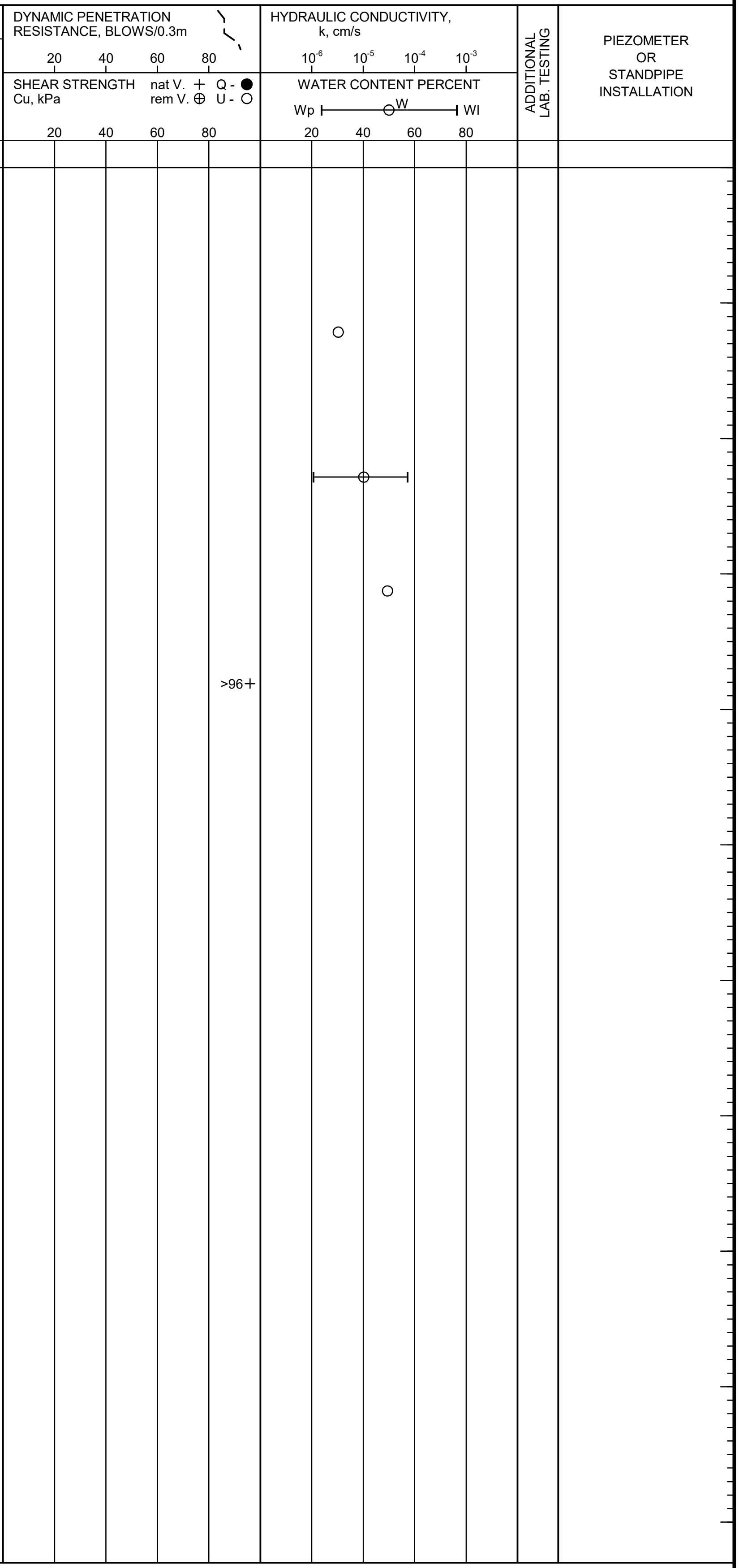
BORING DATE: June 5, 2019

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m
		GROUND SURFACE		86.77			
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (CL) SILTY CLAY; dark brown, contains organic matter	▤	0.00			
		(CI/CH) SILTY CLAY; grey brown, fissured, contains silty fine sand seams (WEATHERED CRUST); cohesive, w>~PL, very stiff	▨	86.54 0.23			
1					1	SS	4
2					2	SS	6
3					3	SS	5
		End of Borehole		82.96 3.81			
4							
5							
6							
7							
8							
9							
10							



DEPTH SCALE

1 : 50

GOLDER

LOGGED: PAH

CHECKED: AL

PROJECT: 1534482

RECORD OF BOREHOLE: 19-05

SHEET 1 OF 1

LOCATION: N 5011523.6 ;E 445053.6

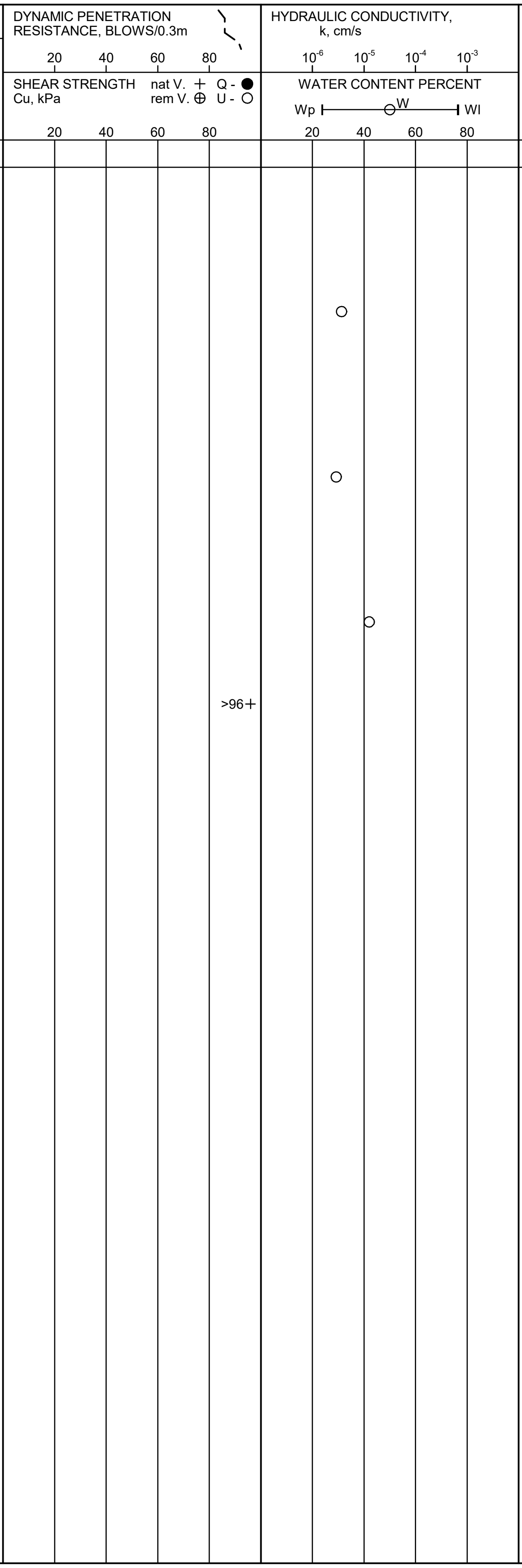
BORING DATE: June 5, 2019

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		87.58					
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (CL) SILTY CLAY; dark brown, contains organic matter		0.00					
		(CI/CH) SILTY CLAY; grey brown, fissured, contains silty fine sand seams (WEATHERED CRUST); cohesive, w>~PL, very stiff		87.33 0.25					
1					1	SS	6		
2					2	SS	4		
3					3	SS	5		
4		End of Borehole		83.62 3.96					
5									
6									
7									
8									
9									
10									



MIS-BHS 001 1534482.GPJ GAL-MIS.GDT 20-2-27 ZS

DEPTH SCALE

1 : 50

GOLDER

LOGGED: PAH

CHECKED: AL

PROJECT: 1534482

RECORD OF BOREHOLE: 16-1

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 20, 2016

DATUM: Geodetic

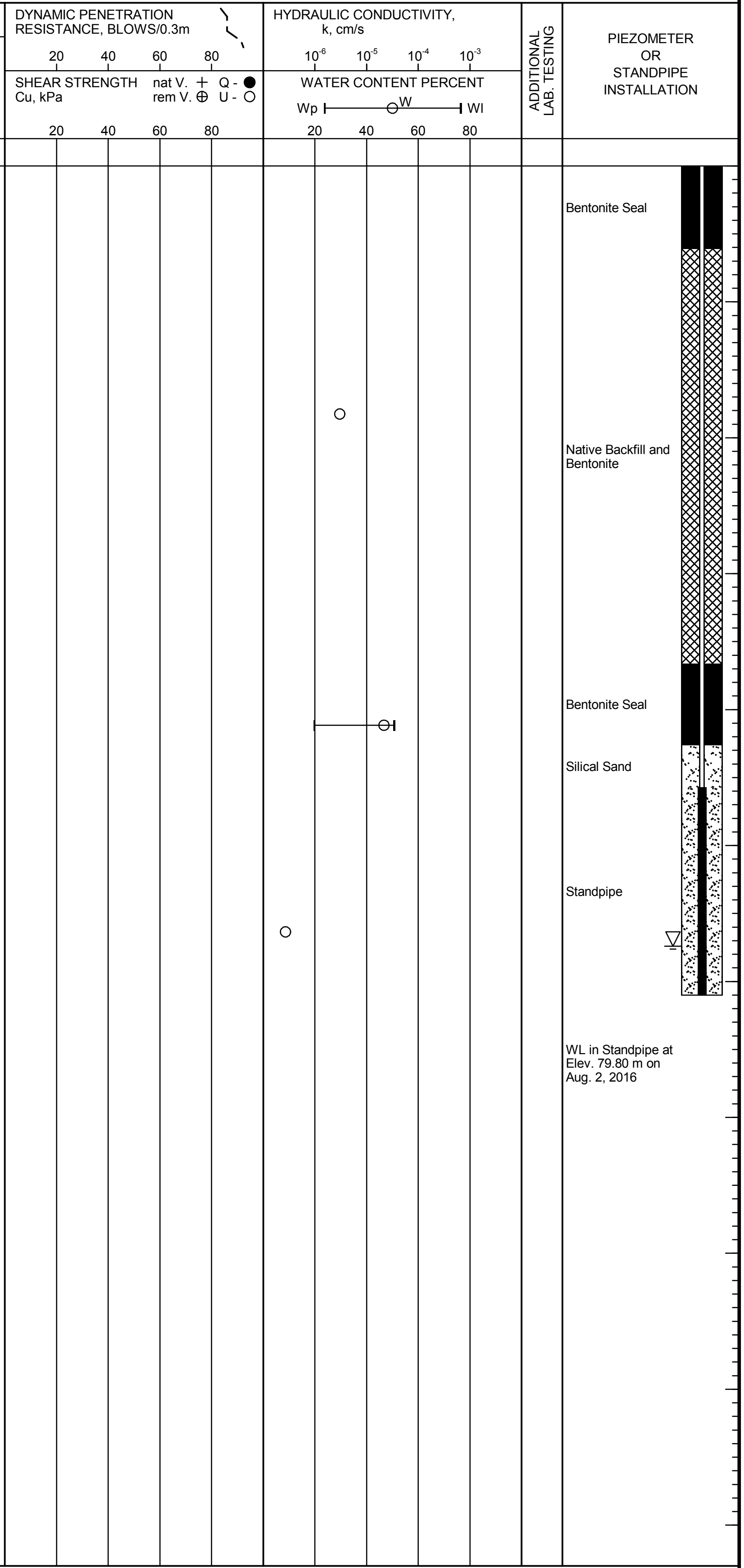
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem)

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	85.54
(ML) sandy SILT; brown: non-cohesive, moist, loose	0.00
(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty sand seams (WEATHERED CRUST); non-cohesive, w>PL; very stiff	84.93 0.61
(ML) sandy SILT, some gravel; grey (GLACIAL TILL); non-cohesive, wet, loose to compact	80.21 5.33
End of Borehole	79.44 6.10

NUMBER	TYPE	BLOWS/0.30m
1	SS	8
2	SS	14
3	SS	11
4	SS	8
5	SS	6
6	SS	7
7	SS	5
8	SS	10



DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JD

CHECKED: SAT

PROJECT: 1534482

RECORD OF BOREHOLE: 16-2

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 21, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	SHEAR STRENGTH Cu, kPa nat V. + rem V. ⊕	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		87.15						
0	Power Auger 200 mm Diam. (Hollow Stem)	(ML) sandy SILT; brown; non-cohesive, moist, compact		0.00	1	SS	11			
		(CI/CH) SILTY CLAY to CLAY, trace sand; grey brown, contains silty sand seams; cohesive, w>PL, very stiff		86.54 0.61	2	SS	8			
2					3	SS	6			
					4	SS	4			
3					5	SS	4			
4					6	SS	4			
		(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, stiff		82.58 4.57	7	SS	WH			
5								⊕ + ⊕ +		
6					8	SS	1			
7								>96+		
					9	SS	4			
8		End of Borehole		79.23 7.92						
9										
10										

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 20 40 60 80

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JD

CHECKED: SAT

PROJECT: 1534482

RECORD OF BOREHOLE: 16-3

SHEET 1 OF 1

LOCATION: See Site Plan

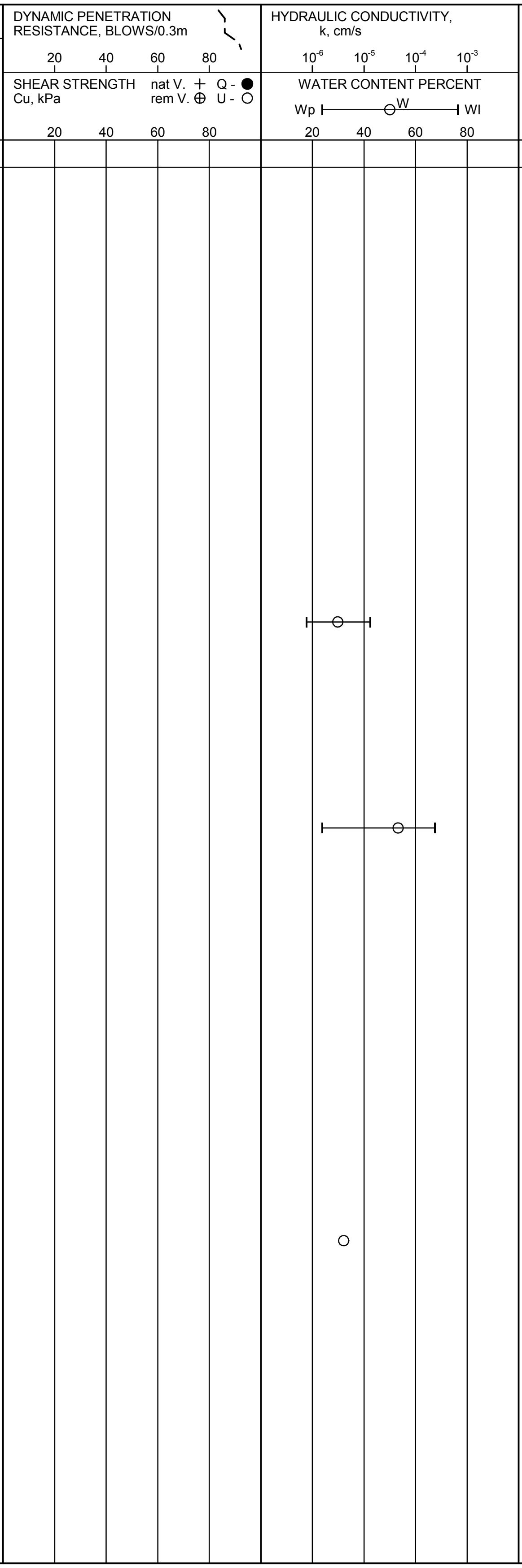
BORING DATE: July 20, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	86.87					
0	Power Auger 200 mm Diam. (Hollow Stem)	(ML) sandy SILT; brown; non-cohesive, moist, loose	0.00	1	SS	8		
		(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty sand seams (WEATHERED CRUST); cohesive, w>PL, very stiff	86.26 0.61	2	SS	8		
				3	SS	8	CHEM	
				4	SS	5		
				5	SS	6		
				6	SS	5		
				7	SS	3		
				8	SS	4		
		(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, stiff	80.77 6.10	9	SS	1		
				10	SS	3		
				11	SS	5		
		End of Borehole	78.59 8.28					



DEPTH SCALE

1 : 50

GOLDER

LOGGED: JD

CHECKED: SAT

PROJECT: 1534482

RECORD OF BOREHOLE: 16-4

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 20, 2016

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)
		GROUND SURFACE		86.57
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) SILTY SAND, trace gravel; dark brown; non-cohesive, moist, loose		0.00
		(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty sand seams (WEATHERED CRUST); cohesive, w>PL, very stiff		86.34 0.23
1				
2				
3				
4				
5				
		(SP/GP) SAND and GRAVEL; grey brown; non-cohesive		80.93 5.66
6		(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty sand seams (WEATHERED CRUST); cohesive, w>PL, very stiff		80.47 6.10
		(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, stiff		
7				
		End of Borehole		79.25 7.32
8				
9				
10				

SAMPLES: NUMBER	TYPE	BLOWS/0.30m
1	SS	7
2	SS	9
3	SS	5
4	SS	5
5	SS	6
6	SS	4
7	SS	4
8	SS	10
9	SS	2

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH (m)	SHEAR STRENGTH Cu, kPa
7	⊕ +
7.3	>96+

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JD

CHECKED: SAT

PROJECT: 1534482

RECORD OF BOREHOLE: 16-5

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 20, 2016

DATUM: Geodetic

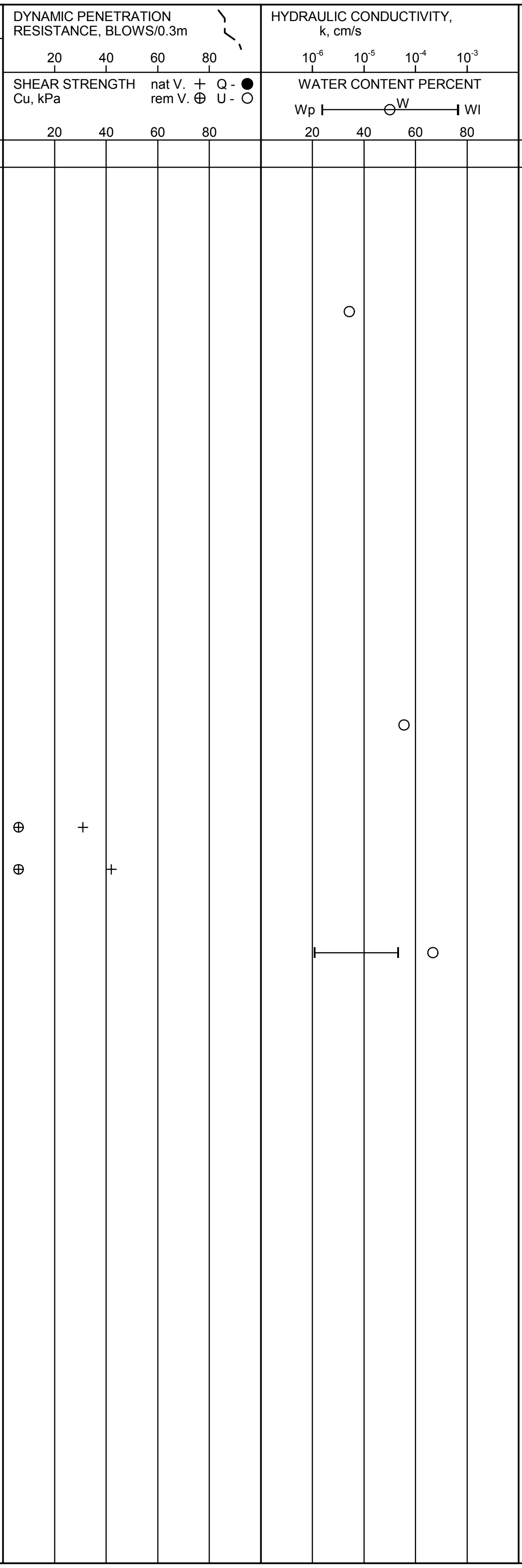
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem)

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	86.71
(SM) SILTY SAND, trace clay; grey brown; non-cohesive, moist, loose	0.00
(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty sand seams (WEATHERED CRUST); cohesive, w>PL, very stiff to stiff	86.10 0.61
(CI/CH) SILTY CLAY to CLAY, trace sand; grey; cohesive, w>PL, firm	82.90 3.81
End of Borehole	80.61 6.10

SAMPLES NUMBER	TYPE	BLOWS/0.30m
1	SS	6
2	SS	6
3	SS	4
4	SS	4
5	SS	3
6	SS	1
7	SS	WH



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

Bentonite Seal

Native Backfill and Bentonite

Bentonite Seal

Silical Sand

Standpipe

WL in Standpipe at Elev. 83.77 m on Aug. 2, 2016

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JD

CHECKED: SAT

PROJECT: 1534482

RECORD OF BOREHOLE: 16-6

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: July 21, 2016

DATUM: Geodetic

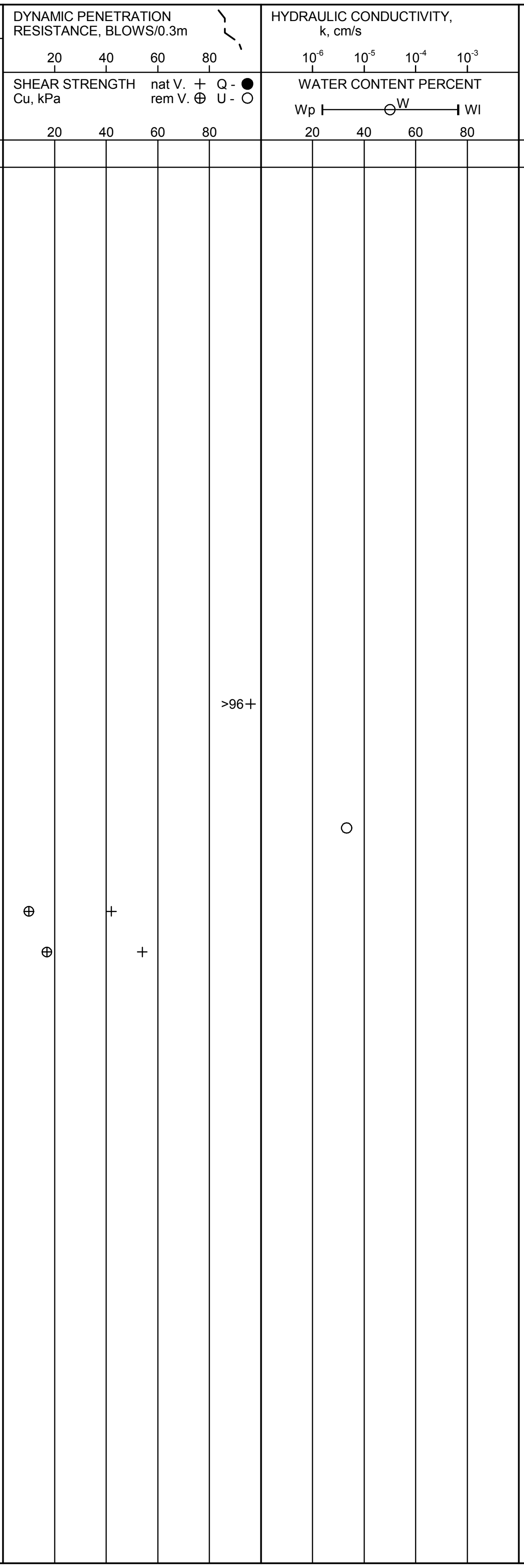
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger
200 mm Diam. (Hollow Stem)

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	88.42
TOPSOIL - (ML) sandy SILT; dark brown; non-cohesive, moist	0.00
(ML) sandy SILT; brown; non-cohesive, moist, loose	88.12 0.30
(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty sand seams (WEATHERED CRUST); cohesive, w>PL, very stiff to stiff	87.81 0.61
(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, firm to stiff	84.46 3.96
End of Borehole	82.62 5.80

NUMBER	TYPE	BLOWS/0.30m
1	SS	10
2	SS	8
3	SS	4
4	SS	3
5	SS	2
6	SS	1



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE
1 : 50

GOLDER

LOGGED: JD
CHECKED: SAT

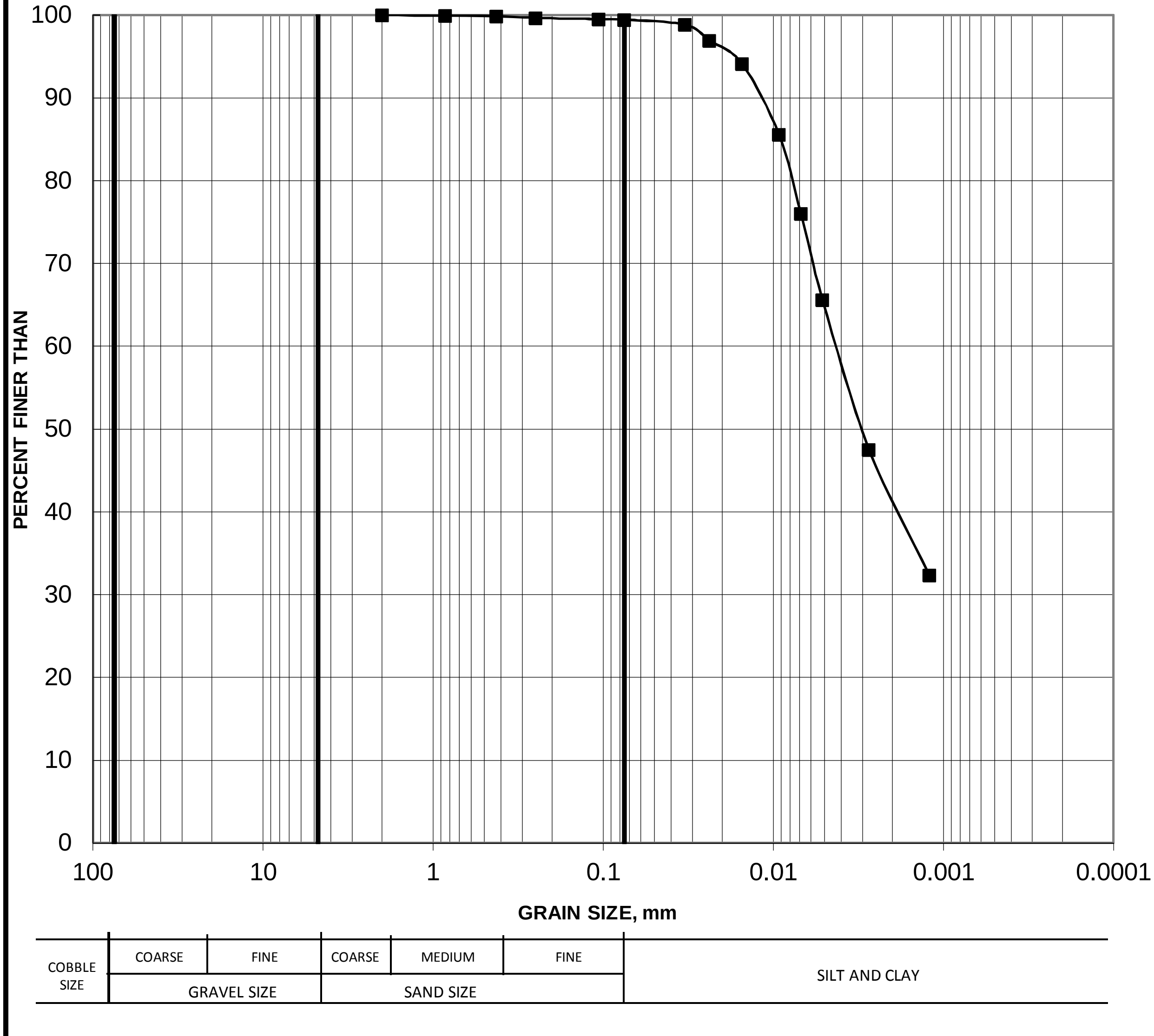
APPENDIX B

Results of Laboratory Testing

GRAIN SIZE DISTRIBUTION

B-1

SILTY CLAY



Borehole	Sample	Depth (m)	Constituents (%) Gravel	Sand	Silt	Clay
—■— 19-01	8	7.62-8.23	0	1	59	40

Project: 1534482

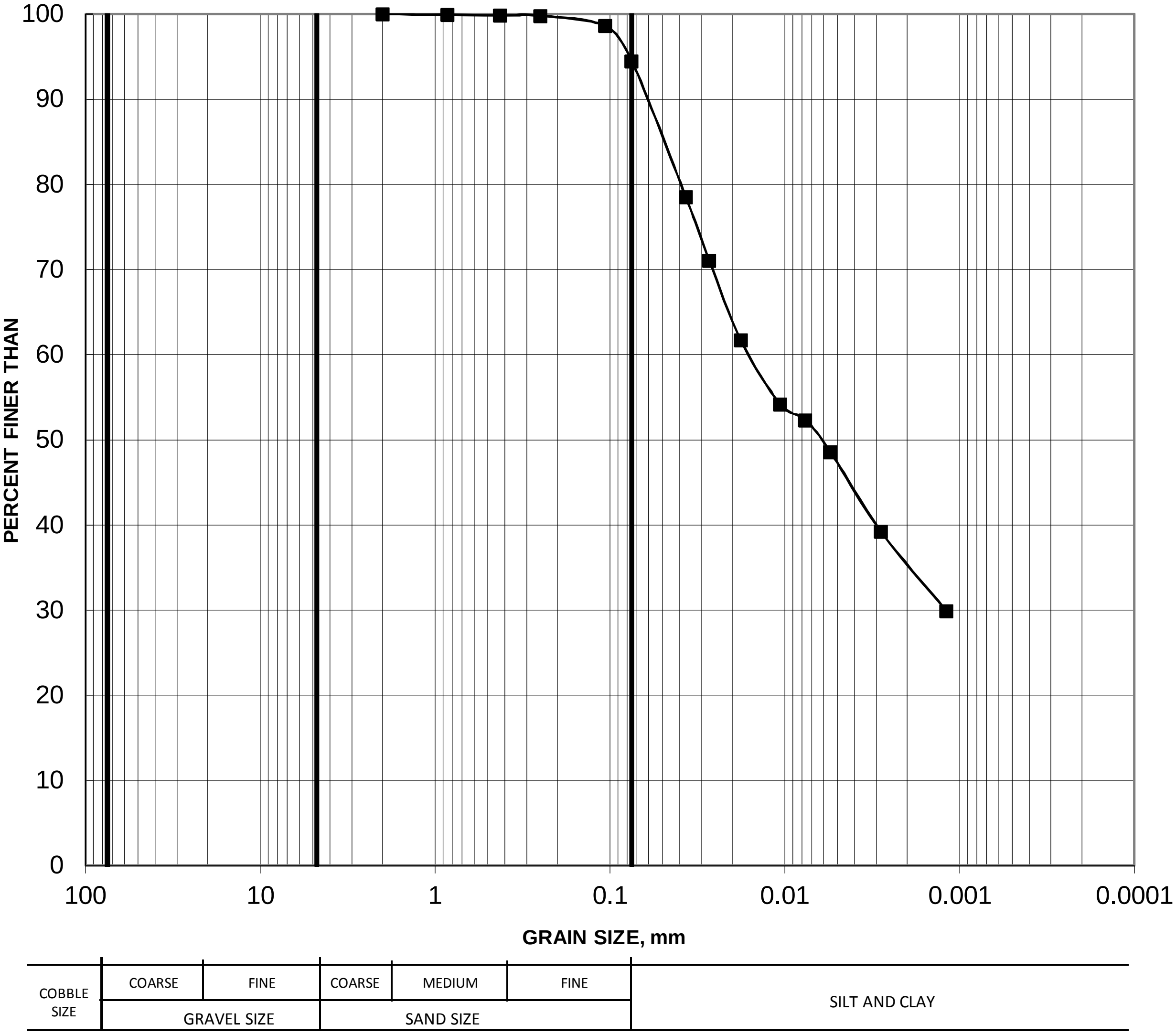
Golder Associates

Created by: PJ
Checked by: MI

GRAIN SIZE DISTRIBUTION

B-2

SILTY CLAY



Borehole	Sample	Depth (m)	Constituents (%) Gravel	Sand	Silt	Clay
—■— 19-05	2	1.98-2.59	0	6	60	35

Project: 1534482

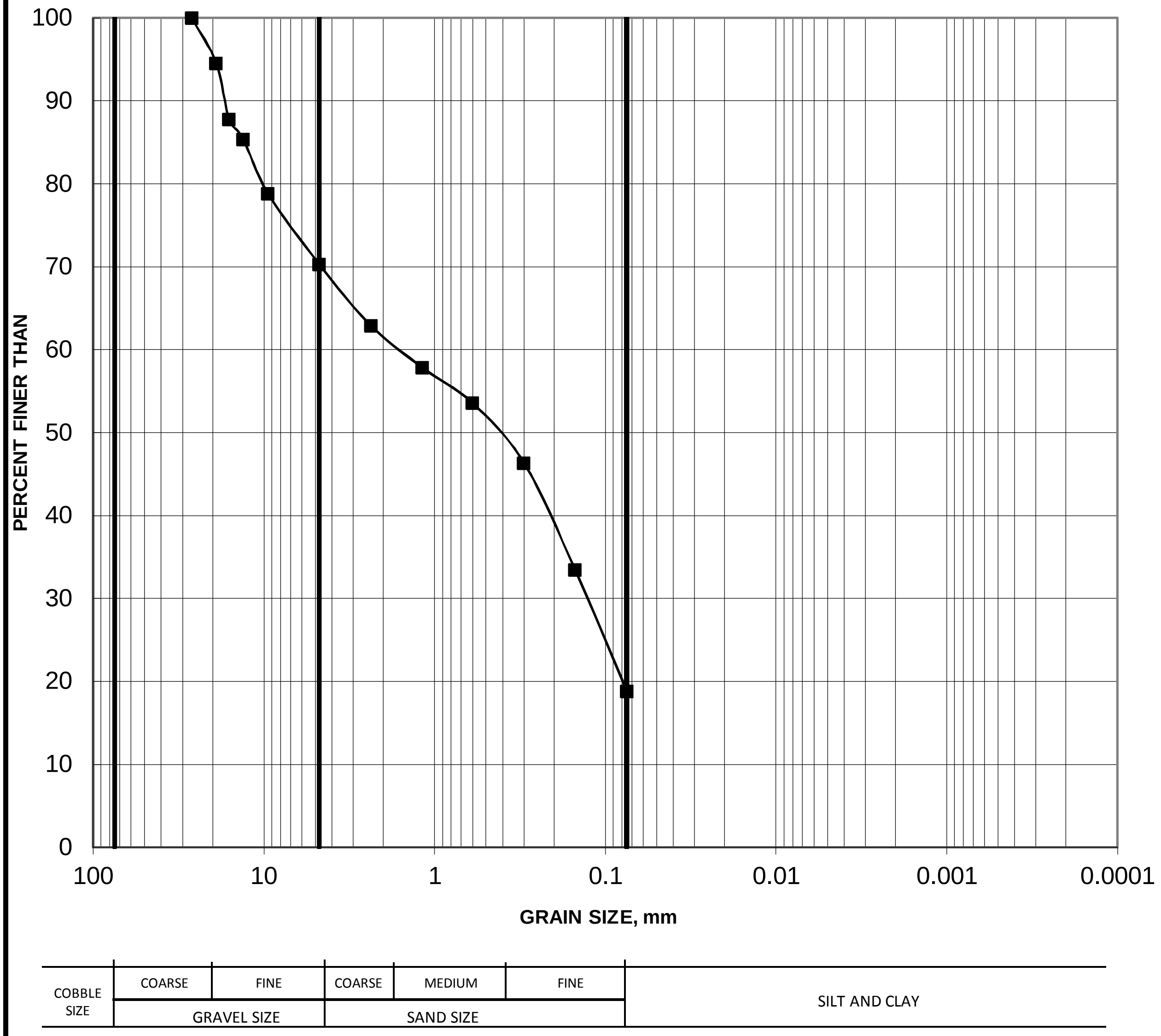
Golder Associates

Created by: PJ
Checked by: MI

GRAIN SIZE DISTRIBUTION

B-3

GLACILA TILL

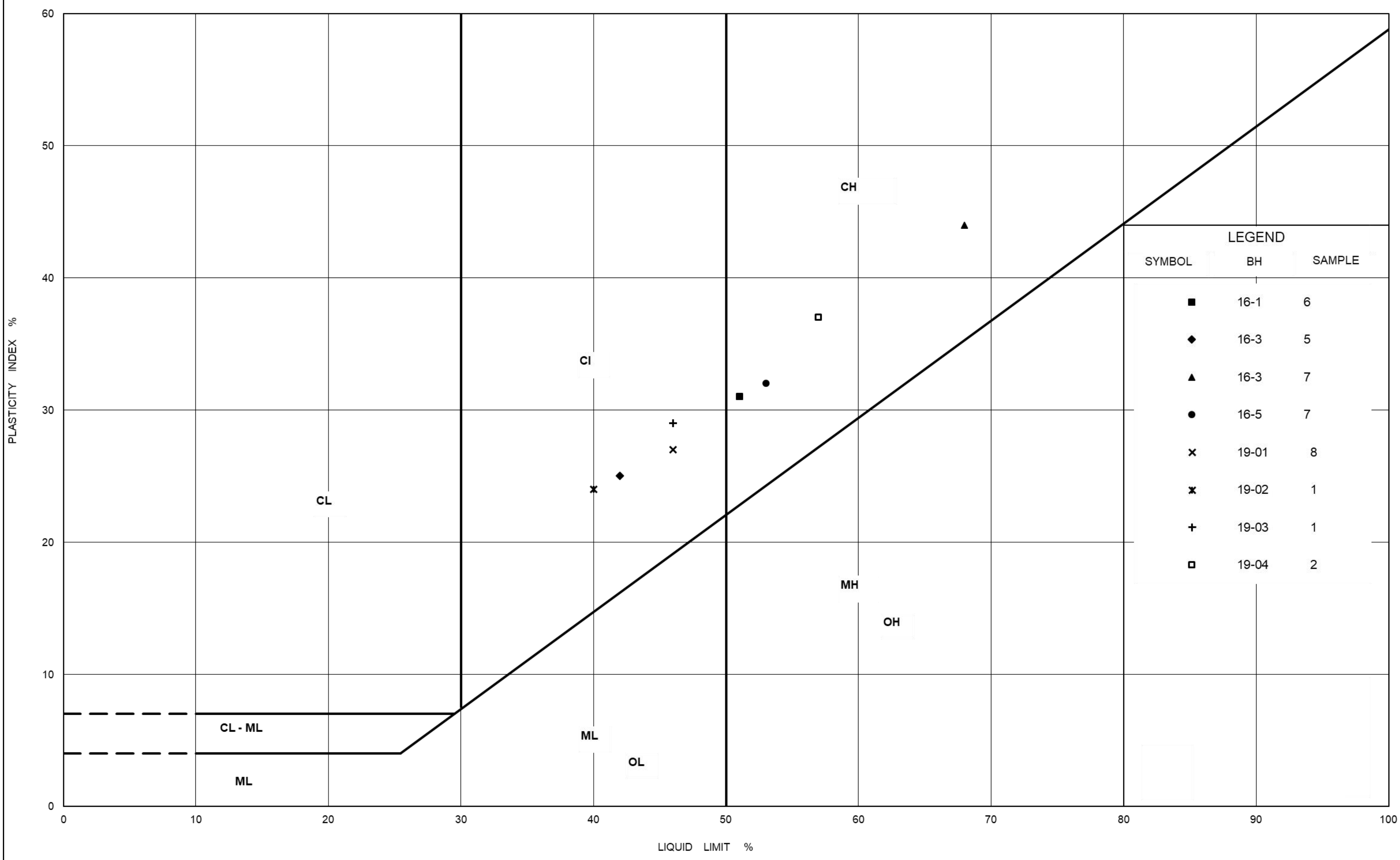


			Constituents (%)		
Borehole	Sample	Depth (m)	Gravel	Sand	Fines
—■— 19-01	11	10.67-11.28	30	52	19

Project: 1534482

Golder Associates

Created by:	PJ
Checked by:	MI



GOLDER

PLASTICITY CHART

Figure : B-4

Project No.: 1534482

Compiled By : ____ Checked By :_AG__

SHRINKAGE LIMIT DETERMINATIONS
ASTM D4943

Borehole Number	19-05	
Sample Number	2	
Depth, m	1.98-2.59	
Shrinkage Dish Number	1	2
Mass of the dry soil pat, g	18.09	18.24
Mass of dry soil pat + shrinkage dish, g	41.27	40.49
Mass of shrinkage dish, g	23.18	22.25
Volume of shrinkage dish, cm^3	13.40	13.33
Mass of wet soil + shrinkage dish, g	48.01	47.28
Moisture content of the soil	37.26	37.23
Mass of dry soil pat before waxing, g	18.09	18.24
Volume of dry soil pat + wax, cm^3	13.21	13.68
Mass of dry soil pat + wax in air, g	21.64	22.26
Mass of dry soil pat + wax in water, g	8.43	8.58
Mass of wax, g	3.55	4.02
Volume of wax, cm^3	3.84	4.35
Specific gravity of wax	0.925	0.925
Volume of dry soil pat, cm^3	9.37	9.33
SHRINKAGE LIMIT, SL	**14.99**	**15.32**
SHRINKAGE RATIO, R	**1.93**	**1.95**

Project Number:	1534482	Date Tested:	June 25, 2019
Project Name:	Regional/Nichols Lock Prop/Ontario	Tested By:	XM

Notes:

Test carried out using wax method (Microsere Wax 5214)

Checked By:

APPENDIX C

Results of Chemical Analysis

EXOVA ENVIRONMENTAL ONTARIO

Certificate of Analysis

Client: Golder Associates Ltd. (Ottawa)
1931 Robertson Road
Ottawa, ON
K2H 5B7
Attention: Ms. Susan Trickey
PO#:
Invoice to: Golder Associates Ltd. (Ottawa)

Report Number: 1614317
Date Submitted: 2016-08-15
Date Reported: 2016-08-19
Project: 1534482
COC #: 810923

				Lab I.D.	1255695
				Sample Matrix	Soil
				Sample Type	
				Sampling Date	2016-07-20
				Sample I.D.	BH 16-3 SA 3
Group	**Analyte**	**MRL**	**Units**	**Guideline**	
Agri. - Soil	pH	2.0			7.6
General Chemistry	Cl	0.002	%		0.002
	Electrical Conductivity	0.05	mS/cm		0.12
	Resistivity	1	ohm-cm		8330
	SO4	0.01	%		<0.01

Guideline = *** = Guideline Exceedence**

All analysis completed in Ottawa, Ontario (unless otherwise indicated by ** which indicates analysis was completed in Mississauga, Ontario).
Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

Certificate of Analysis

Client: Golder Associates Ltd. (Ottawa)
1931 Robertson Road
Ottawa, ON
K2H 5B7
Attention: Ms. Susan Trickey
PO#:
Invoice to: Golder Associates Ltd. (Ottawa)

Report Number: 1614317
Date Submitted: 2016-08-15
Date Reported: 2016-08-19
Project: 1534482
COC #: 810923

Lab I.D.	1255695
Sample Matrix	Soil
Sample Type	
Sampling Date	2016-07-20
Sample I.D.	BH 16-3 SA 3

Group	Analyte	MRL	Units	Guideline	1255695
Agri. - Soil	pH	2.0			7.6
General Chemistry	Cl	0.002	%		0.002
	Electrical Conductivity	0.05	mS/cm		0.12
	Resistivity	1	ohm-cm		8330
	SO4	0.01	%		<0.01

Guideline = *** = Guideline Exceedence**

All analysis completed in Ottawa, Ontario (unless otherwise indicated by ** which indicates analysis was completed in Mississauga, Ontario).
Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

APPENDIX D

Site Reconnaissance Photographs

Photo D-1: Northern Slopes; cross-section A-A'; looking toward northwest

Photo D-2: Northern Slopes; cross-section B-B'; looking toward north

Photo D-3: Northern Slopes; cross-section C-C'; looking toward southeast

Photo D-4: Northern Slopes; cross-section D-D'; looking toward northwest

Photo D-5: Northern Slopes; gully connection to the creek; looking toward southeast

Photo D-6: Northern Slopes; cross-section E-E’; looking toward east

Photo D-7: Northern Slopes; cross-section F-F’; looking toward east

Photo D-8: Northern Slopes; cross-section G-G’; looking toward northeast

Photo D-9: Western Slopes; cross-section H-H’; looking toward northeast

Photo D-10: Western Slopes; cross-section I-I’; looking toward northeast

Photo D-11: Western Slopes; cross-section J-J'; looking toward northeast

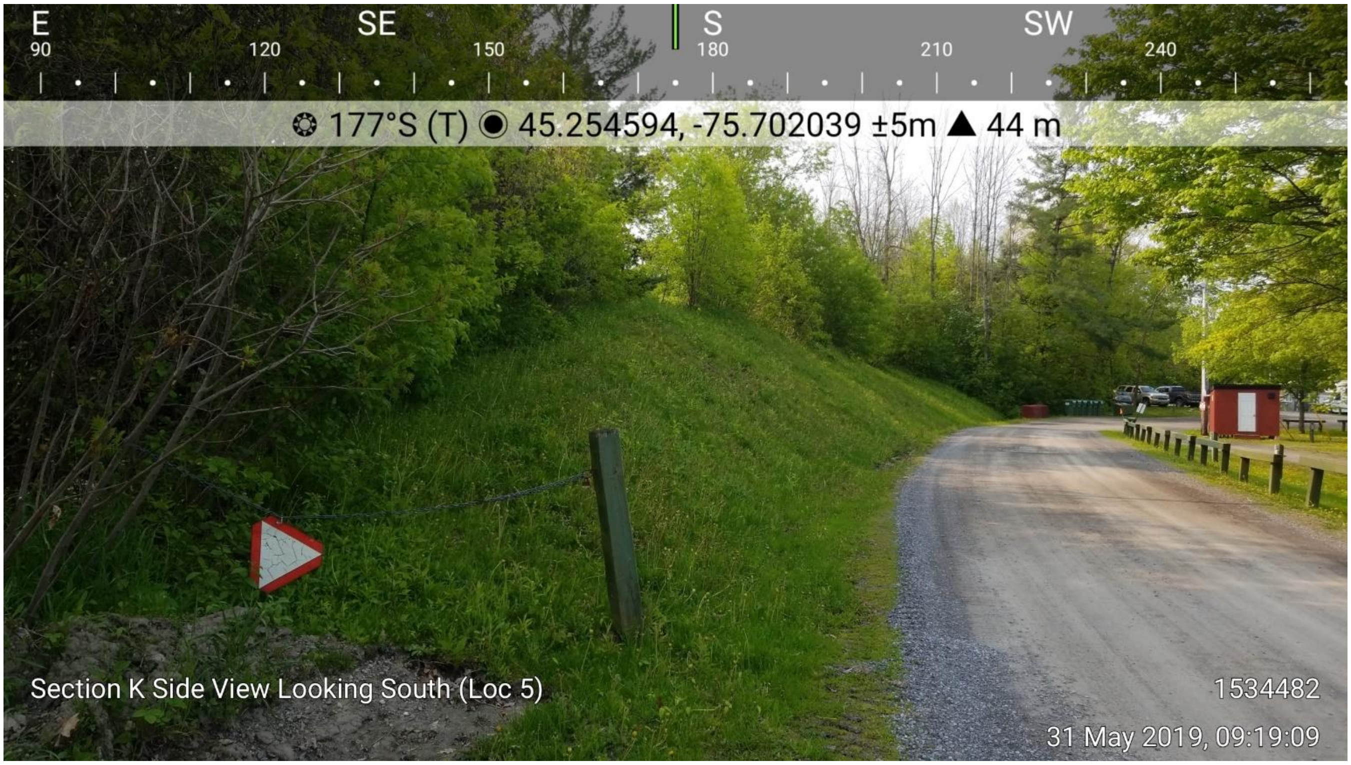
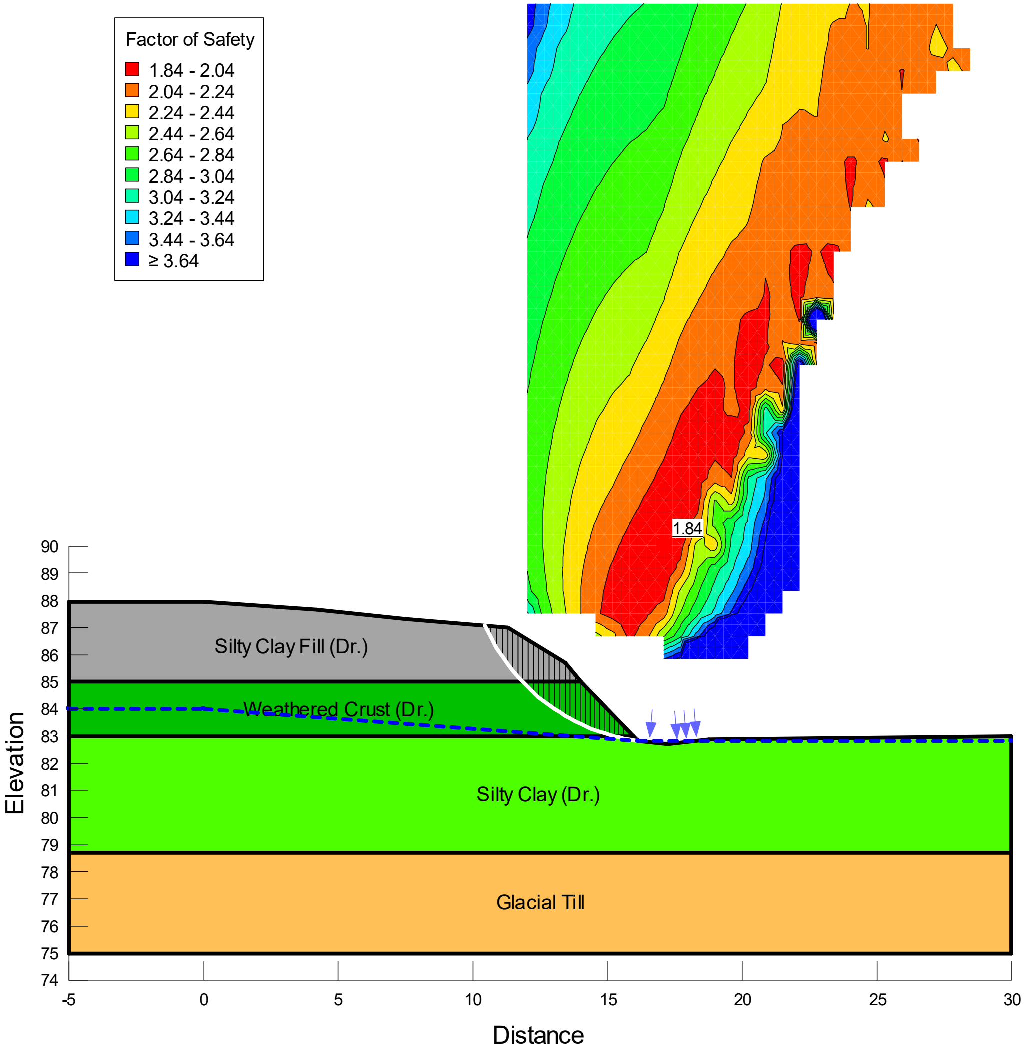


Photo D-12: Western Slopes; cross-section K-K'; looking toward south

APPENDIX E

Slope Stability Results



File Name: 1534482_2019_SectionAA_AG.gsz
Title: 1534482 Slope Analyses
Name: Section AA - Drained Flat Radius
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load:

Groundwater Elevation of 84.0 Metres Down to Creek
Minimum Slip Surface Depth of 1.0 Metres

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟧	Glacial Till	Mohr-Coulomb	21	0	36
🟩	Silty Clay (Dr.)	Mohr-Coulomb	16.5	7.5	32
⬜	Silty Clay Fill (Dr.)	Mohr-Coulomb	17.5	7.5	28
🟩	Weathered Crust (Dr.)	Mohr-Coulomb	17.5	7.5	36

GOLDER

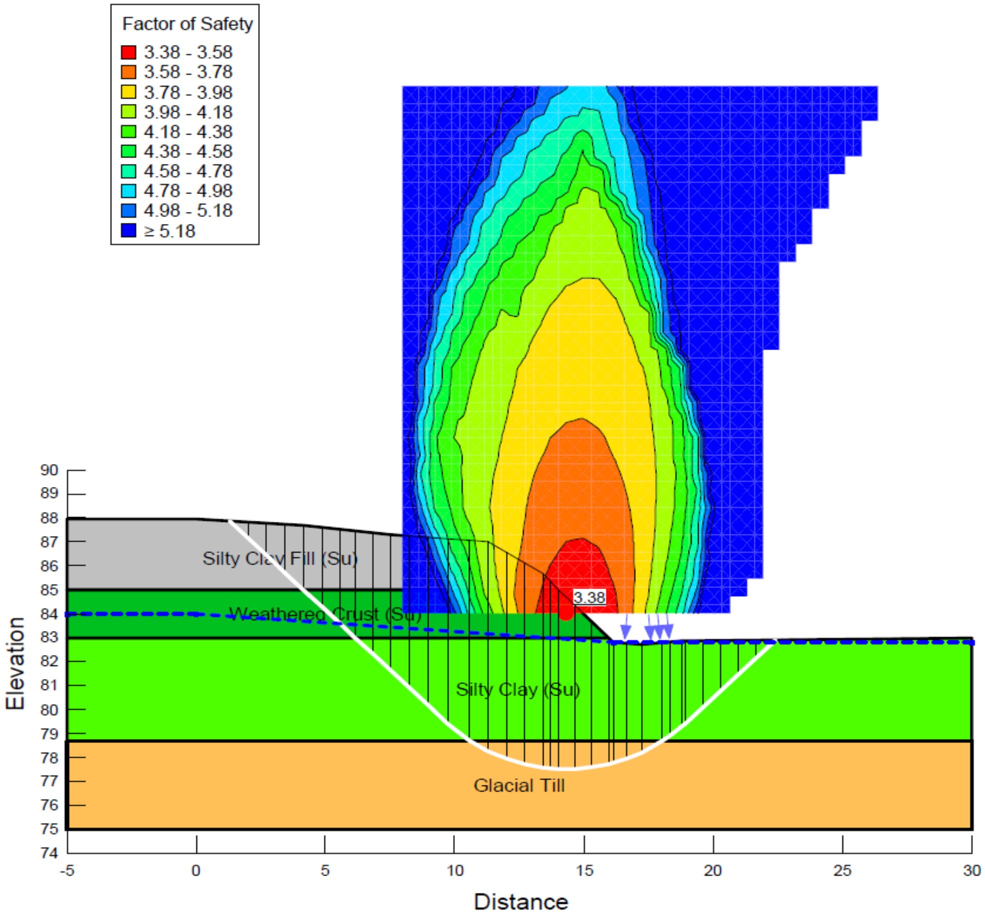
Slope Stability Assessment - Drained (cross-section A-A')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No.	1534482
Drawn:	RK
Date:	2020-02-27
Checked:	AG
Review:	MSS

Figure E-1



File Name: 1534482_2019_SectionAA_AG.gsz
Title: 1534482 Slope Analyses
Name: Section AA - Undrained
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load:

Groundwater Elevation of 84.0 Metres Down to Creek
Minimum Slip Surface Depth of 1.0 Metres

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
🟧	Glacial Till	Mohr-Coulomb	21		0	36
🟩	Silty Clay (Su)	Undrained (Phi=0)	16.5	55		
⬜	Silty Clay Fill (Su)	Undrained (Phi=0)	17.5	70		
🟩	Weathered Crust (Su)	Undrained (Phi=0)	17.5	80		

GOLDER

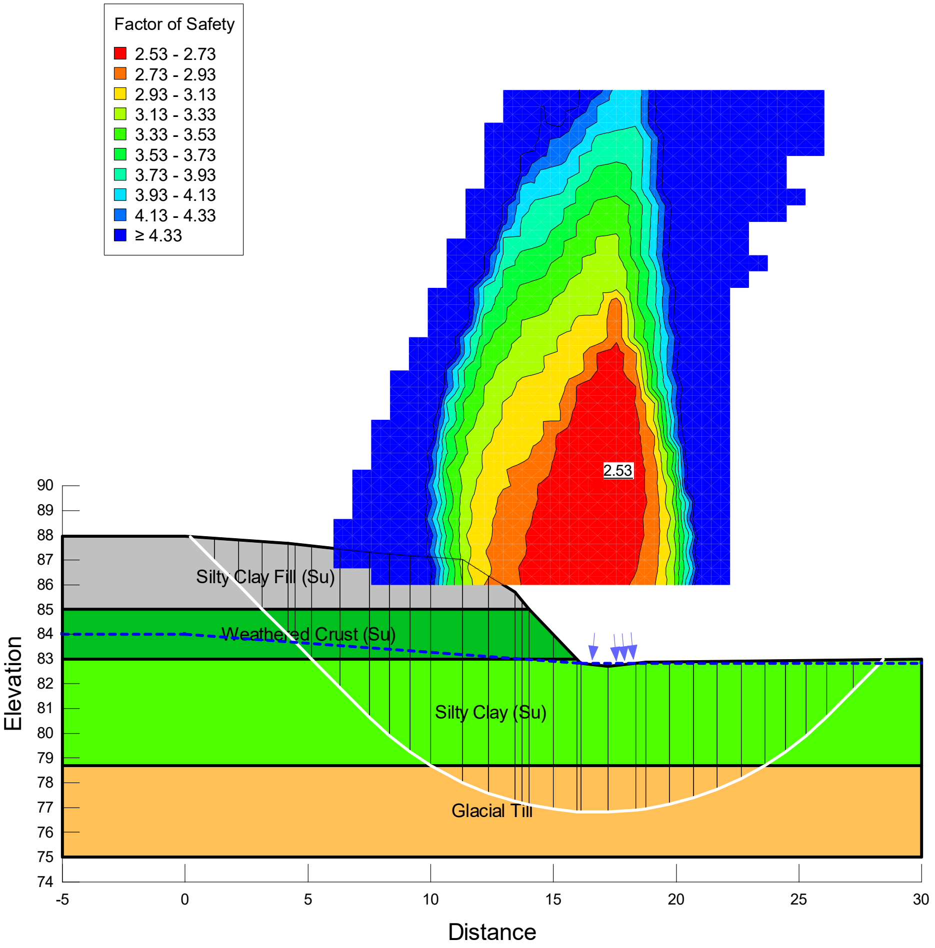
Slope Stability Assessment - Undrained (cross-section A-A')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No.	1534482
Drawn:	RK
Date:	2020-02-27
Checked:	AG
Review:	MSS

Figure E-2



File Name: 1534482_2019_SectionAA_AG.gsz
Title: 1534482 Slope Analyses
Name: Section AA - Undrained Seismic
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load: 0.14

Groundwater Elevation of 84.0 Metres Down to Creek
Minimum Slip Surface Depth of 1.0 Metres

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
🟧	Glacial Till	Mohr-Coulomb	21		0	36
🟩	Silty Clay (Su)	Undrained (Phi=0)	16.5	55		
⬜	Silty Clay Fill (Su)	Undrained (Phi=0)	17.5	70		
🟩	Weathered Crust (Su)	Undrained (Phi=0)	17.5	80		

GOLDER

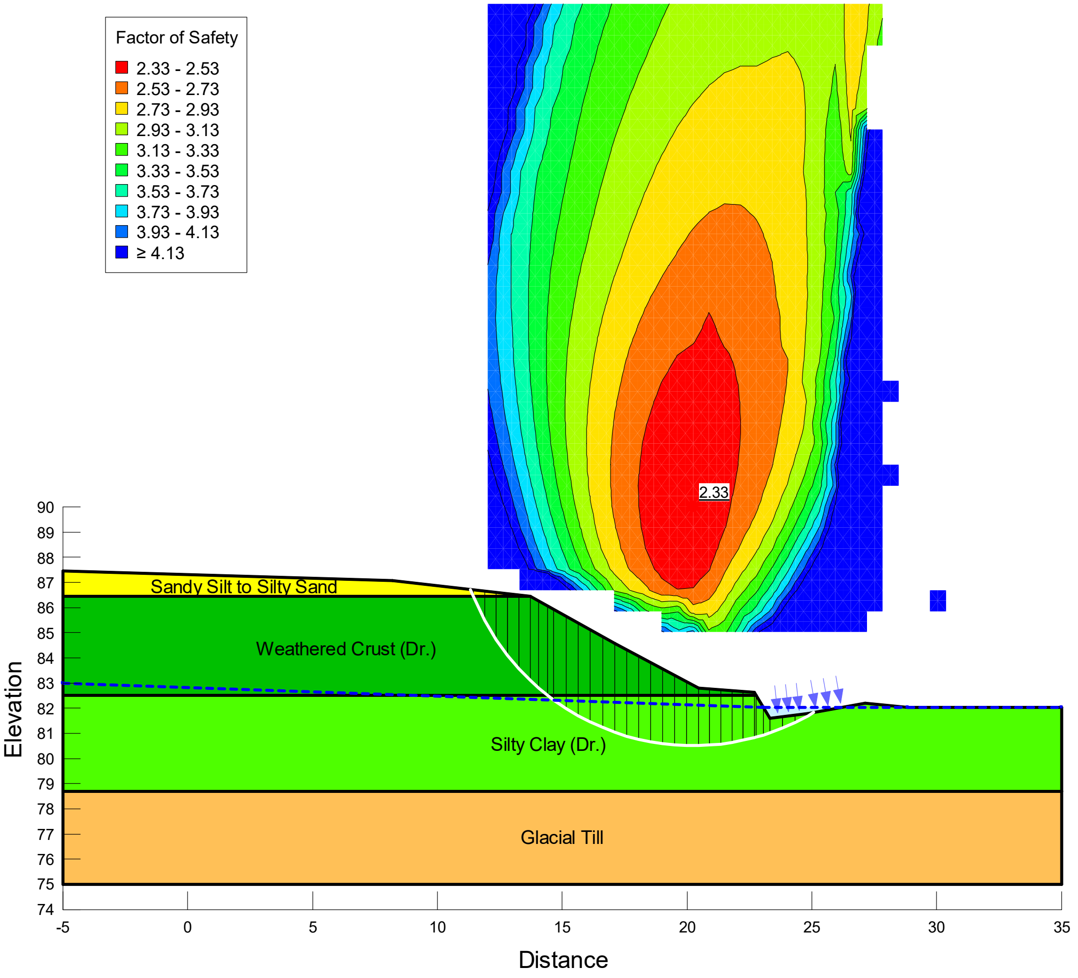
Slope Stability Assessment - Seismic (cross-section A-A')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No.	1534482
Drawn:	RK
Date:	2020-02-27
Checked:	AG
Review:	MSS

Figure E-3



File Name: 1534482_2019_SectionCC_AG.gsz
Title: 1534482 Slope Analyses
Name: Section CC - Drained Flat Radius
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load:

Groundwater Elevation of 83.0 Metres Down to Creek
Minimum Slip Surface Depth of 1.0 Metres

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟧	Glacial Till	Mohr-Coulomb	21	0	36
🟨	Sandy Silt to Silty Sand	Mohr-Coulomb	17.5	0	34
🟩	Silty Clay (Dr.)	Mohr-Coulomb	16.5	7.5	32
🟩	Weathered Crust (Dr.)	Mohr-Coulomb	17.5	7.5	36

GOLDER

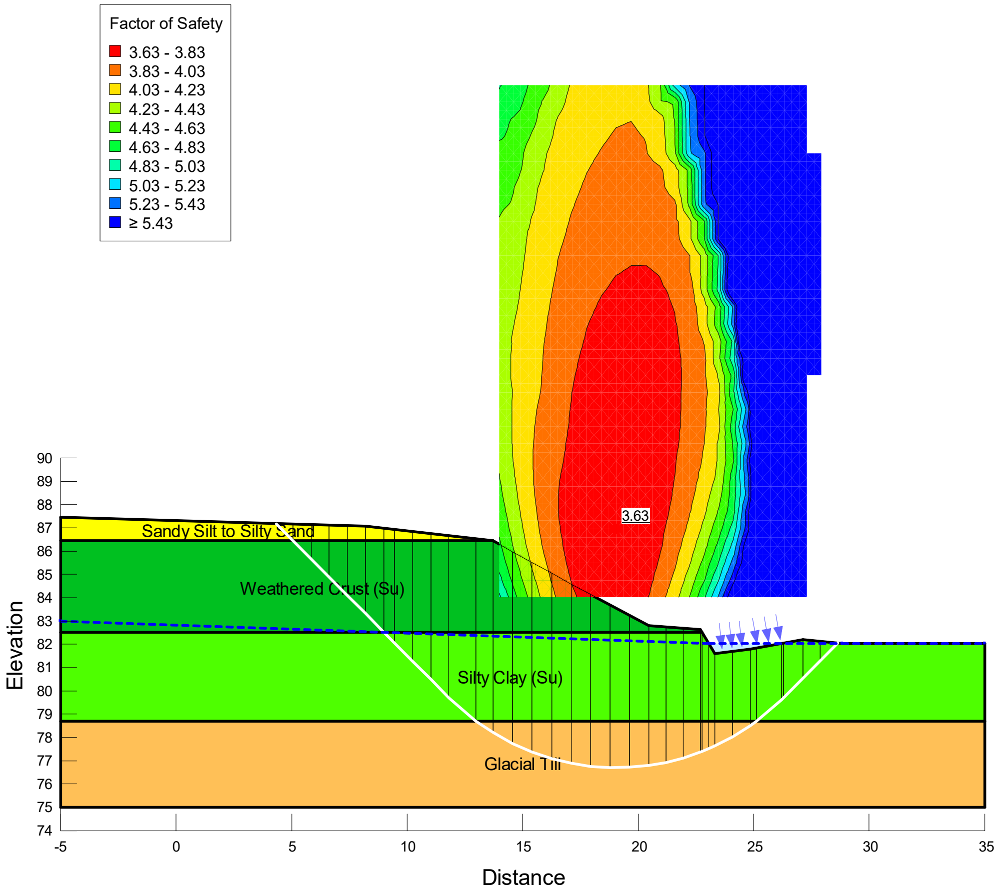
Slope Stability Assessment - Drained (cross-section C-C')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No.	1534482
Drawn:	RK
Date:	2020-02-27
Checked:	AG
Review:	MSS

Figure E-4



File Name: 1534482_2019_SectionCC_AG.gsz
Title: 1534482 Slope Analyses
Name: Section CC - Undrained
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load:

Groundwater Elevation of 83.0 Metres Down to Creek
Minimum Slip Surface Depth of 1.0 Metres

Color	**Name**	**Model**	**Unit Weight (kN/m³)**	**Cohesion (kPa)**	**Cohesion' (kPa)**	**Phi' (°)**
🟧	Glacial Till	Mohr-Coulomb	21		0	36
🟨	Sandy Silt to Silty Sand	Mohr-Coulomb	17.5		0	34
🟩	Silty Clay (Su)	Undrained (Phi=0)	16.5	55		
🟩	Weathered Crust (Su)	Undrained (Phi=0)	17.5	80		

GOLDER

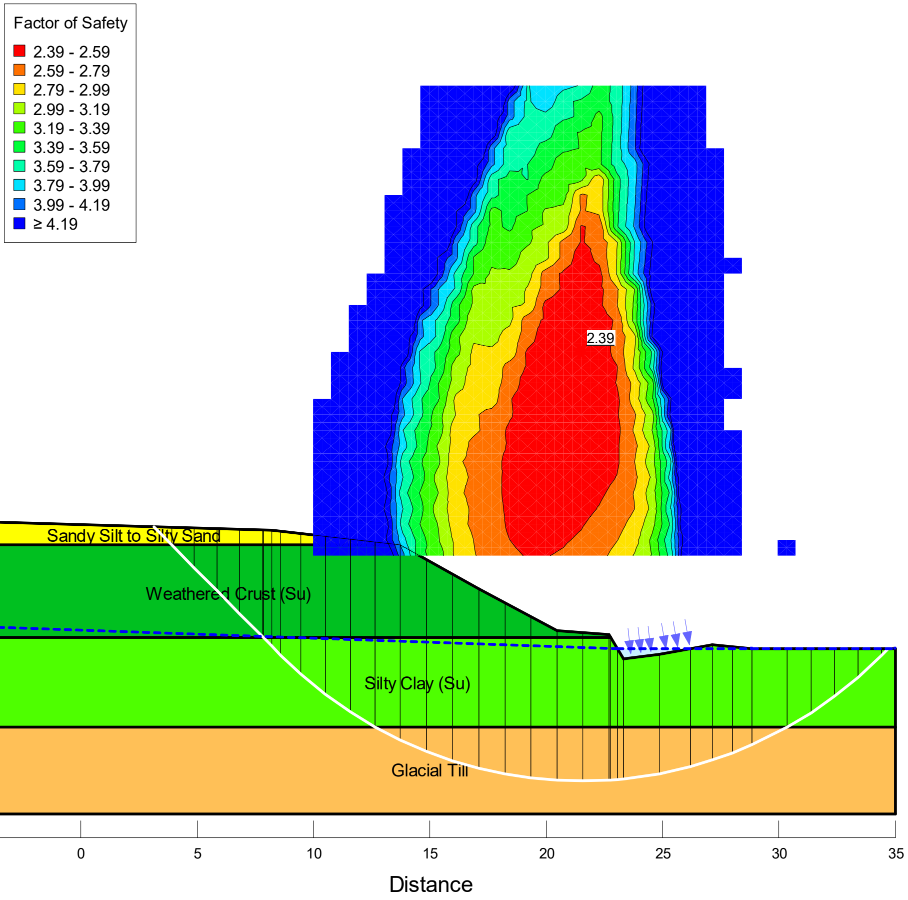
Slope Stability Assessment - Undrained (cross-section C-C')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No.	1534482
Drawn:	RK
Date:	2020-02-27
Checked:	AG
Review:	MSS

Figure E-5



File Name: 1534482_2019_SectionCC_AG.gsz
Title: 1534482 Slope Analyses
Name: Section CC - Undrained Seismic
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load: 0.14

Groundwater Elevation of 83.0 Metres Down to Creek
Minimum Slip Surface Depth of 1.0 Metres

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
🟧	Glacial Till	Mohr-Coulomb	21		0	36
🟨	Sandy Silt to Silty Sand	Mohr-Coulomb	17.5		0	34
🟩	Silty Clay (Su)	Undrained (Phi=0)	16.5	55		
🟩	Weathered Crust (Su)	Undrained (Phi=0)	17.5	80		

GOLDER

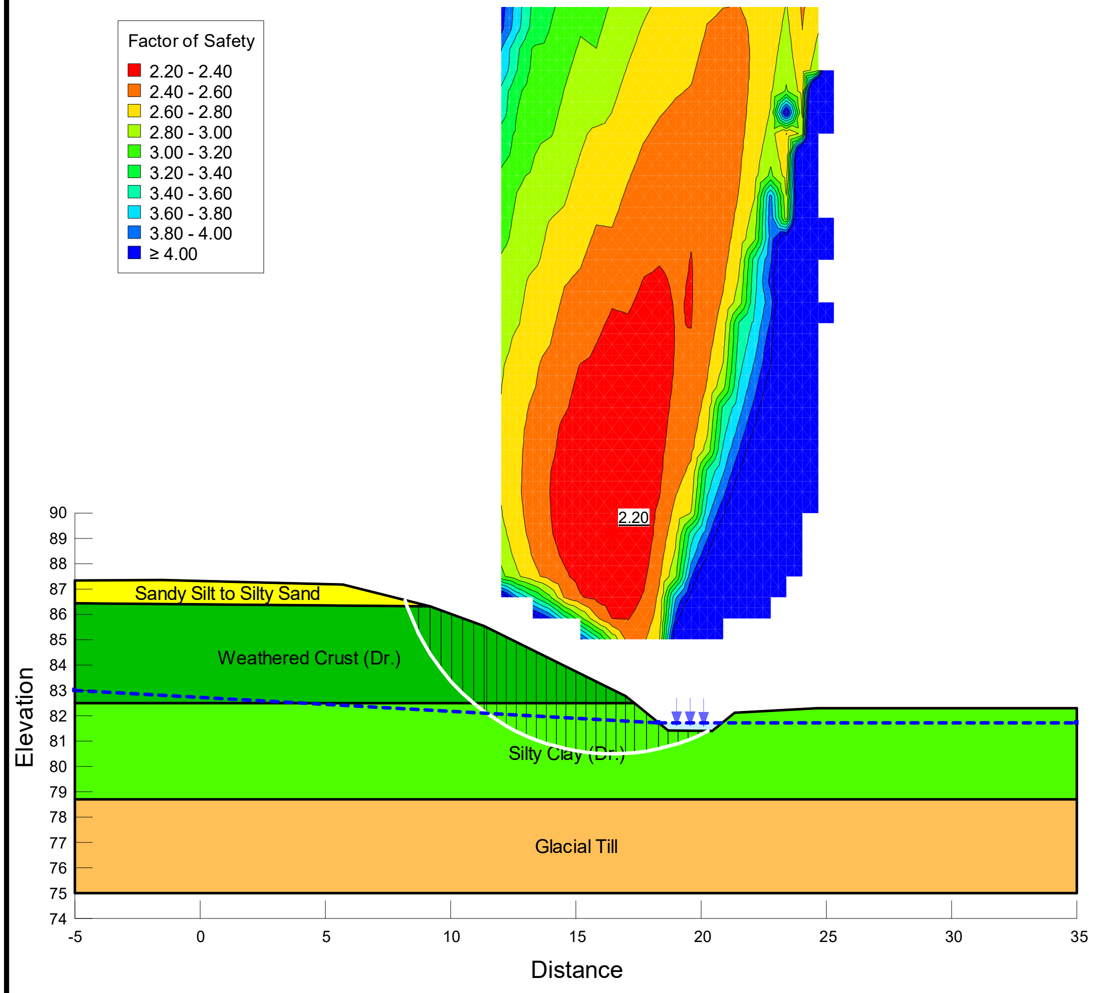
Slope Stability Assessment - Seismic (cross-section C-C')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No.	1534482
Drawn:	RK
Date:	2020-02-27
Checked:	AG
Review:	MSS

Figure E-6



File Name: 1534482_2019_SectionDD_AG.gsz
Title: 1534482 Slope Analyses
Name: Section DD - Drained Flat Radius
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load:

Groundwater Elevation of 83.0 Metres Down to Creek
Minimum Slip Surface Depth of 1.0 Metres

Color	**Name**	**Model**	**Unit Weight (kN/m^3)**	**Cohesion' (kPa)**	**Phi' (°)**
🟧	Glacial Till	Mohr-Coulomb	21	0	36
🟨	Sandy Silt to Silty Sand	Mohr-Coulomb	17.5	0	34
🟩	Silty Clay (Dr.)	Mohr-Coulomb	16.5	7.5	32
🟩	Weathered Crust (Dr.)	Mohr-Coulomb	17.5	7.5	36

GOLDER

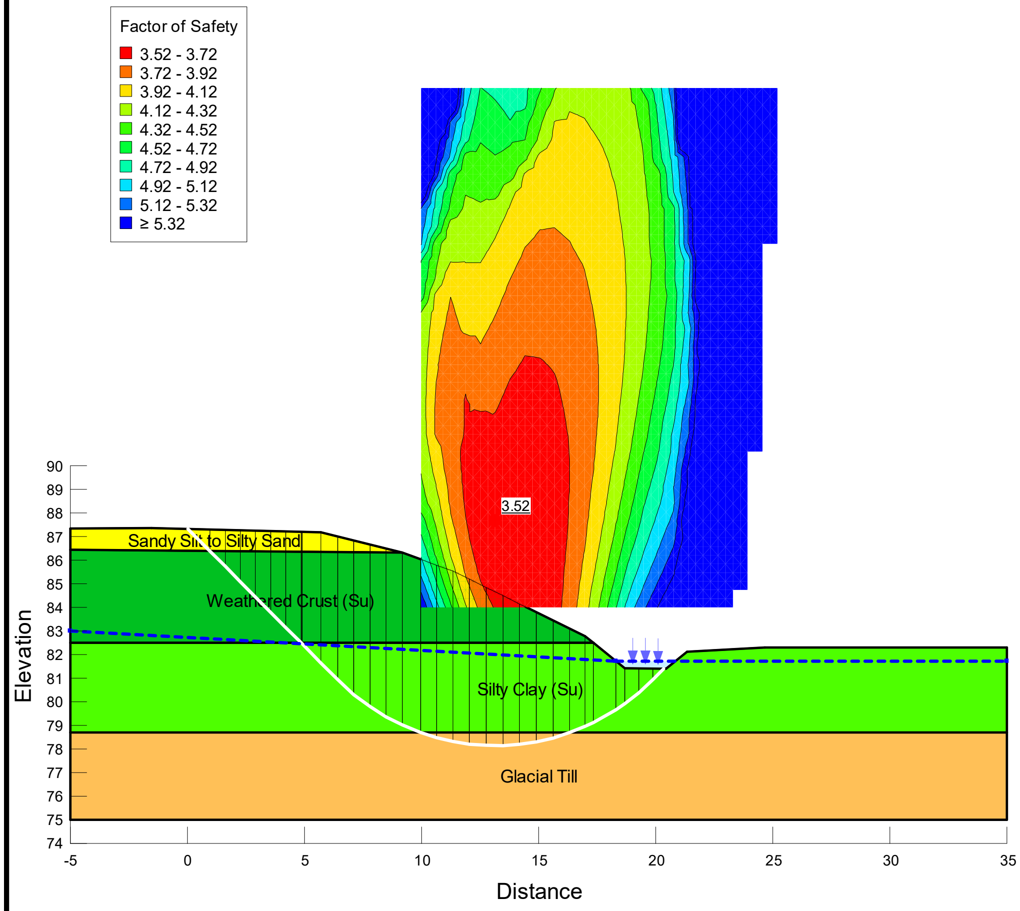
Slope Stability Assessment - Drained (cross-section D-D')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No.	1534482
Drawn:	RK
Date:	2020-02-27
Checked:	AG
Review:	MSS

Figure E-7



File Name: 1534482_2019_SectionDD_AG.gsz
Title: 1534482 Slope Analyses
Name: Section DD - Undrained
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load:

Groundwater Elevation of 83.0 Metres Down to Creek
Minimum Slip Surface Depth of 1.0 Metres

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
🟧	Glacial Till	Mohr-Coulomb	21		0	36
🟨	Sandy Silt to Silty Sand	Mohr-Coulomb	17.5		0	34
🟩	Silty Clay (Su)	Undrained (Phi=0)	16.5	55		
🟩	Weathered Crust (Su)	Undrained (Phi=0)	17.5	80		

GOLDER

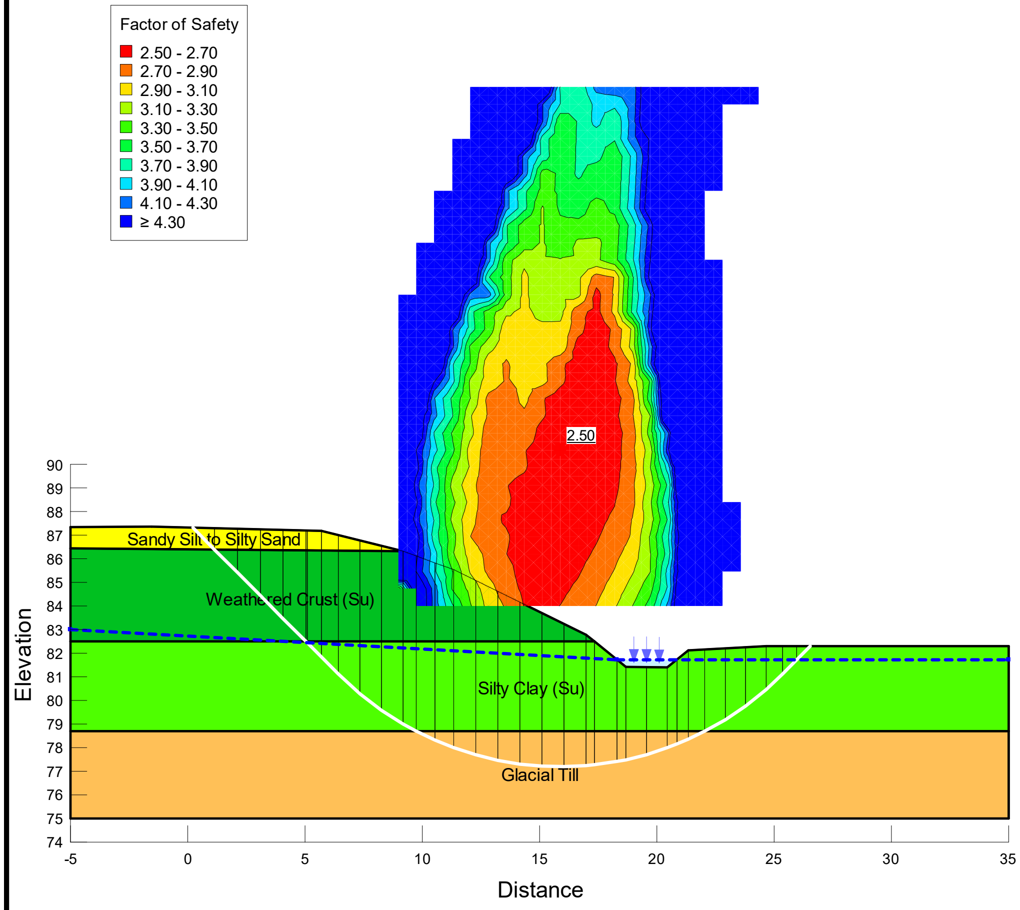
Slope Stability Assessment - Undrained (cross-section D-D')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No.	1534482
Drawn:	RK
Date:	2020-02-27
Checked:	AG
Review:	MSS

Figure E-8



File Name: 1534482_2019_SectionDD_AG.gsz
Title: 1534482 Slope Analyses
Name: Section DD - Undrained Seismic
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load: 0.14

Groundwater Elevation of 83.0 Metres Down to Creek
Minimum Slip Surface Depth of 1.0 Metres

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
🟧	Glacial Till	Mohr-Coulomb	21		0	36
🟨	Sandy Silt to Silty Sand	Mohr-Coulomb	17.5		0	34
🟩	Silty Clay (Su)	Undrained (Phi=0)	16.5	55		
🟩	Weathered Crust (Su)	Undrained (Phi=0)	17.5	80		

GOLDER

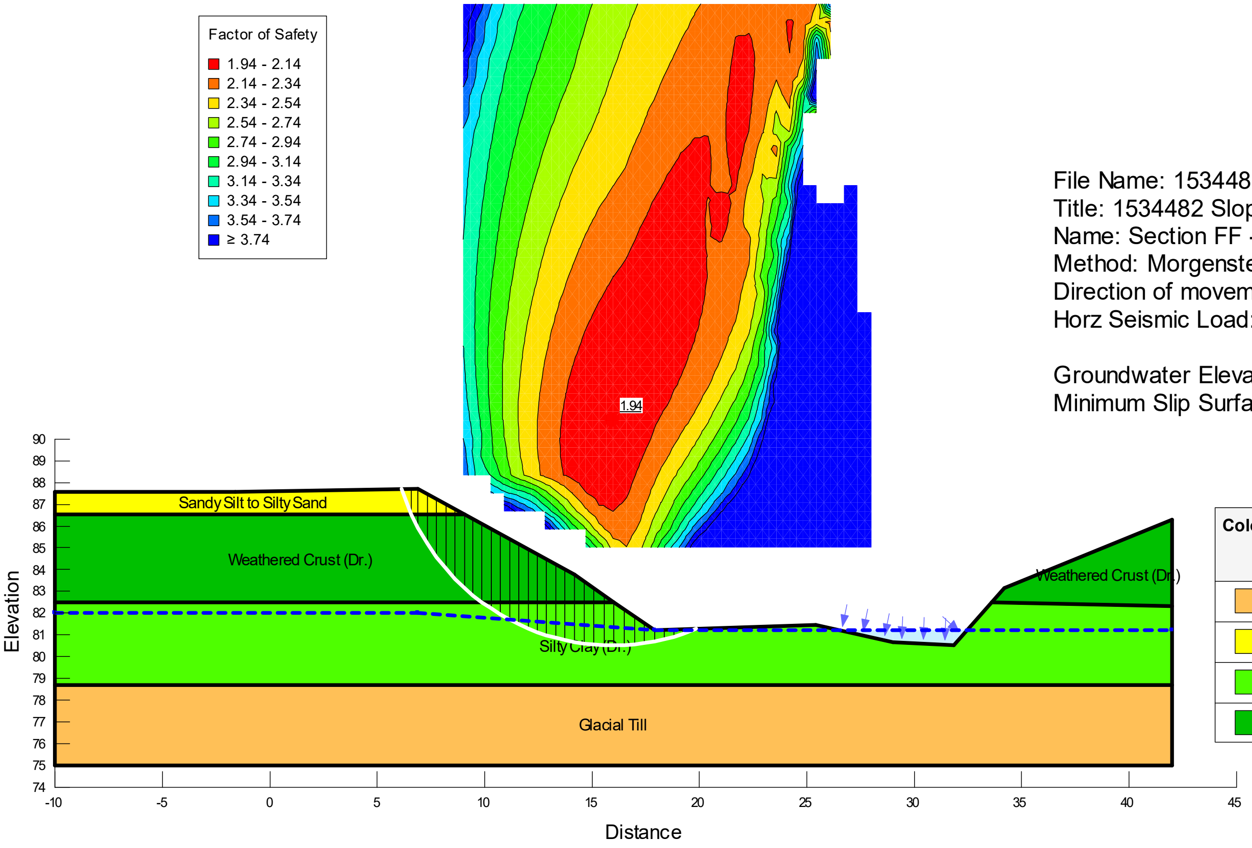
Slope Stability Assessment - Seismic (cross-section D-D')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No.	1534482
Drawn:	RK
Date:	2020-02-27
Checked:	AG
Review:	MSS

Figure E-9



File Name: 1534482_2019_SectionFF_AG.gsz
Title: 1534482 Slope Analyses
Name: Section FF - Drained Flat Radius
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load:

Groundwater Elevation of 82.0 Metres Down to Creek
Minimum Slip Surface Depth of 1.0 Metres

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟧	Glacial Till	Mohr-Coulomb	21	0	36
🟨	Sandy Silt to Silty Sand	Mohr-Coulomb	17.5	0	34
🟩	Silty Clay (Dr.)	Mohr-Coulomb	16.5	7.5	32
🟩	Weathered Crust (Dr.)	Mohr-Coulomb	17.5	7.5	36

GOLDER

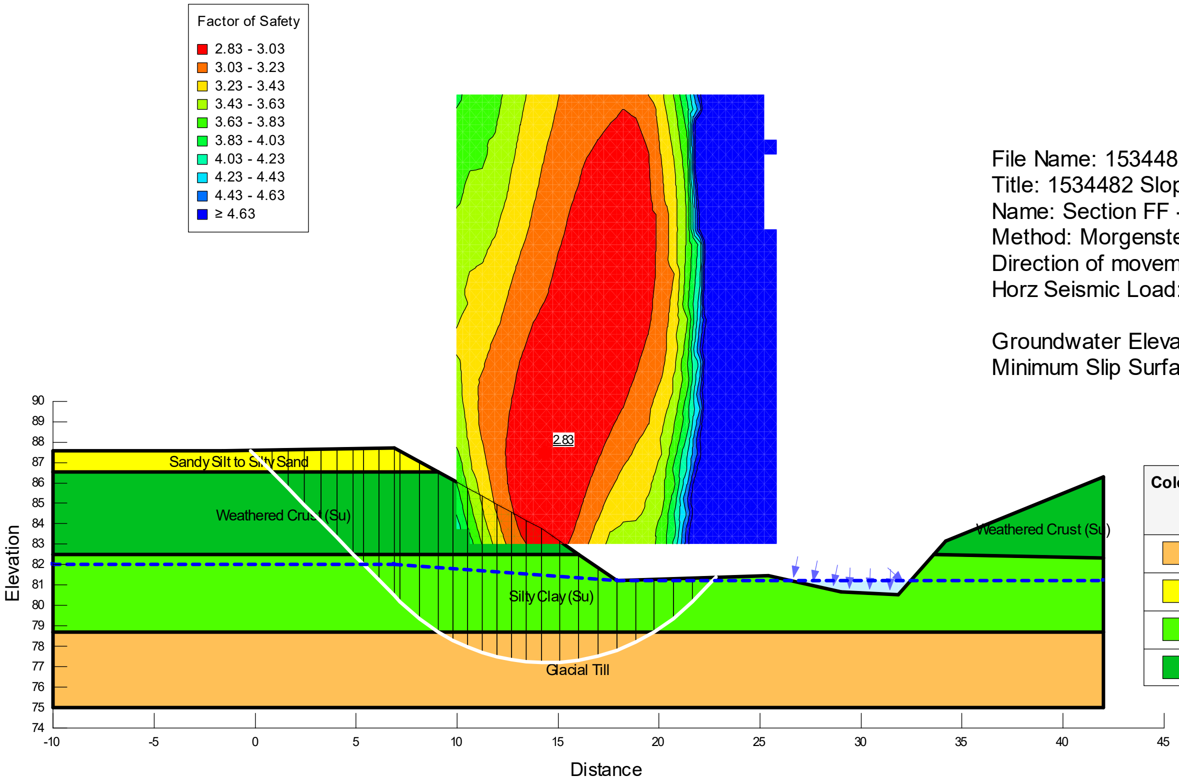
Slope Stability Assessment - Drained (cross-section F-F')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No.	1534482
Drawn:	RK
Date:	2020-02-27
Checked:	AG
Review:	MSS

Figure E-10



File Name: 1534482_2019_SectionFF_AG.gsz
Title: 1534482 Slope Analyses
Name: Section FF - Undrained
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load:

Groundwater Elevation of 82.0 Metres Down to Creek
Minimum Slip Surface Depth of 1.0 Metres

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
🟧	Glacial Till	Mohr-Coulomb	21		0	36
🟨	Sandy Silt to Silty Sand	Mohr-Coulomb	17.5		0	34
🟩	Silty Clay (Su)	Undrained (Phi=0)	16.5	55		
🟩	Weathered Crust (Su)	Undrained (Phi=0)	17.5	80		

GOLDER

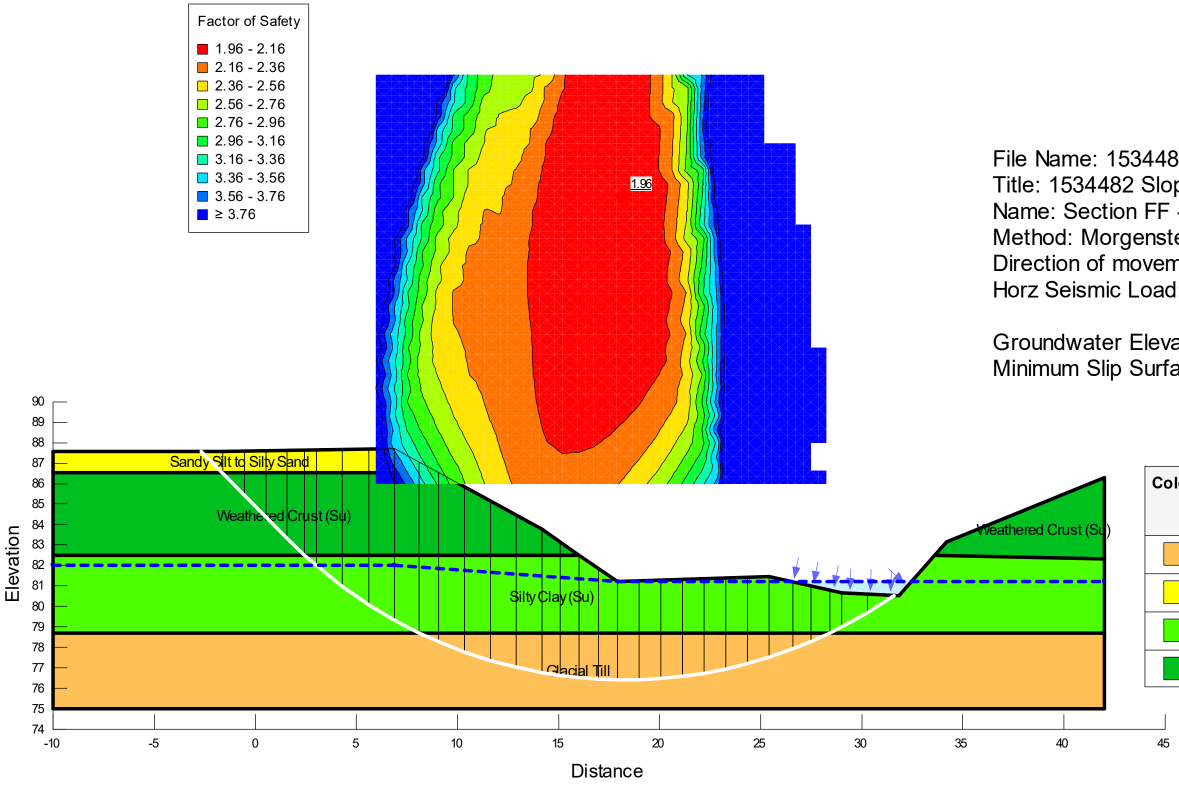
Slope Stability Assessment - Undrained (cross-section F-F')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No.	1534482
Drawn:	RK
Date:	2020-02-27
Checked:	AG
Review:	MSS

Figure E-11



File Name: 1534482_2019_SectionFF_AG.gsz
Title: 1534482 Slope Analyses
Name: Section FF - Undrained Seismic
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load: 0.14

Groundwater Elevation of 82.0 Metres Down to Creek
Minimum Slip Surface Depth of 1.0 Metres

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
🟧	Glacial Till	Mohr-Coulomb	21		0	36
🟨	Sandy Silt to Silty Sand	Mohr-Coulomb	17.5		0	34
🟩	Silty Clay (Su)	Undrained (Phi=0)	16.5	55		
🟩	Weathered Crust (Su)	Undrained (Phi=0)	17.5	80		

GOLDER

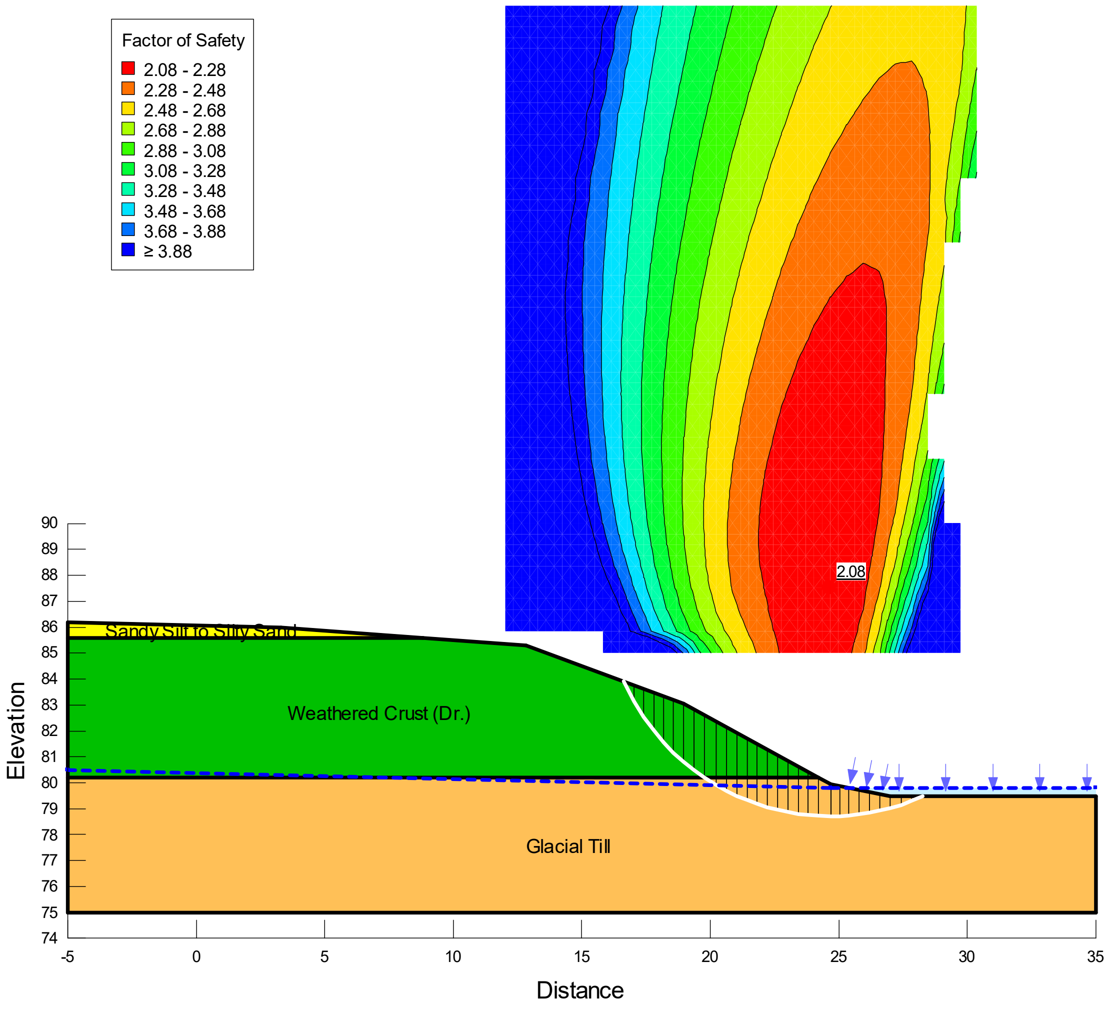
Slope Stability Assessment - Seismic (cross-section F-F')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No. 1534482
Drawn: RK
Date: 2020-02-27
Checked: AG
Review: MSS

Figure E-12



File Name: 1534482_2019_SectionGG_AG.gsz
Title: 1534482 Slope Analyses
Name: Section GG - Drained Flat Radius
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load:

Groundwater Elevation of 80.5 Metres Down to Creek
Minimum Slip Surface Depth of 1.0 Metres

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟧	Glacial Till	Mohr-Coulomb	21	0	36
🟨	Sandy Silt to Silty Sand	Mohr-Coulomb	17.5	0	34
🟩	Weathered Crust (Dr.)	Mohr-Coulomb	17.5	7.5	36

GOLDER

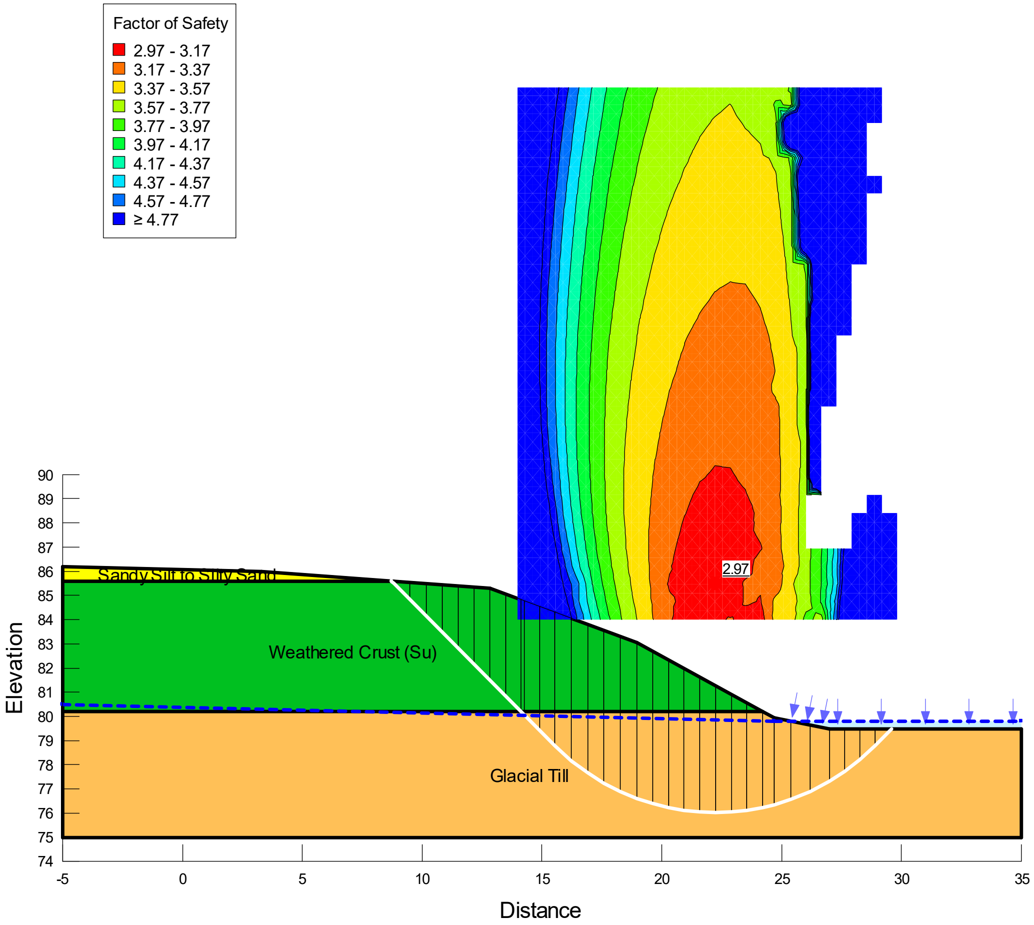
Slope Stability Assessment - Drained (cross-section G-G')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No.	1534482
Drawn:	RK
Date:	2020-02-27
Checked:	AG
Review:	MSS

Figure E-13



File Name: 1534482_2019_SectionGG_AG.gsz
Title: 1534482 Slope Analyses
Name: Section GG - Undrained
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load:

Groundwater Elevation of 80.5 Metres Down to Creek
Minimum Slip Surface Depth of 1.0 Metres

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
🟧	Glacial Till	Mohr-Coulomb	21		0	36
🟨	Sandy Silt to Silty Sand	Mohr-Coulomb	17.5		0	34
🟩	Weathered Crust (Su)	Undrained (Phi=0)	17.5	80		

GOLDER

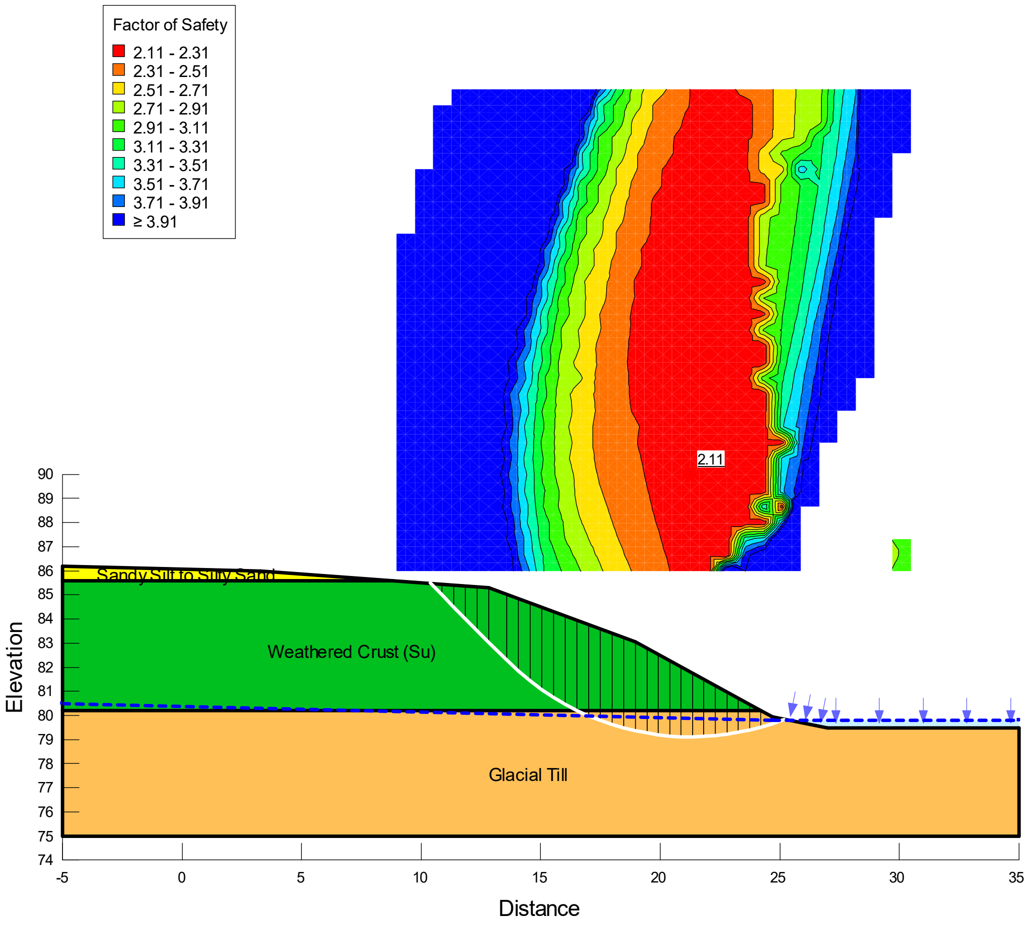
Slope Stability Assessment - Undrained (cross-section G-G')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No.	1534482
Drawn:	RK
Date:	2020-02-27
Checked:	AG
Review:	MSS

Figure E-14



File Name: 1534482_2019_SectionGG_AG.gsz
Title: 1534482 Slope Analyses
Name: Section GG - Undrained Seismic
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load: 0.14

Groundwater Elevation of 80.5 Metres Down to Creek
Minimum Slip Surface Depth of 1.0 Metres

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
🟧	Glacial Till	Mohr-Coulomb	21		0	36
🟨	Sandy Silt to Silty Sand	Mohr-Coulomb	17.5		0	34
🟩	Weathered Crust (Su)	Undrained (Phi=0)	17.5	80		

GOLDER

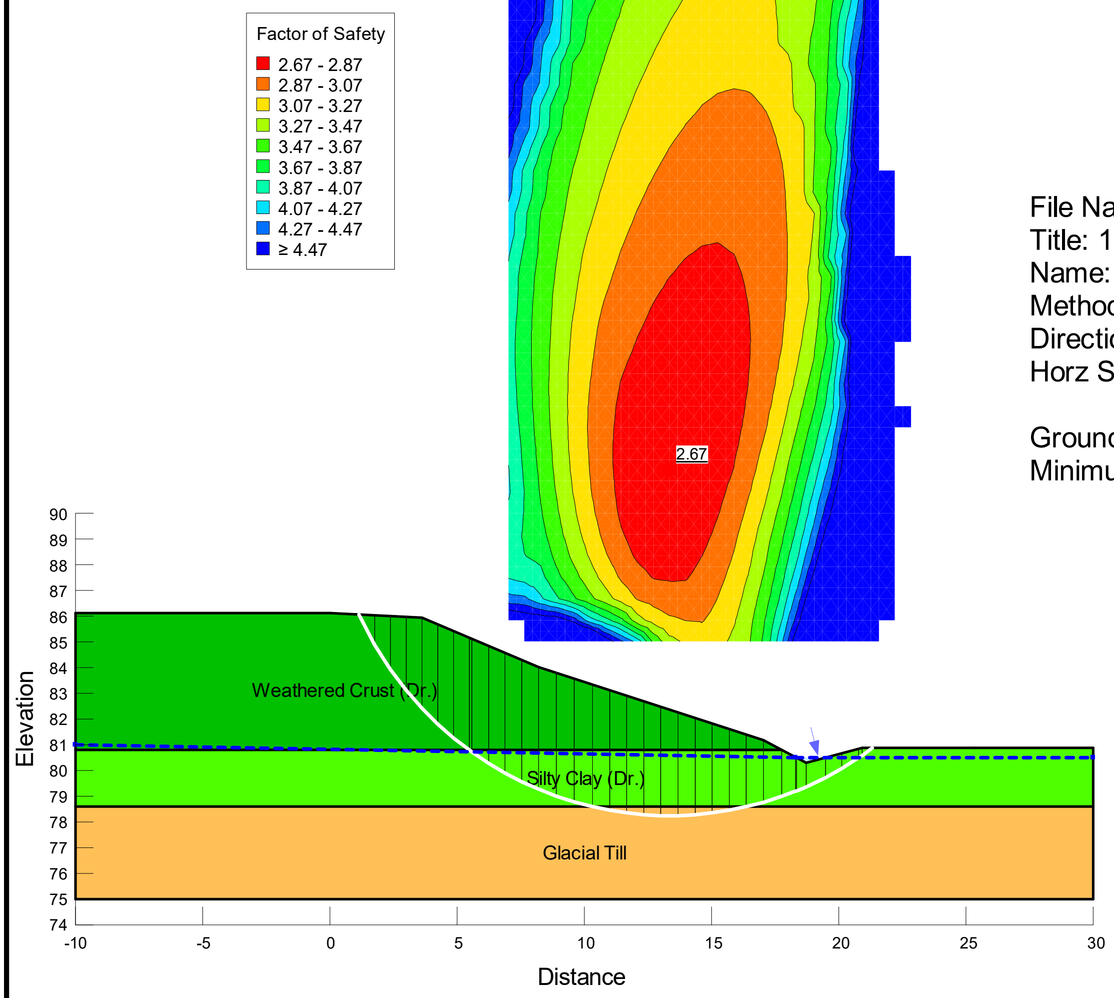
Slope Stability Assessment - Seismic (cross-section G-G')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No.	1534482
Drawn:	RK
Date:	2020-02-27
Checked:	AG
Review:	MSS

Figure E-15



File Name: 1534482_2019_SectionII_AG.gsz
Title: 1534482 Slope Analyses
Name: Section II - Drained Flat Radius
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load:

Groundwater Elevation of 81.0 Metres Down to Roadside Ditch
Minimum Slip Surface Depth of 1.0 Metres

Color	**Name**	**Model**	**Unit Weight (kN/m³)**	**Cohesion' (kPa)**	**Phi' (°)**
🟧	Glacial Till	Mohr-Coulomb	21	0	36
🟩	Silty Clay (Dr.)	Mohr-Coulomb	16.5	7.5	32
🟩	Weathered Crust (Dr.)	Mohr-Coulomb	17.5	7.5	36

GOLDER

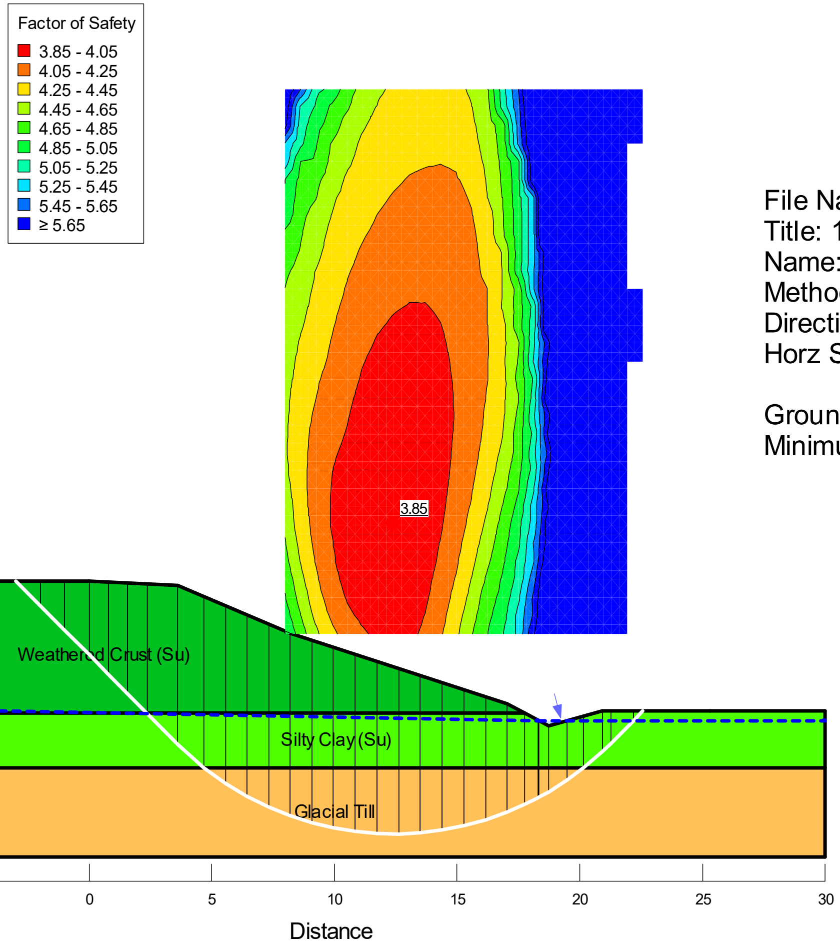
Slope Stability Assessment - Drained (cross-section I-I')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No.	1534482
Drawn:	RK
Date:	2020-02-27
Checked:	AG
Review:	MSS

Figure E-16



File Name: 1534482_2019_SectionII_AG.gsz
Title: 1534482 Slope Analyses
Name: Section II - Undrained
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load:

Groundwater Elevation of 81.0 Metres Down to Roadside Ditch
Minimum Slip Surface Depth of 1.0 Metres

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
🟧	Glacial Till	Mohr-Coulomb	21		0	36
🟩	Silty Clay (Su)	Undrained (Phi=0)	16.5	55		
🟩	Weathered Crust (Su)	Undrained (Phi=0)	17.5	80		

GOLDER

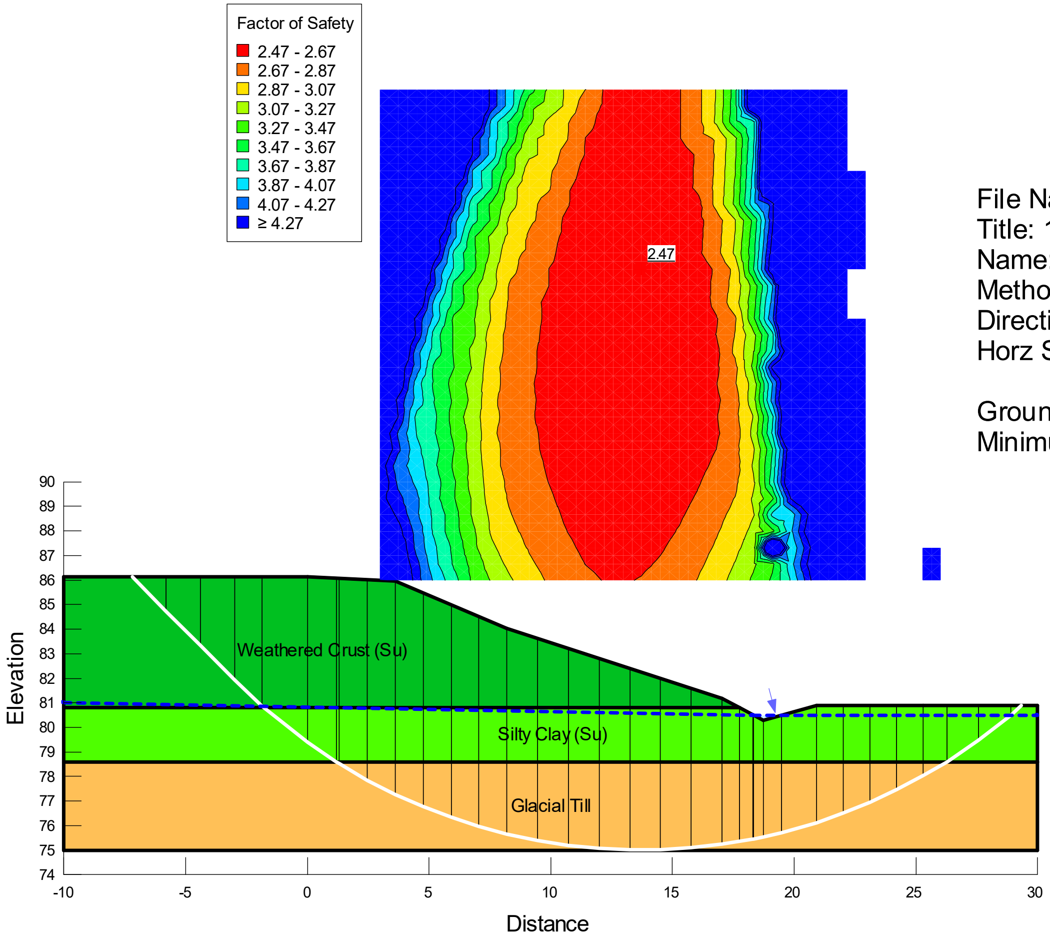
Slope Stability Assessment - Undrained (cross-section I-I')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No.	1534482
Drawn:	RK
Date:	2020-02-27
Checked:	AG
Review:	MSS

Figure E-17



File Name: 1534482_2019_SectionII_AG.gsz
Title: 1534482 Slope Analyses
Name: Section II - Undrained Seismic
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load: 0.14

Groundwater Elevation of 81.0 Metres Down to Roadside Ditch
Minimum Slip Surface Depth of 1.0 Metres

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
🟧	Glacial Till	Mohr-Coulomb	21		0	36
🟩	Silty Clay (Su)	Undrained (Phi=0)	16.5	55		
🟩	Weathered Crust (Su)	Undrained (Phi=0)	17.5	80		

GOLDER

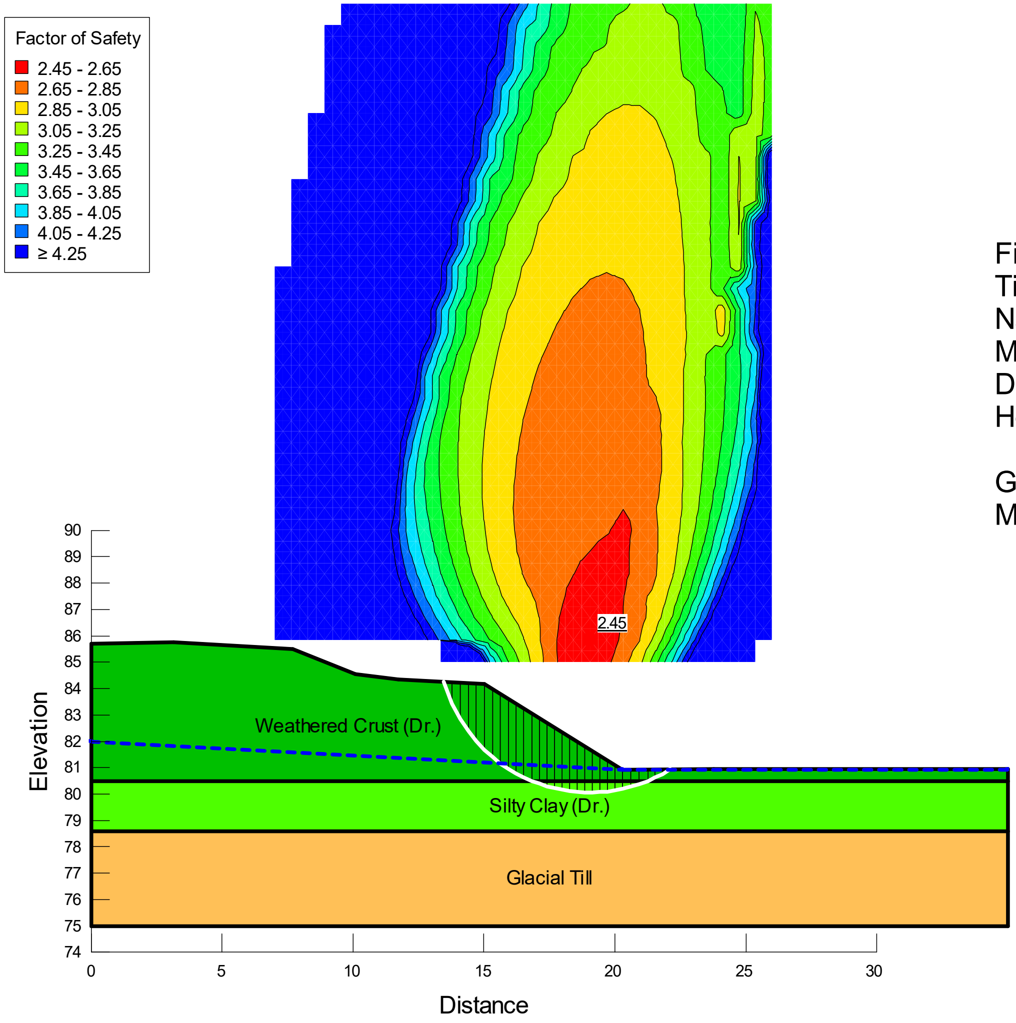
Slope Stability Assessment - Seismic (cross-section I-I')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No. 1534482
Drawn: RK
Date: 2020-02-27
Checked: AG
Review: MSS

Figure E-18



File Name: 1534482_2019_SectionKK_AG.gsz
Title: 1534482 Slope Analyses
Name: Section KK - Drained Flat Radius
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load:

Groundwater Elevation of 82.0 Metres Down to Roadside Ditch
Minimum Slip Surface Depth of 1.0 Metres

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟧	Glacial Till	Mohr-Coulomb	21	0	36
🟩	Silty Clay (Dr.)	Mohr-Coulomb	16.5	7.5	32
🟩	Weathered Crust (Dr.)	Mohr-Coulomb	17.5	7.5	34

GOLDER

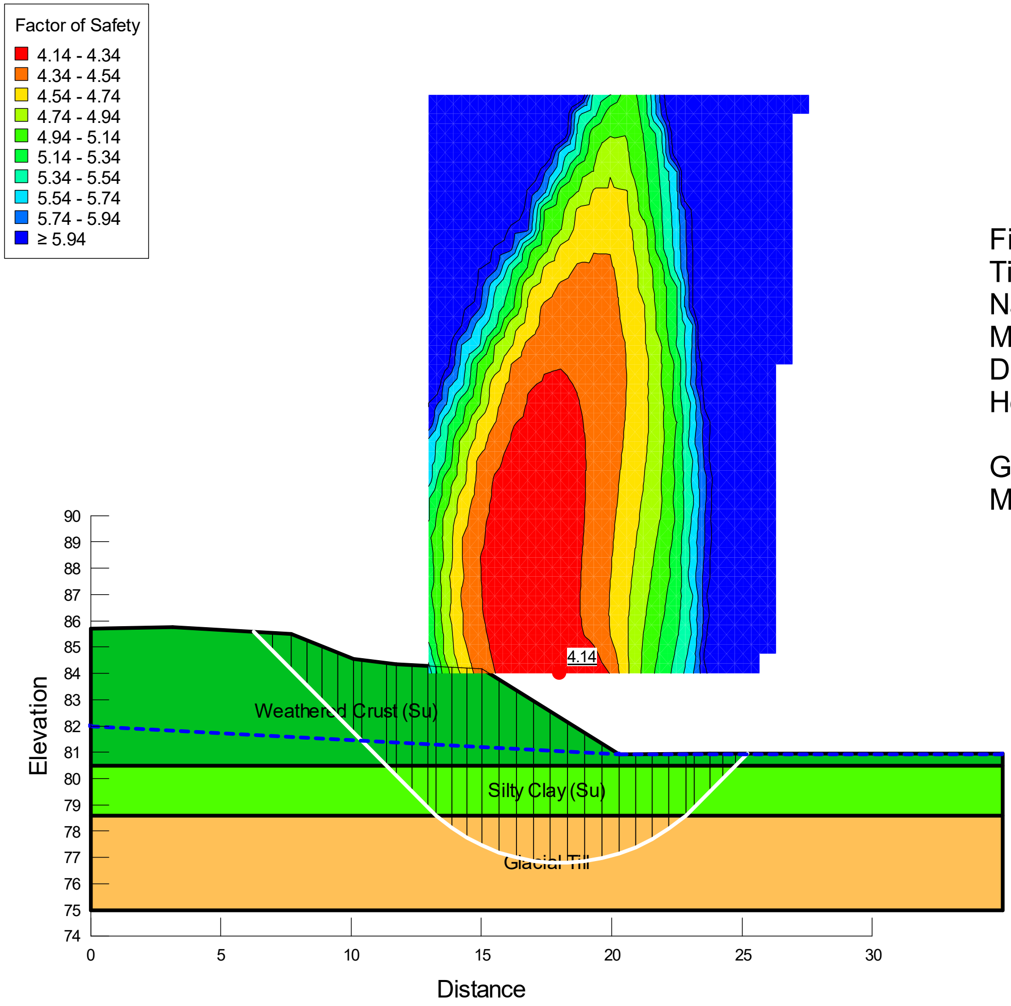
Slope Stability Assessment - Drained (cross-section K-K')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No.	1534482
Drawn:	RK
Date:	2020-02-27
Checked:	AG
Review:	MSS

Figure E-19



File Name: 1534482_2019_SectionKK_AG.gsz
Title: 1534482 Slope Analyses
Name: Section KK - Undrained
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load:

Groundwater Elevation of 82.0 Metres Down to Roadside Ditch
Minimum Slip Surface Depth of 1.0 Metres

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
🟧	Glacial Till	Mohr-Coulomb	21		0	36
🟩	Silty Clay (Su)	Undrained (Phi=0)	16.5	55		
🟩	Weathered Crust (Su)	Undrained (Phi=0)	17.5	80		

GOLDER

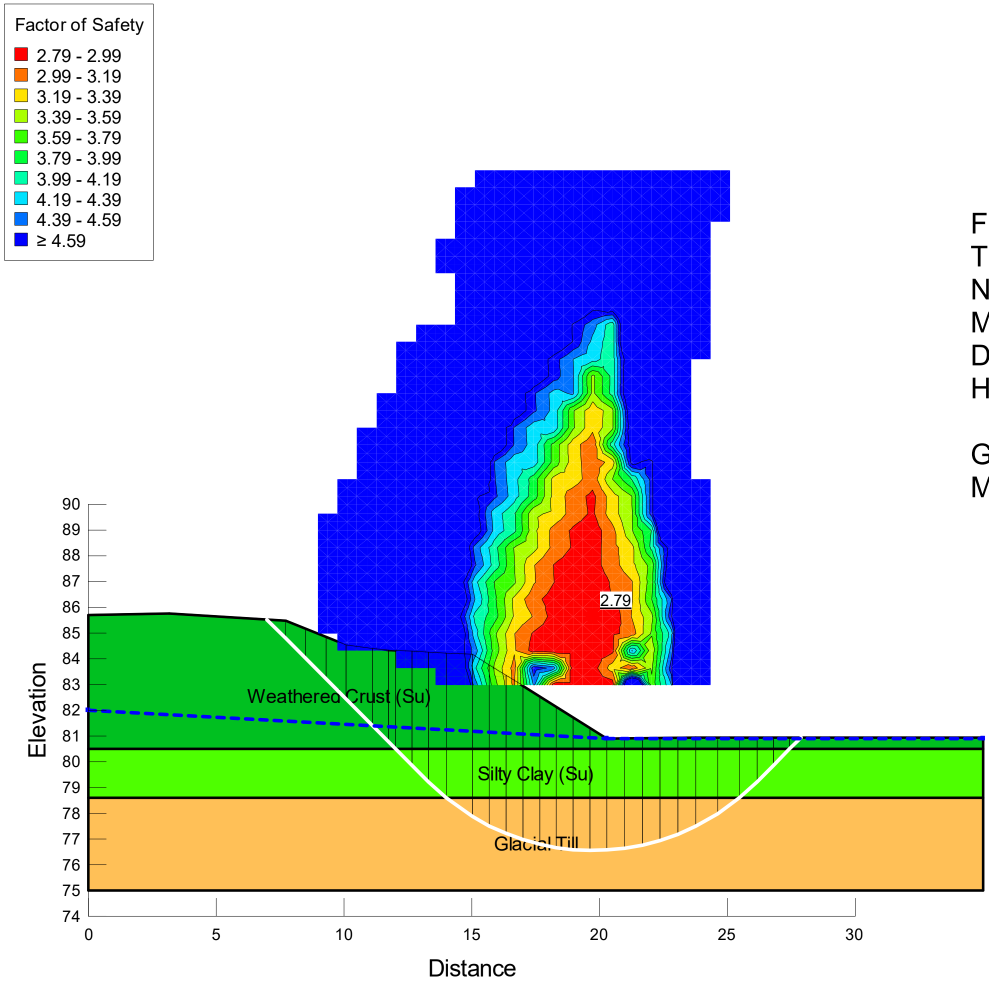
Slope Stability Assessment - Undrained (cross-section K-K')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No.	1534482
Drawn:	RK
Date:	2020-02-27
Checked:	AG
Review:	MSS

Figure E-20



File Name: 1534482_2019_SectionKK_AG.gsz
Title: 1534482 Slope Analyses
Name: Section KK - Undrained Seismic
Method: Morgenstern-Price
Direction of movement: Left to Right
Horz Seismic Load: 0.14

Groundwater Elevation of 82.0 Metres Down to Roadside Ditch
Minimum Slip Surface Depth of 1.0 Metres

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
🟧	Glacial Till	Mohr-Coulomb	21		0	36
🟩	Silty Clay (Su)	Undrained (Phi=0)	16.5	55		
🟩	Weathered Crust (Su)	Undrained (Phi=0)	17.5	80		

GOLDER

Slope Stability Assessment - Seismic (cross-section K-K')

Wright Lands - Northern Slopes

Ottawa, Ontario

Project No.	1534482
Drawn:	RK
Date:	2020-02-27
Checked:	AG
Review:	MSS

Figure E-21

GOLDER

golder.com