Functional Servicing and Stormwater Management Report (FSR/SWM)

Montrose Residential Development, City of Niagara Falls

ARCADIS

IBI GROUP

Prepared for Gemini Corporation
by Arcadis IBI Group
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November 25, 2022

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1 Introduction

Arcadis IBI Group Professional Services (Canada) Inc. (Arcadis IBI Group) was retained by "Gemini Corp." (the "Owner") to prepare a site-specific Functional Servicing and Stormwater Management Report (FSSR), for a proposed residential development at 6729 Montrose Road, Niagara Falls (the "Subject Lands"), in accordance with the City of Niagara Falls (the "City") and the Regional Municipality of Niagara (the "Region") development guidelines.

The total site development area is approximately 2.4 ha and is located at the southwestern corner of Montrose Road and Charnwood Avenue.

Refer to **Plate 1** for an aerial view of the site.

PLATE 1: Site Aerial Photo (Source: maps.google.ca)

This report will document the functional grading, servicing, and stormwater management controls for the subject lands in order to demonstrate the feasibility of the proposed development in accordance with local and municipal regulatory agencies development criteria from a site civil engineering perspective.

2 Existing Conditions

The subject lands are 2.4ha, mainly composed of greenfield and bounded by an existing residential development to the north, greenfield to the south, Montrose Road to the east and Charnwood Park (vacant land) to the west. The nearest intersection to the subject lands is Charnwood Avenue and Montrose Road.

2.1 Existing Roads

Currently, the subject lands are only accessible from Montrose Road (Regional Road 98), which is a Regional urbanized street with two to three lanes of traffic and a right-of-way width varying from 30 to 33m.

2.2 Topography and Drainage

The subject land varies in slope intensity, but generally slopes toward the northeast. There is a high point within the site, with a small area draining to the south. Most of the site drains towards an existing ditch and catch basin manhole on Montrose Road, at the northeast boundary of the subject lands. See **Figure 3** in **Appendix A**, which shows the existing catchment boundary and drainage flow directions of the subject land.

2.3 Existing Storm Services

There are no existing storm services located within the subject lands. Based on the road widening construction drawings provided by Niagara Region Public Works dated July 7, 2019, there are two existing storm services on Montrose Road. There is an existing 600mm storm sewer that drains south and provides a 525mm storm connection near the middle of the site. There is a 525mm storm sewer that drains north and provides a 450mm storm connection at the northeast end of the site.

2.4 Existing Sanitary Services

There are no existing sanitary services located on the subject lands. Based on the road widening construction drawings provided by Niagara Region Public Works dated July 7, 2019, there are existing sanitary services on Montrose Road, ranging from 200mm dia. to 250mm dia. There is an existing sanitary stub located within Montrose Road provided for the subject site, with the flows being directed east to Kinsmen Court, and then south through a combined sewer.

2.5 Existing Water Supply and Distribution

There is no existing watermain servicing the subject site. Per the road widening construction drawings provided by Niagara Region Public Works dated July 7, 2019, there is an existing 200mm dia. watermain on Montrose Road. There is an existing 150mm dia. watermain stub provided for future development of the subject site. There are fire hydrants along Montrose Road adjacent to the subject site.

2.6 Utilities

The nearest residential development is located just north of the subject site on Charnwood Avenue. Utilities such as: hydro, gas, telephone, and cable services are present and can be extended to service the proposed development. Use of these utilities will be verified and confirmed at the detail design phase. There are existing street lights along Montrose Road.

3 Proposed Conditions

The proposed residential development will consist of 18 townhome blocks (91 units) from 2 storey to 3 storey high, landscaped area, parking areas and private laneways (fire route).

Refer to **Figure 2** in **Appendix A** for a preliminary site plan of the development by ACK architects.

3.1 Roads

The proposed development will have two vehicular accesses from Montrose Road. The internal roadway will consist of an 8.0m R.O.W with a pavement width of 6.0m and a sidewalk. There is proposed parking at the north, south-west, and optional middle of the site. The northern area of the internal road (fire route) has a proposed hammerhead for vehicular turn-around.

3.2 Grading

The grading strategy for the proposed development will respect the existing grades along the property lines if possible. In general, the proposed site grading of the site will match the existing perimeter grades where possible. Split lots and walk-out grading of the medium density blocks will be used to minimize the cut/fill requirements. The proposed lot grading will direct runoff unto the private laneway, rear lot swales, and ultimately into the proposed storm sewers. There is only a small area at the north-east of the site that will be released uncontrolled to Montrose Road.

Refer to **Figure 8-1 and Figure 8-2** in **Appendix A** where a preliminary grading plan shows the proposed grading approach.

As a general guideline for the proposed site grading, the following City standards will be observed:

- Lot surfaces shall be constructed to a minimum grading of two precent (2.0%);
- Minimum – maximum road grading (including sidewalks) of 0.5% - 8%;
- Maximum grade of 3:1 for slope;
- Minimum – maximum driveway grade of 2% to 6%; and,
- Minimum – maximum swales of 1.5% to 6% and depth of swale of 150mm to 600mm.

The proposed site grading is constrained by the existing grades along the site perimeter, we will however ensure smooth transitions between proposed and existing ground. Any drainage alteration will not have a negative effect on the neighbouring properties. The majority of the overland flows from the residential development will be conveyed towards the private lane and into the proposed storm sewers. In case of catch basin/outlet blockage, as an emergency outlet the overland flow will drain toward Montrose Road via. the 2 private laneway entrances.

A swale is being proposed on the west side to capture the external drainage from the slope and rear lot drainage and will be conveyed to rear lot catchbasins. To accommodate the swale, we will require regrading of the slope, which will require the need for a grading easement from the City.

For the grading on the south property line, we will be coordinating with the adjacent developer for the grading of the shared retaining wall required for the development.

Grading of the site and building accesses will ensure barrier free walkways to main entrances. Pedestrians will have access throughout the development via sidewalks to the various building entrances.

3.3 Sanitary Infrastructure

The total design flow from the proposed development is 7.75 L/s as per the design guidelines of the City of Niagara Falls Engineering Design Standards (April 2016).

The proposed sanitary sewer network consists of 200mm diameter pipe which collects and conveys sewage towards the north-east of the site along the private laneway with cover ranging from 3.5m – 7.0m. The sewers have slope ranging from 0.50% - 2.00% with 1.0% for the initial sewer leg. The existing sanitary sewer stub at Montrose Road has a slope of 0.95% toward the combined sewer at Kinsmen Crescent. The sanitary outlet for the subject lands will connect to the existing 200mm dia. sanitary sewer on Montrose Rd but will require the removal of a section of the existing sanitary sewer.

The sewer layout and inverts have been conceptually designed and are shown in the **Figure 5** in **Appendix A**.

A minimum of 2.8m of depth on local sanitary sewers have been provided to allow gravity connections to residential dwellings with and without basements.

During detailed design, local sanitary sewers within the site will be sized based on the design flow (detailed below) and in accordance with the Regional design standards.

In accordance with the City's Design Criteria, residential sewage flows shall be calculated on the basis of the following for residential areas:

- Residential Average Daily Domestic Flow – 450 litres/person/day (lpcd);
- Infiltration Allowance for new subdivision – 0.28 litres/sec/hectare;
- Peaking factor – minimum 2.0 and maximum 5.0; and,
- Velocity – minimum 0.6 m/s and maximum 3.0 m/s.

All sanitary sewers shall be sized to handle the theoretical daily peak flow per the City's requirement, the sanitary sewage flows have been estimated using the following formula:

$$Q = \frac{PqM}{86.4} + IA$$

The subject lands are zoned for specific residential use, the following population density has been used and as shown in the following **Table 3.1,** along with the calculated sanitary flow values for the subject lands.

Table 3.1 Sanitary Flow Calculation Values

TYPE OF HOUSING	PERSONS/UNIT	POPULATION	PEAK FACTOR	DESIGN FLOW (L/s)	INFILTRATION (L/s)	TOTAL SANITARY FLOW (L/s)
Townhouses	3.0	273	5	7.11	0.64	7.75

Reviewing the existing sanitary design sheets and drainage area plan provided by Niagara Region for the existing sanitary sewer on Montrose Road, the site was assumed to be residential and commercial with a population of 353 people and approximate calculated flow of 9.20 L/s. Therefore, the site will be conveying less flow than was previously designed/allowed for.

3.4 Stormwater Management

This section provides a brief stormwater management (SWM) review of the existing and proposed conditions and addresses opportunities to reduce peak flows to meet City of Niagara Falls and Niagara Peninsula Conservation Authority (NPCA) criteria.

The City of Niagara Falls and Niagara Peninsula Conservation Authority have the following requirements for stormwater management:

- Attenuate the proposed conditions peak flows for the 2-year, 5-year, 10-year, 25-year, and 100-year design storm to existing conditions levels; and,
- Provide stormwater quality control to an Enhanced Protection Level.

An on-site storm sewer system will capture the 5-year storm runoff from the internal roads, buildings, hardscape, and landscaped areas. For storms greater than the 5-year storm, overland flow routes will be created, generally following the internal roads. The storm sewer and overland flow will convey stormwater to a proposed SWM tank at the east part of the site.

The proposed SWM tank will be designed to provide stormwater quantity control, with an oil/grit separator (OGS) unit providing stormwater quality control.

3.4.1 Existing Drainage Conditions

Under existing conditions, runoff from the subject lands is split, with Area 100 draining to the west, and Area 101 draining east, with all flows discharging to Montrose Road. The existing site consists of pervious pasture areas and impervious packed gravel. External areas EX1 and EX2 from the north drain onto the property. **Table 3.2** summarizes the existing drainage conditions of the site. Refer to **Figure 3** for the pre-development drainage area plan.

Table 3.2 Existing Drainage Areas

DRAINAGE AREA ID	DESCRIPTION	TOTAL AREA (Ha)	IMPERVIOUS (%)
EX1	External pasture	0.187	0
EX2	External pasture	0.230	0
100	Pasture Draining West	0.558	39
101	Pasture Draining East	1.716	14
	TOTAL	**2.691**	**17**

3.4.2 Proposed Drainage Conditions

Based on the current site plan, the proposed development will consist of townhouses, roadways, landscaped areas, and a SWM storage tank. **Table 3.3** provides a summary of the proposed drainage areas. Refer to **Figure 4** for the proposed conditions drainage area plan.

Table 3.3 Proposed Drainage Areas

DRAINAGE AREA ID	DESCRIPTION	TOTAL AREA (Ha)	IMPERVIOUS (%)
EX1	External pasture	0.187	0
EX2	External pasture	0.230	0
200	Buildings/Roads/Yards	2.171	75
201	Buildings/Yards	0.103	50
	TOTAL	**2.691**	**62**

The site will outlet to the existing 525mm diameter storm sewer on Montrose Road at existing structure CBMH11A. Based on drawing DR01 of the RN-16-Road Reconstruction and Widening, Regional Road 98 (Montrose Road), Niagara Falls, Drainage Area Plan (Parsons, January 26, 2017), the portion of the site draining east (Area 11A-11) to CBMH11A has been allotted an area of 0.71 ha and a runoff coefficient of 0.85 as summarized in **Table 3.4**.

Table 3.4 Allowable Drainage Areas and Runoff Coefficients

DRAINAGE AREA ID	DESCRIPTION	TOTAL AREA (Ha)	RUNOFF COEFFICIENT
11A-11	Future Development Land	0.71	0.85

The target peak flows for the site are therefore based on the values in **Table 3.4**. The peak flow calculations for the 2-year to the 100-year storm events are included in **Appendix E** and summarized in **Table 3.5** below.

3.4.3 Proposed Minor Storm Drainage System

The design of the proposed minor system shall capture the runoff from the 5-year storm event. Proposed grading and servicing for the site will capture minor runoff from the majority of the site into the proposed on-site storm sewer system. Minor flows from Areas EX1, EX2, and 200 will be controlled and outlet to the existing 525mm storm sewer on Montrose and drain east. Minor runoff from Area 201 will drain toward Montrose Road via overland flow.

3.4.4 Proposed Major Storm Drainage System

The site will be graded to contain the proposed major system runoff from the majority of the development on site. The major runoff from Areas EX1, EX2, and 200 will be directed via the proposed site storm sewer to the proposed SWM tank and controlled. Major runoff from Area 201 will drain toward Montrose Road via overland flow.

3.4.5 Stormwater Quantity Control

Stormwater management quantity controls for the site will be provided in an underground stormwater tank with an orifice control, with flows discharging to the existing 525mm diameter storm sewer on Montrose Road at existing structure CBMH11A.

Using the stormwater management hydrologic modeling software Visual OTTHYMO, the subject site was modelled for proposed conditions using the variables as shown in **Table 3.3** for a 3-hr duration Chicago style 2-year, 5-year, 10-year, 25-year, and 100-year storm events with rainfall intensity values derived from the City of Niagara Falls IDF curves.

The model determined the storage volume required to reduce proposed development flows from drainage areas EX1, EX2, and 200 to the required levels for the various storm events. The proposed SWM tank will have a total available active storage volume of 562 m^3. A 240 mm orifice opening at the outlet of MH13 will control events up to the 100-year storm. **Table 3.5** summarizes the peak discharges from the development and the proposed conditions storage volume requirements vs. storage volume provided by the SWM tank and orifice control. The stormwater calculations and model output are included in **Appendix E**.

Table 3.5 SWM Tank – Peak Flows and Storage Volumes

RETURN EVENT	ALLOWABLE PEAK FLOW (m^3/s)	PROPOSED CONDITIONS PRIOR TO TANK ROUTING	PROPOSED CONDITIONS AFTER TANK ROUTING (m^3/s)*	UNDERGROUND STORAGE REQUIRED (m^3)	TANK STORAGE PROVIDED (m^3)
2-YR	0.111	0.358	0.111	196	562 (240mm Orifice Plate)
5-YR	0.141	0.463	0.135	271	
10-YR	0.179	0.628	0.159	371	
25-YR	0.186	0.645	0.166	403	
100-YR	0.224	0.768	0.189	518	

Includes Uncontrolled Area 201

As shown in **Table 3.5** above, the proposed conditions peak flows meet the target values. The analysis indicates the following:

- For the 2-year to 100-year events, the total proposed conditions peak discharges from the site will be controlled to the required levels as illustrated in **Table 3.5**. This satisfies the stormwater management quantity control requirement set by the City of Niagara Falls.

- Sufficient storage volume is provided by the SWM storage tank to contain stormwater as summarized in the tables above.

Refer to **Appendix E** for detailed hydrologic modelling input and output files and stormwater management tank stage-storage-discharge calculations.

3.4.6 Stormwater Quality Control

Stormwater quality controls are required to meet an Enhanced Protection with 80 percent total TSS removal, as defined by the Ministry of the Environment, Conservation & Parks (MECP) 2003 Stormwater Management Planning and Design (SWMPD) Manual.

For Areas EX1, EX2, and 200, quality control will be provided by a Stormceptor EFO8 OGS unit (or approved equivalent). The Stormceptor EFO8 treatment unit has been sized to provide 84% TSS removal, based on the fine particle size distribution. The OGS unit will be installed downstream of the orifice control (as described above). Refer to **Appendix E** for sizing results and a detailed drawing of the Stormceptor EFO8. **Table 3.6** summarizes the stormwater quality controls for the site.

Table 3.6 Stormwater Quality Summary

OGS ID	OUTLET LOCATION	DRAINAGE AREA (Ha)	IMPERVIOUS (%)	PERCENT IMPERVIOUS	CDS MODEL
OGS 1	Ex. CBMH13A	2.59	71.2	83%	Stormceptor EFO8

For uncontrolled area 201, the runoff will include a combination of rooftop and landscaped areas from the site which are considered clean.

3.5 Water Supply and Distribution

3.5.1 Existing Water System

The proposed development is to be serviced by the pressure zone 250 m water distribution system, in the City of Niagara Falls. It is mainly supplied from the Niagara Falls Water Treatment and Pumping Station and the Lundy's Lane Elevated Tank (ET). The ET provides water storage and maintains system pressure for the water system in the vicinity of the subject site. The Top Water Level (TWL) of the ET is approximately equal to 250 m.

The subject site has existing municipal water infrastructures as noted:

i. A 200mm diameter watermain is located along Montrose Road and east of the site.

ii. A 150mm diameter is located across Montrose Road and south of Kinsmen Crescent.

In order to confirm the available system head / pressure along the existing pipelines in the vicinity of the proposed development, one (1) fire hydrant flow test was conducted at nearby hydrants. The flow test locations and the hydrant flow test results are shown in **Appendix D**. The static pressure is approximately 580kPa (84psi) during the tests (corresponding to a system head of 247m), and approximately equal to near its 100% full water level at the Lundy's Lane ET.

3.5.2 Proposed Development

Approximately 91 residential units are to be developed within the subject land with the ground elevations ranging from 188 to 196 m.

The estimated water consumption for the proposed residential development is anticipated to be approximately 2 L/s, 4 L/s and 8 L/s for the Average Day Demand (ADD), Maximum Day Demand (MDD) and Peak Hour Demand (PHD) condition, respectively. **Appendix D** shows the water demand estimations and the design guidelines of the Niagara Region Master Plan 2016.

As per City's design, the required fire flow was determined in accordance with the calculations from the FUS. The following assumptions have been made for the fire flow estimations:

- Consist of wood frame construction.
- A fire wall (2-hour rating) each will be installed for every three units within the buildings for each Townhouse block.
- A 25% reduction for the Occupancy and Contents Adjustment Factor.
- Based on the above assumptions, the required fire flow using the FUS method (see **Appendix E** for details) is approximately 133L/s for the subject development.

3.5.3 Proposed System Pressure

As shown in **Table 3.7**, there are no significant pressure reductions with the proposed development under the normal operation conditions (ADD, MDD and PHD). The estimated system pressures within the subject site range from 500 to 580 kPa. The system pressures meet the City's suggested system operational pressure ranges between 275kPa and 700kPa.

As shown in **Table 3.7**, the estimated system pressure for a fire flow under the MDD demand is approximately 200kPa. The available fire flow within the subject site is greater are greater than the required fire flow 133L/s (at pressure 140kPa) for the subject development.

Table 3.7 Proposed System Head and Pressure

DESIGN CONDITION	SYSTEM HEAD (m)	SYSTEM PRESSURE (kPa)
Normal Operations (ADD, MDD and PHD)	247	500 to 580
Maximum Day + Fire Flow 133L/s at Far Northwest End Hydrant	216	200

The existing 150mm diameter is located across Montrose Road (and south of Kinsmen Crescent) will be replaced with a larger watermain (250mm) to minimize the flow velocity under the fire flow conditions. 200mm/300mm watermains will be installed within the subject site. Periodic watermain flushing shall be performed to ensure that adequate water turnover be maintained under the initial development conditions.

3.6 Utilities

The various utility services (i.e., Hydro, Gas, Cable and Telephone) will facilitate the proposed development by extending their respective existing infrastructure from the Montrose Road. We anticipate that each of these utilities will as required, identify their specific requirements through the standard application circulation, review and design process.

4 Erosion & Sediment Control

During construction, erosion and sediment control measures will be required in accordance with the City of Niagara Falls, Niagara Region and Niagara Peninsula Conservation Authority. Details of these controls will be provided during the detailed engineering design and will include as a minimum the following:

- Silt fences erected around the site perimeter before any grading or topsoil stripping begins on the site to protect adjacent areas from migration of sediment in runoff.
- Installation of a “mud mat” at the construction entrance(s) to the site to minimize the amount of sediment transported off site by construction vehicles.
- Stabilization of all disturbed areas to minimize the opportunity for erosion.
- Stabilization of slopes greater than 5:1 using suitable methods (e.g. erosion control mats, tackifier and seed, etc.) as soon as practical.

5 Summary

This report demonstrates that the proposed 6729 Montrose Road Residential Development is feasible from a civil engineering perspective in accordance with the City of Niagara Falls, Regional Municipality of Niagara, and Niagara Peninsula Conservation Authority (NPCA) Engineering Design Standards. The following summarizes key aspects of the design:

- The proposed site grading will achieve compliant site gradients and match into the existing grades at its limits.
- The proposed development will outlet sanitary sewage into municipal infrastructure by connecting to the existing sanitary sewer on Montrose Road, leading to the combined sewer system on Kinsmen Crescent.
- Stormwater management design for the proposed development will provide quantity control using a SWM storage tank. The proposed design will attenuate the proposed conditions peak flows for the 2-year, 5-year, 10-year, 25-year, and 100-year storm events to the required levels.
- Stormwater quality control will be provided to an Enhanced Protection Level utilizing an OGS unit.
- The proposed residential development will connect to the existing 200mm diameter watermain on Montrose Road satisfying domestic water demand and fire flow requirement.

We trust the foregoing in conjunction with the functional engineering drawings are satisfactory to demonstrate the development’s feasibility from a municipal engineering perspective to support the rezoning application for the development. Should there be any questions or if further information required, please do not hesitate to contact Arcadis IBI Group.

Appendix A
Figures

LOCATION PLAN

6729 MONTROSE ROAD,
NIAGARA FALLS, ONTARIO

DATE:	NOV. 2022	PROJECT No.:	126319
SCALE:	N.T.S.	FIGURE No.:	1

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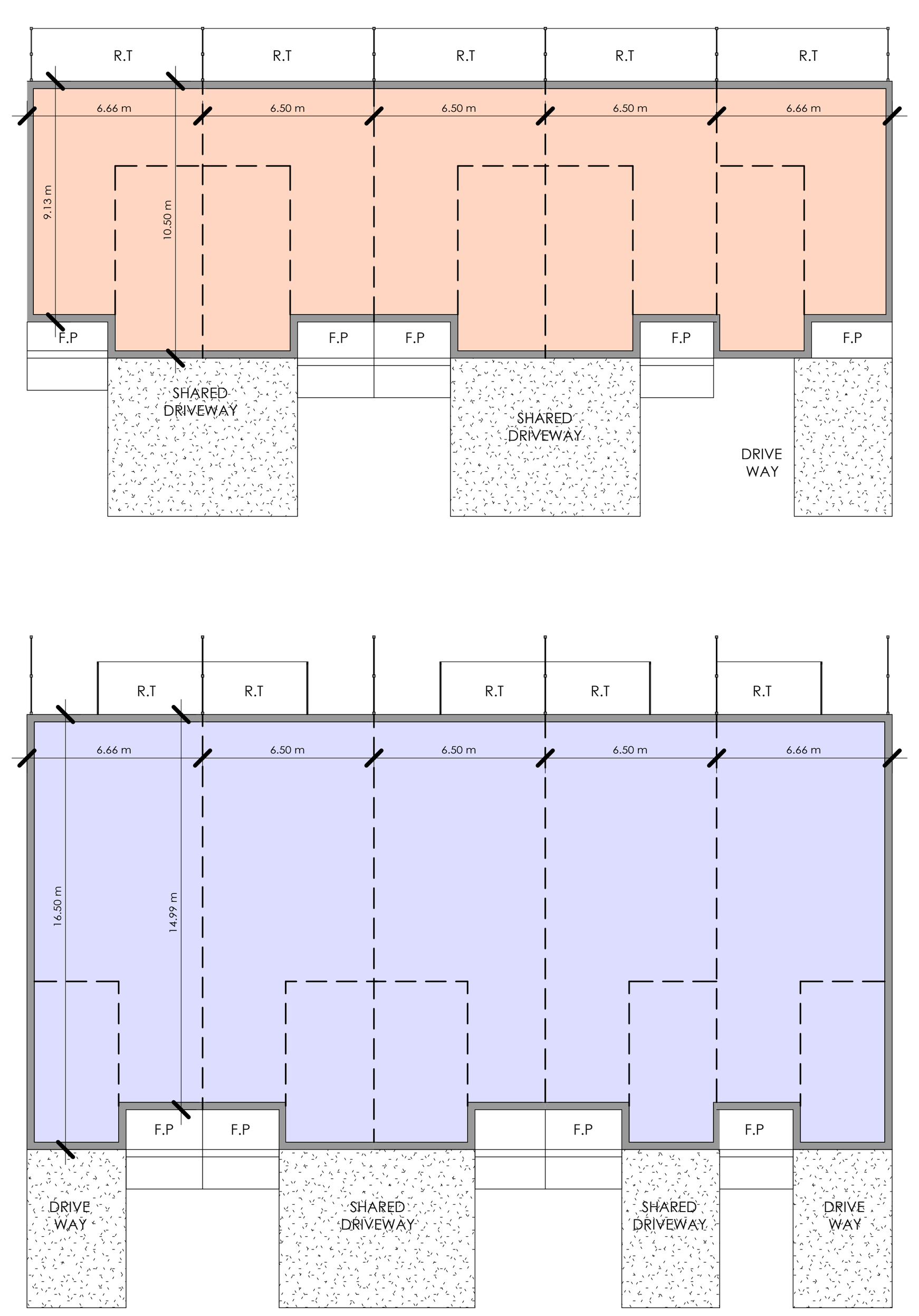
MONTROSE ROAD PROPOSED DEVELOPMENT

6729 MONTROSE ROAD, NIAGARA FALLS, ON

MASTER PLAN

1" = 40'-0"



BLOCK TYPES

1" = 20'-0"

3 STOREY END UNITS

GROUND FLOOR AREA..................................±436 SQFT. (PER UNIT)
MAIN & SECOND FLOOR AREA.....................±709 SQFT. (PER UNIT)
TOTAL GROSS AREA......................................±1,854 SQFT. (PER UNIT)
BUILDING HEIGHT..±11M

3 STOREY MIDDLE UNITS

GROUND FLOOR AREA..................................±427 SQFT. (PER UNIT)
MAIN & SECOND FLOOR AREA.....................±692 SQFT. (PER UNIT)
TOTAL GROSS AREA......................................±1,811 SQFT. (PER UNIT)
BUILDING HEIGHT..±11M

2 STOREY END UNITS

GROUND FLOOR AREA..................................±892 SQFT. (PER UNIT)
SECOND FLOOR AREA................................±1136 SQFT. (PER UNIT)
TOTAL GROSS AREA......................................±2,028 SQFT. (PER UNIT)
BUILDING HEIGHT..±11M

2 STOREY MIDDLE UNITS

GROUND FLOOR AREA..................................±875 SQFT. (PER UNIT)
SECOND FLOOR AREA................................±1,109 SQFT. (PER UNIT)
TOTAL GROSS AREA......................................±1,984 SQFT. (PER UNIT)
BUILDING HEIGHT..±11M

SITE INFORMATION

SITE TOTAL AREA...............................22721 SM
DWELLING TYPE................................ 2 & 3 STOREY TOWNHOMES
TOTAL NUMBER OF UNITS.................91 POTENTIAL ADDITIONAL PARKING.......................6
TOTAL PARKING SPACES...................112 (91 DRIVEWAY & 21 VISITOR)

TOWNHOMES ZONING INFO

MINIMUM LOT FRONTAGE..............................45M
MINIMUM LOT AREA......................................110.45SM per UNIT
MAX LOT COVERAGE..35%
FRONT YARD SETBACK.......................................6.0M
EXTERIOR SIDE YARD SETBACK.........................3.0M
INTERIOR SIDE YARD SETBACK..........................3.0M
MIN. REAR YARD SETBACK...............................4.3M
MAX. BUILDING HEIGHT..................................13.0M

LEGEND

OVERALL PROERTY LINE
SETBACK LINES
DRIVEWAYS
TYPE A 2 STOREY TOWNHOMES
TYPE B 3 STOREY TOWNHOMES
PROPOSED CONCRETE SIDEWALK

NO.	DATE:	REVISION:	BY:
01	DEC 14 2021	SITE PLAN REVISION	SMA

COMMISSION:

MONTROSE ROAD PROPOSED DEVELOPMENT

NIAGARA FALLS, ON

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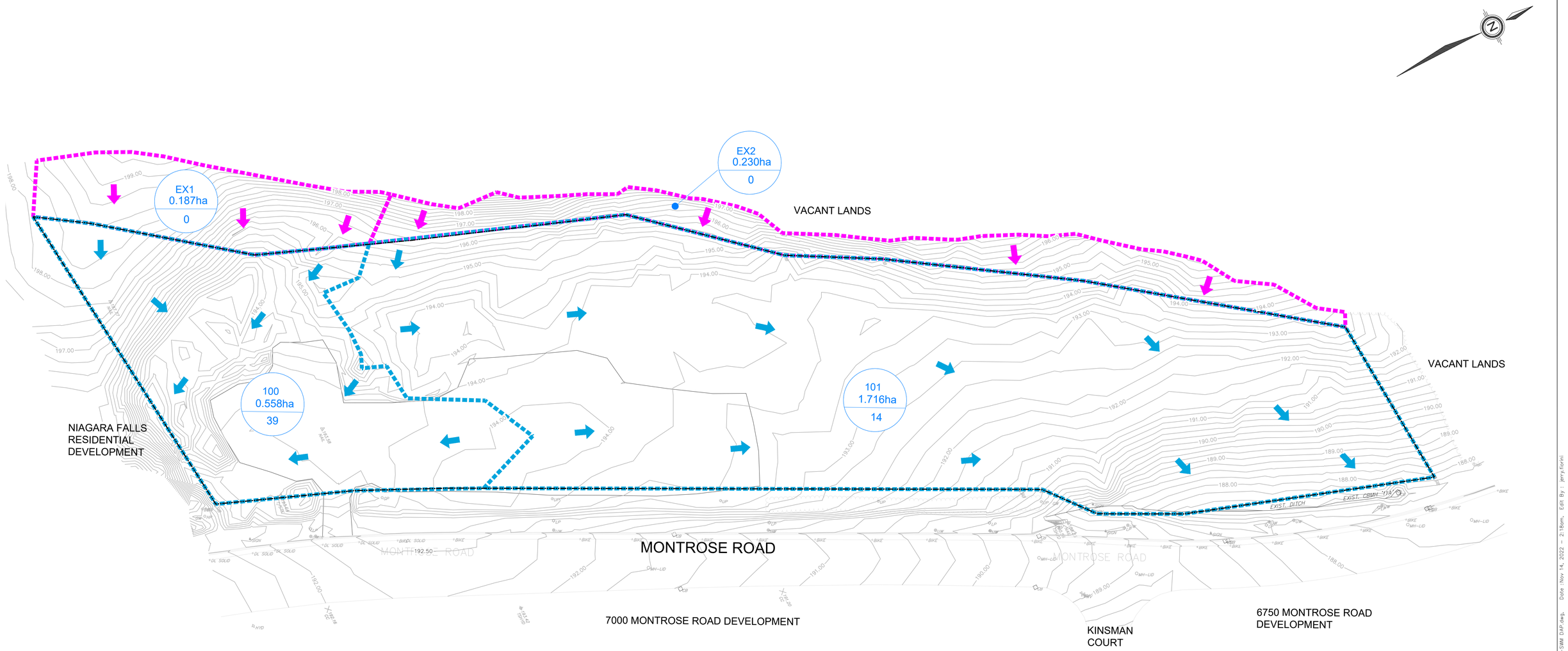
COVER PAGE/ SITE PLAN

Issued for Re-Zoning
Issued for Site Plan Agreement:
Issued for Permit:
Issued for Tender:
Issued for Construction:

DRAWN BY:	SMA	DWG. No.
CHECKED BY:	SMA	SP1
DATE:	JULY 20 2021	
SCALE:	AS SHOWN	
PROJECT No.:	2021-189S	



LEGEND

- EX. CONTOURS
- EXTERNAL OVERLAND FLOW
- OVERLAND FLOW
- EX2 / 0.230ha / 0 — AREA (Ha) / % IMPERVIOUS
- SITE BOUNDARY

PRE-DEVELOPMENT DRAINAGE AREA
MONTROSE ROAD PROPOSED DEVELOPMENT
6729 MONTROSE ROAD,
NIAGARA FALLS, ONTARIO

CLIENT:	GEMINI CORP		
DATE:	NOV. 2022	PROJECT No.:	126319
SCALE:	1:500	FIGURE No.:	3

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File: \\connect.ibigroup.com\LHM\126319_McLeod-Mont\X70_Production\X70_Design\04_Civil\FSR\SHEETS\126319-SWM DMP.dwg, Date: Nov 14, 2022 - 2:18pm, Edit By: jerry.florini

LEGEND

EX. CONTOURS

EXTERNAL OVERLAND FLOW

OVERLAND FLOW

200 / 0.230ha — AREA (Ha)

75 — % IMPERVIOUS

SITE BOUNDARY

POST DEVELOPMENT DRAINAGE AREA

MONTROSE ROAD PROPOSED DEVELOPMENT

6729 MONTROSE ROAD,
NIAGARA FALLS, ONTARIO

CLIENT:	GEMINI CORP.		
DATE:	NOV. 2022	PROJECT No.:	126319
SCALE:	1:500	FIGURE No.:	4

NiagaraFalls CANADA

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tel 905 763 2322 fax 905 763 9983
ibigroup.com

IBI GROUP

PRELIMINARY SANITARY SERVICING PLAN

MONTROSE ROAD PROPOSED DEVELOPMENT

6729 MONTROSE ROAD,
NIAGARA FALLS, ONTARIO

CLIENT:	GEMINI CORP		
DATE:	NOV. 2022	PROJECT No.:	126319
SCALE:	1:500	FIGURE No.:	5

Niagara Falls CANADA

ARCADIS IBI GROUP
Unit 300 – 8133 Warden Avenue
Markham ON L6G 1B3 Canada
tel 905 763 2322 fax 905 763 9983
ibigroup.com

IBI GROUP

LEGEND

- PROP. SANITARY SEWER
- PROP. SAN MANHOLE
- PROP. SANITARY DRAINAGE AREA
- EX. SANITARY SEWER
- EX. SAN MANHOLE
- SITE BOUNDARY
- LIMIT OF CONSTRUCTION
- AREA / UNITS / P/UNIT / POPULATION (0.90 ha, 4, 31, 124)

NOTE:
FIRE WALL NEEDED (MINIMUM 2-HOUR RATING ARE REQUIRED TO BE INSTALLED IN THE MIDDLE OF EACH BLOCK)

LEGEND

200mmØ WATERMAIN	EXISTING 150mmØ WATERMAIN
EXISTING 200mmØ WATERMAIN	EXISTING WATERMAIN TO BE REPLACED
PROPOSED FIRE HYDRANT	SITE BOUNDARY
EX HYD EXISTING FIRE HYDRANT	LIMIT OF CONSTRUCTION

PRELIMINARY WATERMAIN PLAN
MONTROSE ROAD PROPOSED DEVELOPMENT
6729 MONTROSE ROAD,
NIAGARA FALLS, ONTARIO

CLIENT:	GEMINI CORP.		
DATE:	NOV. 2022	PROJECT No.:	126319
SCALE:	1:500	FIGURE No.:	6

NiagaraFalls CANADA

ARCADIS
IBI GROUP
ARCADIS IBI GROUP
Unit 300 – 8133 Warden Avenue
Markham ON L6G 1B3 Canada
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LEGEND	
EX. CONTOURS	UNCONTROLLED OVERLAND FLOW
PROPOSED STORM SEWER	OVERLAND FLOWING
STORM DRAINAGE AREA	

0.70 / 0.35ha — RUNOFF COEFFICIENT AREA (ha)

SITE BOUNDARY
LIMIT OF CONSTRUCTION
EXISTING STORM

PRELIMINARY STORM SERVICING PLAN
MONTROSE ROAD PROPOSED DEVELOPMENT
6729 MONTROSE ROAD,
NIAGARA FALLS, ONTARIO

CLIENT:	GEMINI CORP.		
DATE:	NOV. 2022	PROJECT No.:	126319
SCALE:	1:500	FIGURE No.:	7

Niagara Falls CANADA

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IBI GROUP

LEGEND

EX. CONTOURS	4.0% SLOPE ARROW	SITE BOUNDARY	
× 335.24 EX EX. ELEVATION	TRANSITION SLOPE	OVERLAND FLOW	
× 331.25 PROP. ELEVATION	PROP. CATCHBASIN/RLCB	LIMIT OF CONSTRUCTION	

PRELIMINARY GRADING PLAN

MONTROSE ROAD PROPOSED DEVELOPMENT

6729 MONTROSE ROAD,
NIAGARA FALLS, ONTARIO

CLIENT:	GEMINI CORP.		
DATE:	NOV. 2022	PROJECT No.:	126319
SCALE:	1:250	FIGURE No.:	8-1

Niagara Falls CANADA

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Markham ON L6G 1B3 Canada
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IBI GROUP

PRELIMINARY GRADING PLAN

MONTROSE ROAD PROPOSED DEVELOPMENT

6729 MONTROSE ROAD,
NIAGARA FALLS, ONTARIO

CLIENT:	GEMINI CORP.		
DATE:	NOV. 2022	PROJECT No.:	126319
SCALE:	1:250	FIGURE No.:	8-2

NiagaraFalls CANADA

ARCADIS IBI GROUP

ARCADIS IBI GROUP
Unit 300 – 8133 Warden Avenue
Markham ON L6G 1B3 Canada
tel 905 763 2322 fax 905 763 9983
ibigroup.com

LEGEND

Symbol	Description	Symbol	Description	Symbol	Description
	EX. CONTOURS	4.0%	SLOPE ARROW		SITE BOUNDARY
× 335.24 EX	EX. ELEVATION		TRANSITION SLOPE		OVERLAND FLOW
× 331.25	PROP. ELEVATION		PROP. CATCHBASIN/RLCB		LIMIT OF CONSTRUCTION

Appendix B

Sanitary Calculations

B1 – Sanitary Design Sheet
B2 – Existing Sanitary Drainage Plan and Design Sheet

Minimum Dia. = 200 mm

Mannings "n"= 0.013

Minimum Velocity = 0.60 m/s

Minimum Grade = 0.50 %

Avg. Domestic Flow = 450 l/c/d

Infiltration = 0.28 l/s/ha

Max. Peaking Factor= 5.0

Min. Peaking Factor= 2.0

Maximum Velocity = 3.00 m/s

SANITARY SEWER DESIGN SHEET

Project - 6729 Montrose Road Development

City of Niagara Falls

Niagara Regional

Project: Montrose Residential Development

Project No: 126319

Date: July 26, 2022

Designed by: J.C.F.

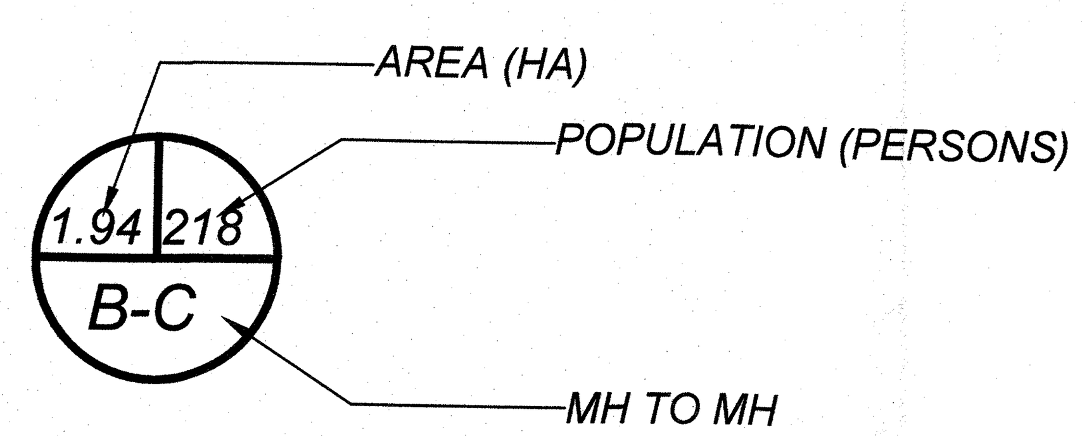
NOMINAL PIPE SIZE USED

\\caneast.ibigroup.com\J\HM\126319_McLeod-Montr\7.0_Production\7.03_Design\04_Civil\FSR\REPORT\design sheets\san\[126319_Mcleod-Montrose_SAN_FSR.xls]Design

STREET	FROM MH	TO MH	RESIDENTIAL							MEDIUM DENSITY					FLOW CALCULATIONS						PIPE DATA				
			AREA (ha)	ACC. AREA (ha)	UNITS (#)	DENISTY (P/ha)	DENSITY (P/unit)	POP	ACC. RES. POP.	AREA (ha)	ACC. AREA (ha)	EQUIV. POP. (p/ha)	FLOW RATE (l/s/ha)	ACC. EQUIV. POP.	INFILTRATION (l/s)	TOTAL ACC. POP.	PEAKING FACTOR	RES. FLOW (l/s)	COMM. FLOW (l/s)	TOTAL FLOW (l/s)	DIA. (mm)	SLOPE (%)	Q FULL (l/s)	V FULL (m/s)	V ACT (m/s)
Private Laneway	MH01A	MH03A	0	0.00	8		3.00	24	24	0	0	0	0	0	0.00	24	5.00	0.63	0.0	0.63	200	1.00	32.8	1.04	0.39
Private Laneway	MH02A	MH03A	0	0.00	2		3.00	6	6	0	0	0	0	0	0.00	6	5.00	0.2	0.0	0.16	200	1.00	32.8	1.04	0.23
Private Laneway	MH03A	MH13A	0	0.00	0		3.00	0	30	0	0	0	0	0	0.00	30	5.00	0.8	0.0	0.78	200	1.00	32.8	1.04	0.42
Private Laneway	MH13A	MH04A	0	0.00	2		3.00	6	36	0	0	0	0	0	0.00	36	5.00	0.9	0.0	0.94	200	1.00	32.8	1.04	0.44
Private Laneway	MH04A	MH05A	0	0.00	29		3.00	87	123	0	0	0	0	0	0.00	123	5.00	3.2	0.0	3.20	200	0.50	23.2	0.74	0.52
Private Laneway	MH05A	MH06A	0	0.00	27		3.00	81	204	0	0	0	0	0	0.00	204	5.00	5.3	0.0	5.31	200	0.50	23.2	0.74	0.59
Private Laneway	MH06A	MH07A	0	0.00	5		3.00	15	219	0	0	0	0	0	0.00	219	5.00	5.7	0.0	5.70	200	1.00	32.8	1.04	0.78
Private Laneway	MH10A	MH09A	0	0.00	2		3.00	6	6	0	0	0	0	0	0.00	6	5.00	0.2	0.0	0.16	200	1.00	32.8	1.04	0.23
Private Laneway	MH09A	MH08A	0	0.00	15		3.00	45	51	0	0	0	0	0	0.00	51	5.00	1.3	0.0	1.33	200	1.00	32.8	1.04	0.49
Private Laneway	MH08A	MH07A	0	0.00	1		3.00	3	54	0	0	0	0	0	0.00	54	5.00	1.4	0.0	1.41	200	0.50	23.2	0.74	0.40
Private Laneway	MH07A	MH12A	0	0.00	0		3.00	0	273	0	0	0	0	0	0.00	273	5.00	7.1	0.0	7.11	200	2.00	46.4	1.48	1.06
Private Laneway	MH12A	EX. MH D	2.27	2.27	0		3.00	0	273	0	0	0	0	0	0.64	273	5.00	7.1	0.0	7.74	200	0.95	32.0	1.02	0.83

DR02

LEGEND



NO.	REVISION	DATE	INIT.
B	ISSUED FOR MOE REVIEW	2019/01/09	Y.W.
A	ISSUED FOR REVIEW	2017/01/26	Y.W.

NOTES/LEGEND

1 THE POSITION OF POLE LINES, CONDUITS, WATERMAINS, SEWER AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS AND, WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

CAD R.B./R.C.
DESIGN Y.W.
CHECKED BY M.S.
APPROVED BY N.B.

LICENSED PROFESSIONAL ENGINEER
Y. WENG
100110138
9/1/19
PROVINCE OF ONTARIO

PARSONS

RN-16-
ROAD RECONSTRUCTON AND WIDENING
REGIONAL ROAD 98 (MONTROSE ROAD)
NIAGARA FALLS
SANITARY AREA PLAN

CONSULTANT FILE No. 603119
DATE 2017/01/26
SCALE 1:1250
REF. No.
DWG No. DR02
REV. B

RECEIVED BY
MAR 15 2019
PLANNING AND DEVELOPMENT SERVICES

Parsons Inc.

SANITARY SEWER DESIGN SHEET (Metric)

Region of Niagara

Project Name: Montrose Rd Improvement
Project No.: 603119
Date: 9-Jan-19

Infiltration Factor (l/s/ha): 0.286
Consumption (l/pp/day): 450

Infiltration: 0.286 per sec per ha

LOCATION	FROM MH	TO MH	Commercial Area Incr. (ha)	Commercial Area Persons/ha	Residential Areas Incr. (ha)	Residential Areas Persons/ha	Total Area Incr. (ha)	Total Area Accum. (ha)	Population Incr.	Population Total	Peaking Factor M	Average Q L/s Increment	Peak Q L/s Total	Infiltration (L/s)	Total Flow (L/s)	Total Flow (m^3/s)	n	PROPOSED SEWER Size (mm)	Slope %	Capacity (m^3/s)	Length in metres	Velocity (m/s) Full	Velocity (m/s) Actual	Drop in MH	US MH	DSMH	% Cap
																	0.013	250	0.50	0.042	100.0	0.86	0.00	0.03	185.55	185.05	0
	A	B			2.460	135.000	2.460	2.460	332	332	4.059	1.73	7.02	0.70	7.72	0.0077	0.013	250	0.50	0.042	61.1	0.86	0.81	0.03	185.02	184.71	18
	B	C	1.880	90.000	1.480	135.000	3.360	5.82	369	701	3.894	3.65	14.22	1.66	15.88	0.0159	0.013	250	0.50	0.042	150.0	0.86	1.00	0.03	184.68	183.93	38
	C	D	1.700	90.000			1.700	7.520	153	854	3.843	4.45	17.10	2.15	19.25	0.0192	0.013	250	0.50	0.042	117.9	0.86	1.05	0.03	183.90	183.31	46
	D	Ex.MH					0.000	7.520	0	854	3.843	4.45	17.10	2.15	19.25	0.0192	0.013	250	0.50	0.042	47.4	0.86	1.05	0.06	183.25	183.02	46

File: Montrose san Aug 7 18 Developer.xlsx
Designed By: JE
Print Date: 2/21/2019

Appendix C

Storm Calculations

C1 – Storm Design Sheet
C2 – Existing Storm Drainage Plan and Design Sheet

100 yr Storm Sewer Design Sheet
City of Niagara Falls
Niagara Region

ARCADIS

IBI GROUP

Project: Montrose Residential Development
Project No: 126319
Date: Aug. 15, 2022
Designed by J.C.F.

Rainfall Intensity = $\frac{A}{(Tc+B)^c}$

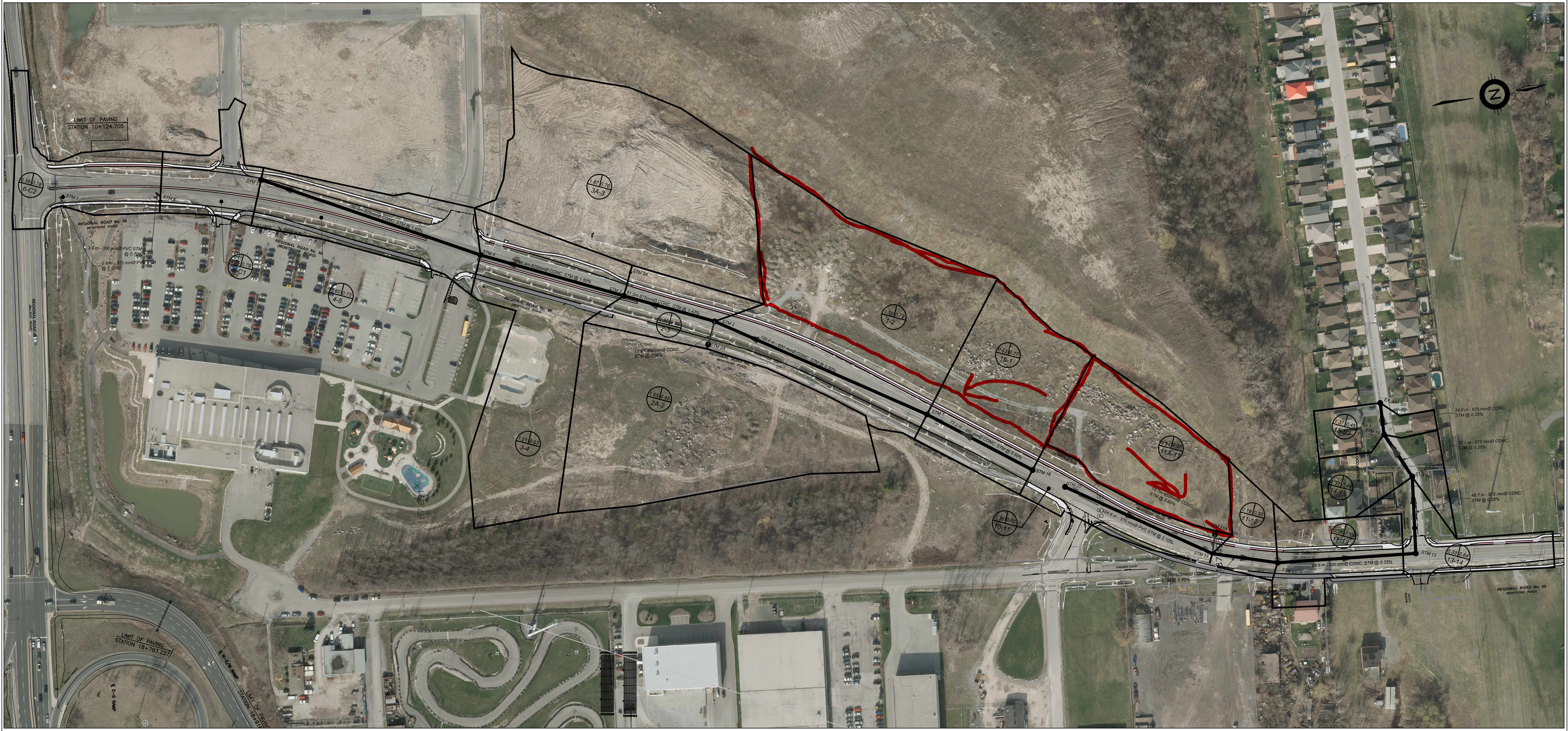
5-YEAR		100-YEAR
A=	719.5	A= 1264.67
B=	6.34	B= 7.72
c=	0.769	c= 0.781

Starting Tc = 10 min

File Location: \\caneast.ibigroup.com\J\HM\126319_McLeod-Montr\7.0_Production\7.03_Design\04_Civil\FSR\REPORT\design sheets\stm\[126319_McLeod-Montr_STM_FSR-20220815.xls]PRESENTATION

STREET	FROM MH	TO MH	5-YR AREA (ha)	5-YR RUNOFF COEFFICIENT "R"	5-YR "AR"	5-YR ACCUM. "AR"	TIME OF CONCENTRATION (min)	5-YR RAINFALL INTENSITY (mm/hr)	5-YR ACCUM. FLOW (m^3/s)	100-YR AREA (ha)	100-YR RUNOFF COEFF. "R"	100-YR "AR"	100-YR ACCUM. "AR"	100-YR RAINFALL INTENSITY (mm/hr)	100-YR ACCUM. FLOW (m^3/s)	Control Flow	Total Flow (m^3/s)	PIPE LENGTH (m)	PIPE SLOPE (%)	PIPE DIAMETER (mm)	FULL FLOW CAPACITY (m3/s)	FULL FLOW VELOCITY (m/s)	TIME OF TRAVEL (min)	ACCUMULATED TIME (min)	% FULL FLOW (%)	COMMENT
Private Lane	*STM 01*	*STM 02*	*0.00*	*0.53*	*0.000*	*0.000*	*10.00*	*84.02*	*0.000*	*0.450*	*0.765*	*0.344*	*0.344*	*133.791*	*0.128*	*100-yr*	*0.128*	*43.8*	*1.00*	*375*	*0.175*	*1.587*	*0.46*	*10.46*	*73%*	
Private Lane	*STM 05*	*STM 02*	*0.00*	*0.70*	*0.000*	*0.000*	*10.00*	*84.02*	*0.000*	*0.130*	*0.850*	*0.111*	*0.111*	*133.791*	*0.041*	*100-yr*	*0.041*	*33.3*	*0.50*	*300*	*0.068*	*0.967*	*0.57*	*10.57*	*60%*	
Private Lane	*STM 02*	*STM 07*	*0.00*	*0.67*	*0.000*	*0.000*	*10.57*	*81.82*	*0.000*	*0.590*	*0.835*	*0.493*	*0.947*	*130.501*	*0.343*	*100-yr*	*0.343*	*105*	*0.50*	*600*	*0.434*	*1.536*	*1.14*	*11.71*	*79%*	
Private Lane	*STM 07*	*STM 08*	*0.00*	*0.66*	*0.000*	*0.000*	*11.71*	*77.82*	*0.000*	*0.760*	*0.830*	*0.631*	*1.578*	*124.482*	*0.546*	*100-yr*	*0.546*	*100*	*0.50*	*750*	*0.787*	*1.782*	*0.94*	*12.65*	*69%*	
Private Lane	*STM 08*	*STM 09*	*0.00*	*0.60*	*0.000*	*0.000*	*12.65*	*74.86*	*0.000*	*0.230*	*0.800*	*0.184*	*1.762*	*119.992*	*0.587*	*100-yr*	*0.587*	*33.9*	*0.50*	*750*	*0.787*	*1.782*	*0.32*	*12.97*	*75%*	
Private Lane	*STM 12*	*STM 09*	*0.00*	*0.70*	*0.000*	*0.000*	*10.00*	*84.02*	*0.000*	*0.090*	*0.850*	*0.077*	*0.077*	*133.791*	*0.028*	*100-yr*	*0.028*	*33.75*	*1.00*	*300*	*0.097*	*1.368*	*0.41*	*10.41*	*29%*	
Private Lane	*STM 09*	*STORAGE*	*0.00*	*0.70*	*0.000*	*0.000*	*12.97*	*73.91*	*0.000*	*0.240*	*0.850*	*0.204*	*2.043*	*118.553*	*0.673*	*100-yr*	*0.673*	*57.2*	*0.50*	*750*	*0.787*	*1.782*	*0.54*	*13.50*	*85%*	
Private Lane	*DICB*	*STORAGE*	*0.00*	*0.50*	*0.000*	*0.000*	*10.00*	*84.02*	*0.000*	*0.100*	*0.750*	*0.075*	*0.075*	*133.791*	*0.028*	*100-yr*	*0.028*	*6*	*5.00*	*300*	*0.216*	*3.059*	*0.03*	*10.03*	*13%*	

DR01



LEGEND

- AREA (HA)
- RUNOFF COEFFICIENT
- MH TO MH

(1.94 | 0.70 / 1-2)

GEOGRAPHIC PROJECTION: U.T.M. NAD 83 ZONE 17
VERTICAL MONUMENT: Vertical Monument description XXXXXXXXXX ELEV. ###.###
DATUM: DATUM description XXXXXXXXXX ELEV. ###.###

DWG NAME:
FILE FORMAT: Autodesk Land Desktop 2004

BOUNDING COORDINATES UPPER LEFT: Northing Easting BOUNDING COORDINATES UPPER RIGHT: Northing Easting BOUNDING COORDINATES LOWER LEFT: Northing Easting BOUNDING COORDINATES LOWER RIGHT: Northing Easting

IMAGES:

X-REFERENCES:

APPROVALS
MOE YYYY/MM/DD
MTO YYYY/MM/DD
REGION YYYY/MM/DD
CNR YYYY/MM/DD
CPR YYYY/MM/DD

UTILITIES
NRBN YYYY/MM/DD
CNP YYYY/MM/DD
LOCAL HYDRO YYYY/MM/DD
ONTARIO HYDRO YYYY/MM/DD
GAS YYYY/MM/DD
BELL YYYY/MM/DD
CATV YYYY/MM/DD

NO.	REVISION	DATE	INIT.
B	ISSUED FOR MOE REVIEW	2018/12/05	Y.W.
A	ISSUED FOR REVIEW	2017/01/26	Y.W.

NOTES/LEGEND

1 THE POSITION OF POLE LINES, CONDUITS, WATERMAINS, SEWER AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS AND, WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

CAD R.B./R.C.
DESIGN Y.W.
CHECKED BY XX
APPROVED BY XX

LICENSED PROFESSIONAL ENGINEER
Y. WENG
100110138
5/12/18
PROVINCE OF ONTARIO

PARSONS

RN-16-
ROAD RECONSTRUCTON AND WIDENING
REGIONAL ROAD 98 (MONTROSE ROAD)
NIAGARA FALLS
DRAINAGE AREA PLAN

CONSULTANT FILE No.	603119
DATE	2017/01/26
SCALE	1:2500
REF. No.	
DWG No.	DR01
REV.	B

STORM SEWER DESIGN SHEET (Metric)

Project Name: Montrose Rd Improvement
Project No.: 603119
Date: Aug 7 18

Region of Niagara

Q peak flow in litres per second (L/s)
A area in hectares (ha)
I rainfall intensity in millimetres per hour (mm/h)
R runoff coefficient

	a	b	c
5yr	**719.500**	**6.340**	**0.7687**
2yr	521.970	5.280	0.7588
10yr	577.930	2.483	0.6690
25yr	1020.690	7.290	0.7777
100yr	1264.670	7.720	0.7814

$I = a / (t + b)^{c}$

north area

south area

Location			Area (ha)								Incretment Area	Composite R	indiv 2.78 AR	Accum 2.78 AR	Time of Conc.	Rainfall Intensity I	Peak Flow Q (L/s)	SEWER DATA							
Street	From	To	R = 0.20	R = 0.30	R = 0.45	R= 0.50	R = 0.55	R = 0.70	R = 0.85	R = 0.90								Diam (mm)	Slope (%)	Length (m)	Capacity (L/s) n = .013	Volume (m^3)	Velocity (m/s)	Time of Flow (minutes)	Capacity Check
Monstrose Rd	***STMH 11A***	***STMH 11***							***0.71***		***0.71***	***0.85***	***1.68***	***1.68***	***10.00***	***84.0***	***141***	***450***	***0.50***	***15.3***	***202***	***2***	***1.27***	***0.20***	***70%***
Monstrose Rd	***STMH 10***	***STMH 11***						0.36			***0.36***	***0.70***	***0.70***	0.70	10.00	84.0	59	375	2.10	104.6	***254***	***12***	***2.30***	0.76	***23%***
Monstrose Rd	***STMH 11***	***STMH 12***		0.13						0.06	***0.19***	***0.50***	***0.27***	2.64	10.76	81.1	215	525	0.40	42.7	***272***	***9***	***1.26***	0.57	***79%***
Monstrose Rd	***STMH 12***	***STMH 13***		0.23						0.16	***0.39***	***0.55***	***0.59***	3.23	11.32	79.1	256	600	0.25	89.5	***307***	***25***	***1.09***	1.37	***83%***
Monstrose Rd	***STMH 13***	***STMH 14***		***0.14***						***0.19***	***0.33***	***0.64***	***0.59***	3.82	12.70	74.7	285	675	0.25	49.7	***420***	***18***	***1.17***	0.71	***68%***
Charnwood Ave	***STMH 14***	***STMH 17***			***0.31***						***0.31***	***0.45***	***0.39***	4.21	13.40	***72.7***	***306***	675	***0.25***	***8.1***	***420***	***3***	***1.17***	***0.11***	***73%***
Charnwood Ave	***STMH 17***	***STMH 15***												4.21	13.52	***72.3***	***304***	675	***0.25***	***24.6***	***420***	***9***	***1.17***	***0.35***	***72%***
Charnwood Ave	***STMH 15***	***EX. MH 'S3'***			***0.18***						***0.18***	***0.45***	***0.23***	4.43	13.87	***71.4***	***316***	675	***0.25***	***20.0***	***420***	***7***	***1.17***	***0.28***	***75%***
Charnwood Ave	*EX. MH 'S3'*	*EX. MH 'S4'*			*0.63*						*0.63*	*0.45*	*0.79*	5.22	14.15	*70.6*	*369*	*675*	*0.25*	*80.0*	*420*	*29*	*1.17*	*1.14*	*88%*
Charnwood Ave	*EX. MH 'S4'*	*EX. MH 'S5'*			*0.90*						*0.90*	*0.45*	*1.13*	6.35	15.29	*67.7*	*430*	*675*	*0.35*	*110.0*	*497*	*39*	*1.39*	*1.32*	*86%*
Charnwood Ave	*EX. MH 'S5'*	*EX. MH 'S6'*			*0.96*						*0.96*	*0.45*	*1.20*	7.55	16.61	*64.7*	*489*	*750*	*0.25*	*109.0*	*557*	*48*	*1.26*	*1.44*	*88%*
Charnwood Ave	*EX. MH 'S9'*	*EX. MH 'S6'*			*0.47*						*0.47*	*0.45*	*0.59*	0.59	10.00	*84.0*	*49*	*375*	*0.40*	*81.5*	*111*	*9*	*1.00*	*1.35*	*45%*
Charnwood Ave	*EX. MH 'S6'*	*EX. MH 'S7'*									*0.00*		*0.00*	8.14	18.05	*61.8*	*503*	*750*	*0.31*	*58.0*	*620*	*26*	*1.40*	*0.69*	*81%*
Charnwood Ave	*EX. MH 'S7'*	*EX. MH 'S8'*			*0.70*						*0.70*	*0.45*	*0.88*	9.01	18.74	*60.5*	*545*	*750*	*0.35*	*55.0*	*659*	*24*	*1.49*	*0.61*	*83%*
Monstrose Rd	***STMH 16***	***STMH 1***		***0.1335***					***0.55***	***0.1487***	***0.83***	***0.77***	***1.78***	***1.78***	***10.00***	***84.0***	***150***	***450***	***0.50***	***77.2***	***202***	***12***	***1.27***	***1.02***	***74%***
Monstrose Rd	***STMH 1***	***STMH 2***		***0.2199***					***1.15***	***0.3341***	***1.70***	***0.79***	***3.74***	***3.74***	***10.00***	***84.0***	***314***	***600***	***0.50***	***150.0***	***434***	***42***	***1.54***	***1.63***	***72%***
Monstrose Rd	***STMH 2A***	***STMH 2***							***1.65***		***1.65***	***0.85***	***3.90***	***3.90***	***10.00***	***84.0***	***328***	***600***	***0.50***	***15.3***	***434***	***4***	***1.54***	***0.17***	***75%***
Monstrose Rd	***STMH 2***	***STMH 3***						***0.30***			***0.30***	***0.70***	***0.58***	***8.22***	***11.63***	***78.1***	***642***	***675***	***1.02***	***61.1***	***849***	***22***	***2.37***	***0.43***	***76%***
Monstrose Rd	***STMH 3A***	***STMH 3***						***1.87***			***1.87***	***0.70***	***3.64***	***3.64***	***10.00***	***84.0***	***306***	***600***	***0.50***	***15.7***	***434***	***4***	***1.54***	***0.17***	***70%***
Monstrose Rd	***STMH 3***	***STMH 4***		***0.7886***				***1.77***		***0.3881***	***2.95***	***0.62***	***5.07***	***16.93***	***12.06***	***76.7***	***1299***	***825***	***1.50***	***96.4***	***1758***	***52***	***3.29***	***0.49***	***74%***
Monstrose Rd	***STMH 4***	***STMH 5***		***0.1665***						***0.4345***	***0.60***	***0.73***	***1.23***	***18.16***	***12.55***	***75.2***	***1365***	***825***	***1.65***	***150.0***	***1844***	***80***	***3.45***	***0.72***	***74%***
Monstrose Rd	***STMH 6***	***Culvert 1***		***0.0529***						***0.2400***	***0.29***	***0.79***	***0.64***	***0.64***	***10.00***	***84.0***	***54***	***300***	***0.70***	***3.9***	***81***	***4***	***1.14***	***0.06***	***67%***
Monstrose Rd	***STMH 7***	***Culvert 2***		***0.0923***						***0.3581***	***0.45***	***0.78***	***0.97***	***0.97***	***10.00***	***84.0***	***82***	***375***	***0.50***	***2.4***	***124***	***2***	***1.12***	***0.04***	***66%***

Appendix D

Water Demand Calculations

D1 – Estimated Water Demand
D2 – Water Meter Chamber Details

HYDRANT FLOW TESTING

NOTE:Hydrants tested according to NFPA 291: Recommended Practice for Fire Flow Testing and Marking of Hydrants

GENERAL INFORMATION

General Information

Date of Testing	07-Jul-22
Project Number:	126319
Site Location / Address:	6729 Montrose Rd
Region / Municipality	Niagara
Hydrants Opened By:	Niagara Region
Tested by:	Daniel S Val V

HYDRANT TEST INFORMATION

Hydrant Test Location - Residual Hydrant=R, Flow Hydrant=F (North at Top)

.

Test Data

Time of Test	9:05 AM
Pipe Size (mm)	150/200
Flow Hydrant Test Location (description)	6729 Montrose Rd
Residual Hydrant Test Location (description)	6750 Montrose Rd
Static Pressure(PSIG)	84

Q1 Test Data (1 Orifice)

# OUTLETS	ORIFICE SIZE(IN)	PITOT PRESSURE(PSIG)	FLOW(USGPM)	RESIDUAL PRESSURE(PSIG)
1	2.5	42	1087	76

QT Test Data (2 Orifices)

# OUTLETS	ORIFICE SIZE(IN)	PITOT PRESSURE(PSIG)	FLOW(USGPM)	RESIDUAL PRESSURE(PSIG)
2	2.5	25	1678	70

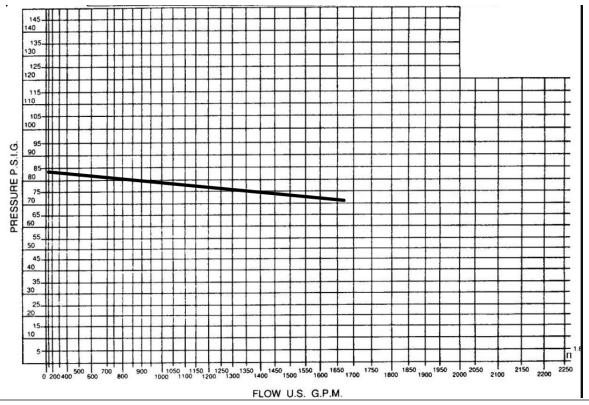
Calculations

FORMULA: Q= 29.83 cd^2√p.....Where: c- coefficient of discharge (1 in smooth pipe)
..... d- pipe diameter (inches)
.....p- pitot reading (psig)

Q1 - 1 Orifice(s)	Q1= (29.83)(0.9)(2.5)^2 √42=1087
QT - 2 Orifice(s)	QT= 2(29.83)(0.9)(2.5)^2 √25=1678
Static Pressure(PSIG)	84

Test Results - Plot

Plot



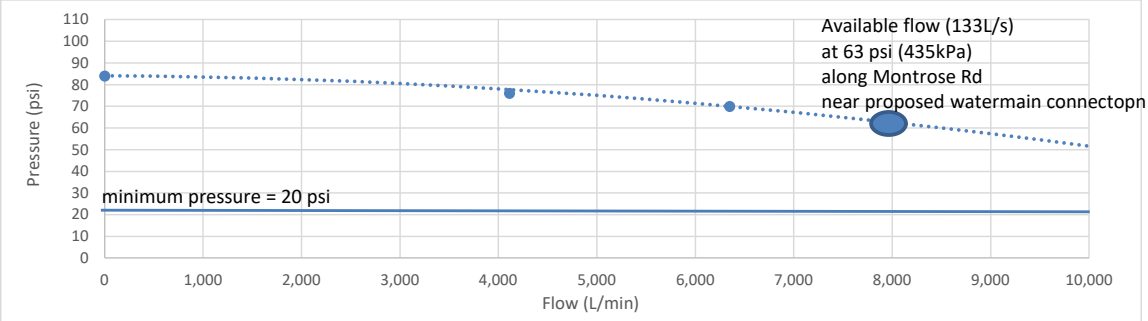
WATER SYSTEM PRESSURE

Project:	6729 Montrose Road, Niagara Falls	Proj.#	126319
Date:	Aug-22		
Calc'ed by:	SK		

Hydrant Flow Test Results

Flow Hydrant Test Location:	6729 Montrose Rd	
Residual Hydrant Test Location:	6750 Montrose Rd	
Main Size:	150mm/200mm Dia.	Test Time: 9:05 AM
Test Date:	07-Jul-20	
Tested By:	Val V, Daniel S	

Number of Outlets & Orifice Size	Pilot Pressure (psi)	Flow (US GPM)	Flow (L/min)	Residual Pressure (psi)
0	0	0	0	84
1 x 2.5"	42	1,087	4,115	76
2 x 2.5"	25	1,678	6,352	70



$$Q_R = \mathrm{Q_T}\left(\frac{\mathrm{P_S} - \mathrm{Pr}}{\mathrm{P_S} - \mathrm{Pt}}\right)\text{^}0.54$$

Where,

Q_r = Projected Flow Rate

Q_t = Flow Rate from Flow Test = 6352 L/min

P_s = Static Pressure = 84 psi

P_r = Desired System Pressure

P_t = Residual Presure inTest = 70 psi

Pressure Under Fire Suppression (P_{r1}) =	20.0	psi	
Calculated Flow Rate (Q_{r1}) =	14,432	L/min	3,813 USGPM
Pressure Under Normal Operation (P_{r2}) =	40.0	psi	
Calculated Flow Rate (Q_{r2}) =	11,789	L/min	3,114 USGPM

6729 Montrose Road

Residential Development

DOMESTIC WATER DEMAND CALCULATIONS

Project Name: 6729 Montrose Road
Project Number: 126319
Date: August 15, 2022
Designed By: SK

1. Based on the City of Toronto Standards and
2. ADD = 300 L/cap/day for residential uses

Peaking Factors		
Land Use	Peak Hour	Maximum Day
Residential (Apartments)	4.0	1.6

					(ADDxP.F.)	*(ADDxP.F.)*
Building	Units / Area	Density	Population	ADD (L/s)	PHD (L/s)	MDD (L/s)
-	91 units	3.0 pp/unit	273	2.0	8.0	4.0

6729 Montrose Road

Residential Development

FIRE FLOW DEMAND CALCULATIONS
2 Storey Townhouse Block

Project Name: 6729 Montrose Road
Project Number: 126319
Date: August 15, 2022
Designed By: SK

Based on the Water Supply for Public Fire Protection Manual, 1999 by the Fire Underwriters Survey

Step 1: Calculate Fire Flow (based on area)

Construction Coefficient =	1.5	
Largest Floor Area =		m2
Floor Above =		m2
Floor Below =		m2
Area =	566	m2
Fire Flow (F) =	**8,000**	L/min

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

F = required fire flow (L/min)
C = coefficient related to type of construction
0.6 for fire resistive (fully protected, 3-hr ratings)
0.8 for non combustible (i.e. unprotected metal buildings)
1.0 for ordinary construction
1.5 for wood frame construction
A = total floor area excluding basements 50% below grade

	3 Storey	2 Storey	
Each unit (ft2)	1854	2028	
Total Area(m2)	862	943	5 units
Total Area(m2)	1034	1131	6 units
Total Area(m2)	517	566	3 units

** If vertical openings are inadequately protected, consider two largest two largest adjoining floors plus 50% of each of any floors above up to eight floors.*
** If vertical openings are adequately protected (one hour rating), consider largest floor area + 25% of two immediately floors.*

Step 2: Adjustment for Building Occupancy (shall not be less than 2000 L/s)

Occupancy Adjustment =	-25%	Non-Combust.	-25%	Free Burning	15%
F_1 = Fire Flow x Adjustment =	**6000** L/min	Limited Comb.	-15%	Rapid Burning	25%
		Combustible	No change		

Step 3: Adjust F1 for Fire Suppression System

Sprinkler Adjustment =	0%	Automatic Sprinklers (monitored)	-50%
$F_2 = F_1$ x Adjustment =	**0** L/min	Adequately Designed System	-30%

Step 4: Adjust F1 for Exposure / Proximity (shall not exceed 75%)

Proximity Adjustment =	40%	(max 75%)
$F_3 = F_1$ x Factor =	**2,400**	L/min

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

East	>3m	20%
North	>45 m	0%
west	Fire Wall	10%
south	>20m	10%
	sub-total	40%

Step 5: Calculate Adjusted Fire Flow (shall not be less than 2000 L/min or greater than 45,000 L/min)

F_1 =	6,000	L/min
- F_2 =	0	L/min
+ F3 =	2,400	L/min
Fire Flow =	8,000	L/min
Fire Flow =	**133**	L/s
Total Demand (Fire Flow + MDD) =	**137**	L/s

$$\text{Fire Flow} = F_1 - F_2 + F_3$$

Checks:
Fire Flow greater than 2000 L/min
Fire Flow less than 45,000 L/min

6729 Montrose Road
Residential Development

IBI

FIRE FLOW DEMAND CALCULATIONS
3 Storey Townhouse Block

Project Name: 6729 Montrose Road
Project Number: 126319
Date: August 15, 2022
Designed By: SK

Based on the Water Supply for Public Fire Protection Manual, 1999 by the Fire Underwriters Survey

Step 1: Calculate Fire Flow (based on area)

Construction Coefficient =	1.5	
Largest Floor Area =		m2
Floor Above =		m2
Floor Below =		m2
Area =	517	m2
Fire Flow (F) =	**8,000**	L/min

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

F = required fire flow (L/min)
C = coefficient related to type of construction
0.6 for fire resistive (fully protected, 3-hr ratings)
0.8 for non combustible (i.e. unprotected metal buildings)
1.0 for ordinary construction
1.5 for wood frame construction
A = total floor area excluding basements 50% below grade

	3 Storey	2 Storey	
Each unit (ft2)	1854	2028	
Total Area(m2)	862	943	5 units
Total Area(m2)	1034	1131	6 units
Total Area(m2)	517	566	3 units

** If vertical openings are inadequately protected, consider two largest two largest adjoining floors plus 50% of each of any floors above up to eight floors.*

** If vertical openings are adequately protected (one hour rating), consider largest floor area + 25% of two immediately floors.*

Step 2: Adjustment for Building Occupancy (shall not be less than 2000 L/s)

Occupancy Adjustment =	-25%	
F_1 = Fire Flow x Adjustment =	**6000**	L/min

Non-Combust.	-25%	Free Burning	15%
Limited Comb.	-15%	Rapid Burning	25%
Combustible	No change		

Step 3: Adjust F1 for Fire Suppression System

Sprinkler Adjustment =	0%	
$F_2 = F_1$ x Adjustment =	**0**	L/min

Automatic Sprinklers (monitored)	-50%
Adequately Designed System	-30%

Step 4: Adjust F1 for Exposure / Proximity (shall not exceed 75%)

Proximity Adjustment =	40%	(max 75%)
$F_3 = F_1$ x Factor =	**2,400**	L/min

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

East	>20m	10%
North	Fire Wall	10%
west	>45m	0%
south	>3m	20%
	sub-total	40%

Step 5: Calculate Adjusted Fire Flow (shall not be less than 2000 L/min or greater than 45,000 L/min)

F_1 =	6,000	L/min
- F_2 =	0	L/min
+ F3 =	2,400	L/min
Fire Flow =	8,000	L/min
Fire Flow =	**133**	L/s
Total Demand (Fire Flow + MDD) =	**137**	L/s

$$\text{Fire Flow} = F_1 - F_2 + F_3$$

Checks:
Fire Flow greater than 2000 L/m
Fire Flow less than 45,000 L/mir

6729 Montrose Road, Niagara Falls

Date: August 2022

File: 139168_head loss.xls

Estimated System Head and Pressure

Pipeline Section	From	To	Length	Diameter	Area	Pipe Flow	Velocity	"C"	Head Loss	Elevation	Available	
			L	D	A	Q	V	Factor	Hf[1]		System Head[2]	Pressure
			(m)	(m)	(m^2)	(m^3/s)	(m/s)	-	(m)	(m)	(m)	(kPa)
Static system Pressure/head at Hydrant test location (along Montrose Rd)											247	580
Estimated system Pressure/head for flow rate 133L/s (2100 usgpm / 8000 L/min) along Montrose Rd)											232	435
Section 1	Montrose Road	Private Lane Connection	45	0.25	0.049	0.136	2.8	120	1.5	196.0	230.9	235
Section 2	Private Lane Connection	Private Lane West End	290	0.25	0.049	0.136	2.8	120	9.4	196.0	221.5	235
Section 3	Private Lane West End	Private Lane Northwest End Hydrant	55	0.20	0.031	0.068	2.2	110	1.7	196.0	219.7	235
				Loss head losses via Backflow Preventer					3.5			
	Private Lane West End	Private Lane Northwest End Hydrant					Sub-total		**16.1**			
	At Far Northwest End Hydrant within subject site (under **Max Day + Fire Flow**)									196.0	216.2	**200**
Static system pressure/head at high ground area at far north west end Hydrant (within subject site)										196.0	247.2	**500**
Static system pressure/head at low high ground area near east end Hydrant (within subject site)										188.0	247.2	**580**

Note: [1] Hf=10.7*(Q/C)^1.85*(1/D^4.87)*L

[2] Available System Head: The available system head near the proposed watermain connection along Montrose Road was estimated from the hydrant test (on July 7, 2022)

A PRODUCT SHEET OF NEPTUNE TECHNOLOGY GROUP

High Performance PROTECTUS® III Stainless Steel (S) Fire Service Meter

SIZES: 4", 6", 8", and 10"

The Neptune® HP PROTECTUS® III Stainless Steel (S) fire service meter measures extremely wide flow ranges at 100% ± 1.5% accuracy. All HP fire service meters meet or exceed AWWA C703 Standard, are certified to NSF/ANSI 61 and 372 requirements, and are Underwriters Laboratory (UL) Listed and Factory Manual (FM) Approved for fire service use.

Application

The HP PROTECTUS III S fire service meter is designed to measure both domestic and fire service water usage through a single water line. A typical application would be in a warehouse, hotel, or hospital where one water line may supply any number of faucets or bathrooms as well as an automatic sprinkler system.

Operation

At low flow rates, all flow is through the bypass meter. As flow increases, pressure loss through the bypass meter increases and the detector check valve automatically opens. This condition occurs, for example, when a fire sprinkler system goes into operation. This permits flow through the mainline turbine meter. As flow decreases, reduced pressure loss closes the detector check valve and flow is again directed through the bypass meter.

Construction

The combined readings of the mainline turbine and the bypass meter indicate total consumption through the HP PROTECTUS III S meter.

- 300 series stainless steel mainline body
- Integral detector check valve (stainless steel spring-loaded type)
- 300 series stainless steel strainer body with stainless steel basket
- Epoxy-coated steel strainer and valve cover
- HP Turbine measuring element
- Lockable ball valves used on bypass
- Check valve used on bypass
- 1" T-10® meter (on 4" size)
- 1½" T-10 or 1½" HP Turbine meter (on 6" size)
- 2" T-10 or 2" HP Turbine meter (on 8" and 10" sizes)

KEY FEATURES

Compact Size

- Standard laying length fits existing installations
- Lowers new installation and replacement costs

Wide Operating Range

- Measures extremely wide flow ranges at 98.5%–101.5% accuracy
- Combines low-flow sensitivity of disc meter with high-flow capacity of turbine meter
- Registers leaks or unauthorized use of water from fire service lines

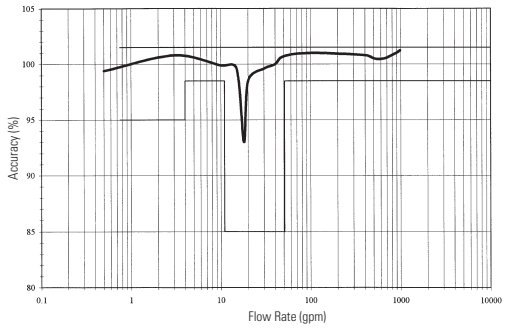
Component Repair and Maintenance

- Owner maintenance easily accomplished by replacement of major components
- Calibration vane allows in-field calibration of unitized measuring element (UME)

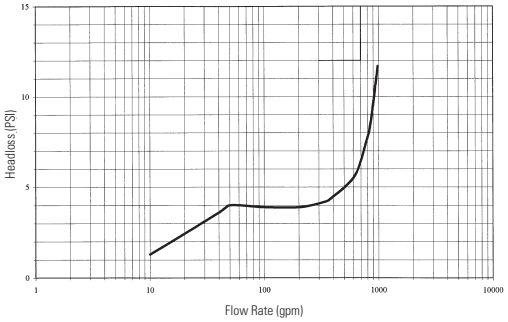
Roll-Sealed Registers

- Eliminates leaking and fogging
- In-line serviceability
- Magnetic driven, low-torque registration
- Tamperproof seal design

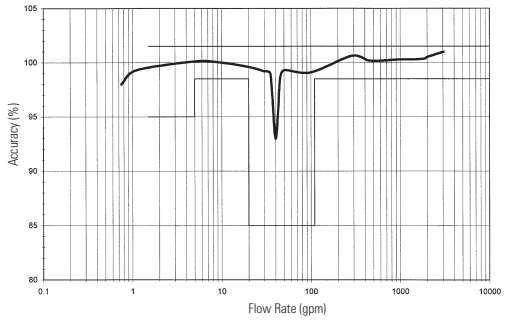
4" Accuracy



4" Headloss



6" Accuracy



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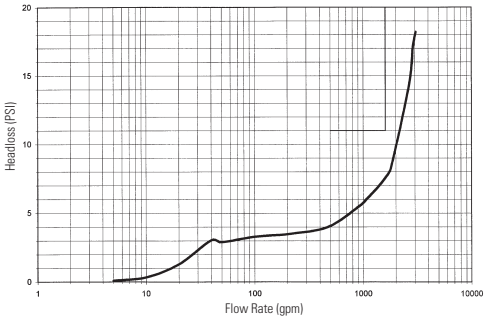
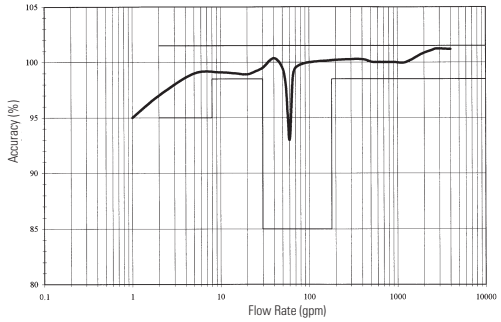
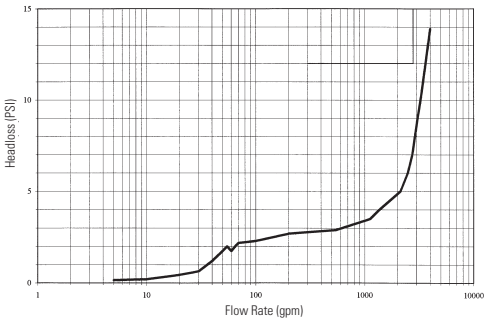


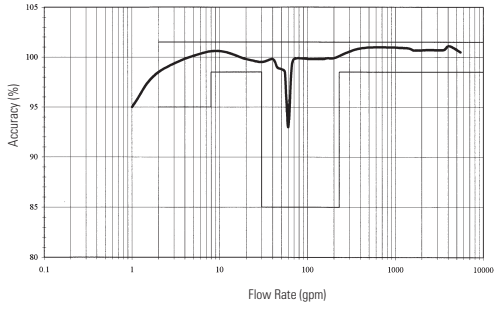
8" Accuracy



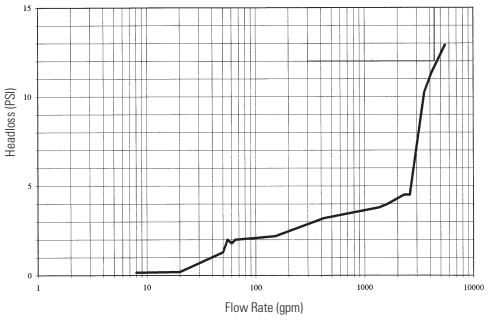
8" Headloss



10" Accuracy



10" Headloss



These charts show typical meter performance. Individual results may vary.

Operating Characteristics

Meter Size	Normal Operating Range @ 100% Accuracy (+/- 1.5%)	AWWA Standard	Low Flow @ 95% - 101% Accuracy	Maximum Intermittent Flow Rate
4"	¾ to 1200 US gpm 0.171 to 272.55 m³/h	4 to 700 US gpm 0.91 to 159 m³/h	⅜ US gpm 0.09 m³/h	1500 US gpm 340.7 m³/h
6"	1½ to 2500 US gpm 0.34 to 567.81 m³/h	5 to 1600 US gpm 1.14 to 363 m³/h	¾ US gpm 0.17 m³/h	3100 US gpm 704.1 m³/h
8"	2 to 4000 US gpm 0.45 to 908.5 m³/h	8 to 2800 US gpm 1.8 to 636 m³/h	1 US gpm 0.23 m³/h	5000 US gpm 1135.6 m³/h
10"	2 to 6500 US gpm 0.45 to 1476.31 m³/h	8 to 4400 US gpm 1.8 to 999 m³/h	1 US gpm 0.23 m³/h	8000 US gpm 1817 m³/h

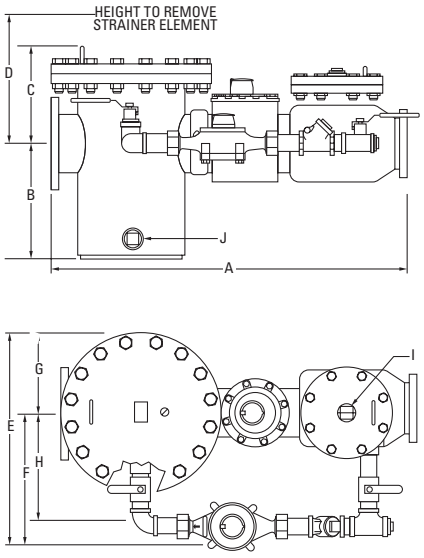
Dimensions

Meter Size	A in/mm	B in/mm	C in/mm	D in/mm	E in/mm	F in/mm	G in/mm	H in/mm	I in/mm	J in/mm	Weight lbs/kg
4"	33 838	10 254	10 ¾ 273	17 ½ 445	22 559	15 ¼ 387	6 ¾ 171	12 305	2 51	2 51	215 98
6"	45 1143	11 1/16 281	11 ⅜ 289	21 ¼ 540	29 737	19 ½ 495	9 ½ 241	16 406	2 51	3 76	570 258
8"	53 1346	11 13/16 300	13 29/64 342	25 ⅞ 657	34 ¼ 870	21 ¾ 552	12 ½ 318	17 432	3 76	3 76	765 347
10"	68 1727	14 13/16 376	15 381	30 1/16 764	36 ¼ 921	22 ½ 572	13 ¾ 349	18 457	3 76	3 76	900 408

Registration

Registration (per sweep hand revolution)	Disc Side			Turbine Side		
	1"	1½"	2"	4"	6"	8" & 10"
1,000 US Gallons					✓	✓
100 Gallons		✓	✓	✓		
100 Cubic Feet					✓	✓
10 US Gallons	✓					
10 Cubic Feet		✓	✓	✓		
1 Cubic Foot	✓					
10 Cubic Metres					✓	✓
1 Cubic Metre			✓	✓		
0.1 Cubic Metre	✓	✓				

Register Capacity (6 active wheel odometer)	Disc Side			Turbine Side		
	1"	1½"	2"	4"	6"	8" & 10"
1,000,000,000 Gallons					✓	✓
100,000,000 Gallons		✓	✓	✓		
100,000,000 Cubic Feet					✓	✓
10,000,000 Gallons	✓					
10,000,000 Cubic Feet		✓	✓	✓		
10,000,000 Cubic Metres					✓	✓
1,000,000 Cubic Metres			✓	✓		
1,000,000 Cubic Feet	✓					
100,000 Cubic Metres	✓	✓				



Specifications

Application

- Cold water measurement of flow in one direction

Maximum Operating Pressure

- 175 psi (1206 kPa)

Register

- Direct reading, center sweep, roll-sealed magnetic drive with low-flow indicator

Measuring Element

- AWWA Class II Turbine, hydrodynamically-balanced rotor, nutating disc

Flanges

- Round flanged ends per AWWA C207, Class D

Approvals

- NSF/ANSI 61
- NSF/ANSI 372
- UL Listed
- FM Approved

Options

Sizes

- 4", 6", 8", and 10"

300 Series Stainless Steel Strainer Cover and Valve Cover

300 Series Stainless Steel Bolts

Left Side Bypass

Units Of Measure

- U.S. gallons, Imperial gallons, cubic feet, cubic metres

Register types

- Remote reading systems*: ProRead™, ProCoder™, E-CODER®, E-CODER®)R900*i*™, E-CODER®)R450*i*™, TRICON®/S, TRICON/E®3
- Reclaim

Companion Flanges

- Cast iron
- Bronze (4" only)

Special Meter Flanges**

- 12" (for 10" meter size)

**Consult factory for meter performance specifications when fitted with ARB.*

***Non-UL/FM approved.*

Guaranteed Systems Compatibility

All HP PROTECTUS III S fire service meters are guaranteed adaptable to our ProRead, ProCoder, E-CODER, E-CODER)R900*i*, E-CODER)R450*i*, TRICON/S, TRICON/E3, and Neptune meter reading systems without removing the meter from service.

Warranty

Neptune provides a limited warranty with respect to its HP PROTECTUS III S fire service meter for performance, materials, and workmanship.

When desired, owner maintenance is easily accomplished by in-line replacement of the UME.

NEPTUNE TECHNOLOGY GROUP

#winyourday
neptunetg.com

Neptune Technology Group
1600 Alabama Highway 229
Tallassee, AL 36078
800-633-8754 f 334-283-7293

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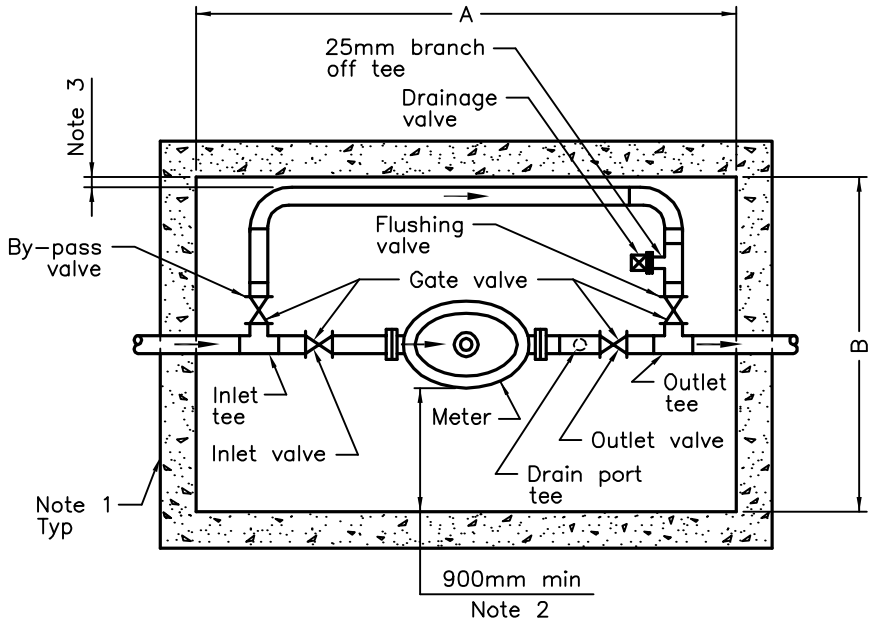

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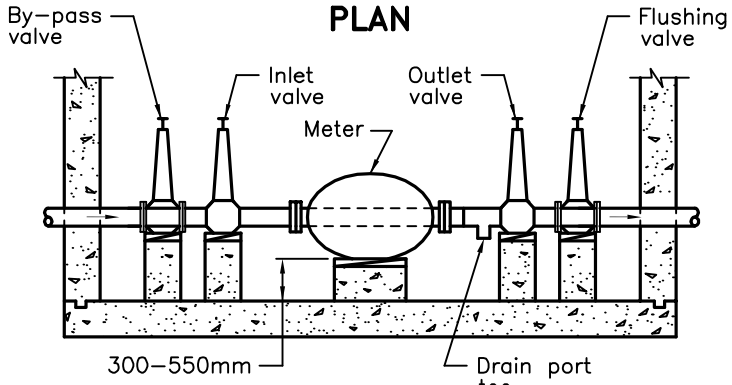


ELEVATION

Pipe and Chamber Size		
Private water service pipe size mm	Minimum A m	Minimum B m
75–100	3.5	2.3
150	4.3	2.5
200	5.0	2.7
250	6.0	3.0
300	6.6	3.2

NOTES:

1 Circular chambers may be used if clearances are maintained.

2 Water meters shall be installed with a minimum 900mm unobstructed clearance in front of water meter to the nearest wall.

3 By–pass piping shall be installed with a minimum 300mm unobstructed clearance from the outside wall of the bypass pipe to the nearest wall.

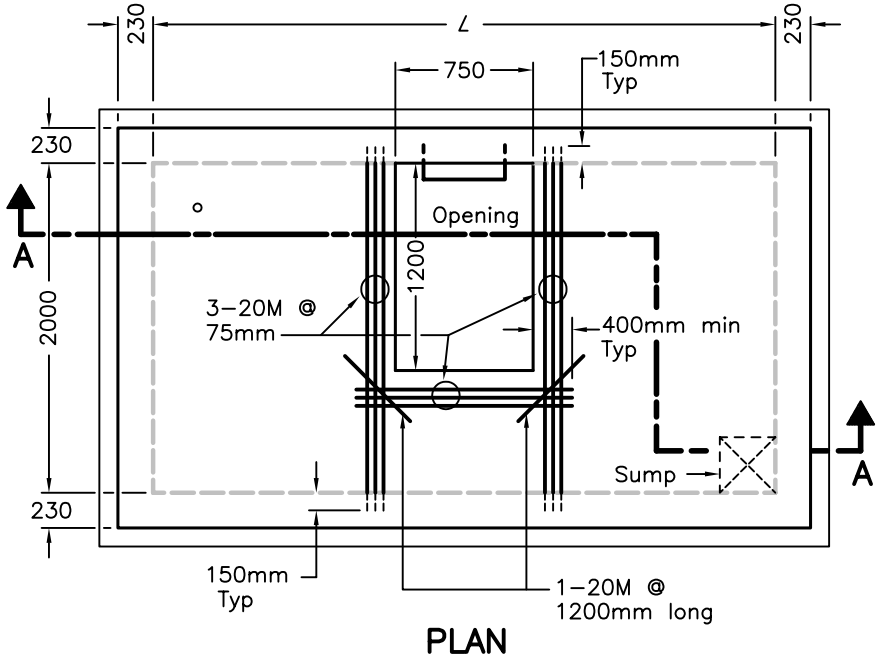
A A 75mm meter shall have 75mm to 100mm increasers on each side.

B By–pass line size shall be same size as the meter line.

C All joints shall be restrained.

D All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2014	Rev	2
PIPING LAYOUT FOR WATER METERS 75 TO 250mm IN CHAMBERS WITH BY–PASS			
	OPSD 1107.020		



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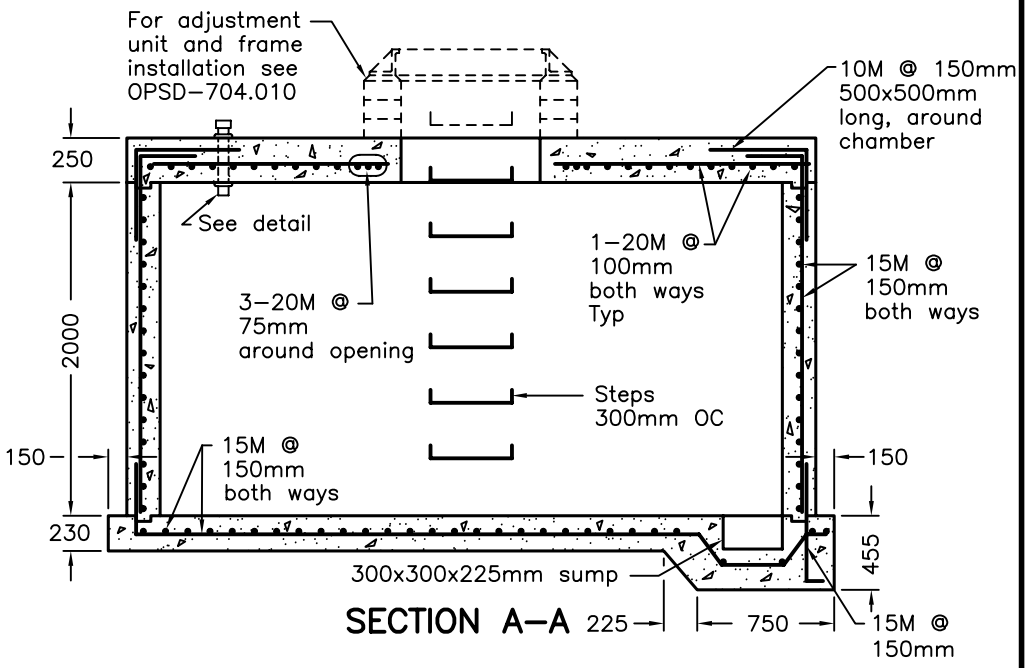
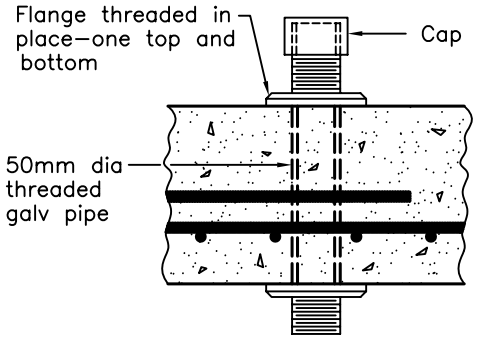


SECTION A–A

METER SIZE	L
75 and 100	3400
150	3700
200	4100
250	4600



DETAIL

REMOTE READER CABLE SLEEVE

NOTES:

A Reinforcing bars to have minimum 50mm cover.

B Frame and cover according to OPSD–402.030.

C Flexible material sealant is to be used where pipe goes through the wall.

D All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING

CAST–IN–PLACE WATER METER CHAMBER FOR 75 TO 250mm METERS

April 1999 | Rev

OPSD – 1108.010

Appendix E

Stormwater Management

E1 – Target Peak Flow Calculations
E2 – Stage-Storage-Discharge Calculations – SWM Tank
E3 – Stormceptor Sizing Reports and Drawings
E4 – VO Model Schematic
E5 – VO Model Output

126319 - Montrose Development, Niagara Falls, ON
Target Peak Flow Calculations

Area =	0.71	ha
C =	0.85	
Iinlet Time	10	min.

Return Event	A	B	C	i	Q
	Coefficients			(mm/hr)	(m^3/s)
2	521.97	5.28	0.7588	65.9	0.111
5	719.50	6.34	0.7687	84.0	0.141
10	577.93	2.48	0.6690	106.8	0.179
25	1020.69	7.29	0.7777	111.2	0.186
100	1264.67	7.72	0.7814	133.8	0.224

126319 - Montrose Development, Niagara Falls, ON
Area 201 - Underground Tank Stage-Storage-Discharge Relationship

Orifice # 1

Pipe Invert =	184.96	m (@ MH13)
Orifice Radius =	0.1200	m
Orifice Diameter =	240	mm
Orifice Centreline =	185.080	m
Orifice Coefficient =	0.6	
Orifice Area =	0.0452376	m^2

Tank # 1 Storage

Tank Invert =	185.03	m
Tank Obvert =	187.57	m
Storage =	221.3	m^3/m
Total Storage =	562.0	m^3

Overflow (@ Driveway)

Spill Elevation =	188.48	m
Weir Length =	6.00	m
Weir Coefficient =	1.6	

Hydraulic Depth (m)	Elevation (m)	Description	Orifice # 1 Flow (m^3/s)	Weir Flow (m^3/s)	Total Flow (m^3/s)	Tank Total Storage (m^3)	Tank Active Storage (m^3)
0.00	185.03	Tank # 1 Invert	0.00000	0.00000	0.00000	0.0	0.0
0.30	185.33		0.04500	0.00000	0.04500	66.4	66.4
0.60	185.63		0.08914	0.00000	0.08914	132.8	132.8
0.90	185.93		0.11082	0.00000	0.11082	199.1	199.1
1.20	186.23		0.12890	0.00000	0.12890	265.5	265.5
1.50	186.53		0.14474	0.00000	0.14474	331.9	331.9
1.80	186.83		0.15901	0.00000	0.15901	398.3	398.3
2.10	187.13		0.17210	0.00000	0.17210	464.6	464.6
2.40	187.43		0.18427	0.00000	0.18427	531.0	531.0
2.54	187.57	Tank # 1 Obvert	0.18968	0.00000	0.18968	562.0	562.0
2.97	188.00		0.20540	0.00000	0.20540	562.0	562.0
3.35	188.38	Top of Grate MH13	0.21836	0.00000	0.21836	562.0	562.0
3.45	188.48	Spill Elevation	0.22164	0.00000	0.22164	562.0	562.0

Orifice equation: $Q = C_o \times A \times (2 \times g \times h)^{0.5}$

Weir equation: $Q = C_w \times L \times (H)^{3/2}$

where:

A = orifice area (m^2)
g = 9.806 m/s^2
h = head above c/l of orifice (m)
L = weir length (m)
H = head above weir (m)

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

07/25/2022

Province:	Ontario
City:	Niagara Falls
Nearest Rainfall Station:	ST CATHARINES AP
Climate Station Id:	6137287
Years of Rainfall Data:	33

Site Name:	Montrose Development
Drainage Area (ha):	2.59
% Imperviousness:	71.20

Runoff Coefficient 'c': 0.72

Particle Size Distribution:	Fine
Target TSS Removal (%):	80.0

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	58.57
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	Montrose Development
Project Number:	126319
Designer Name:	Andy Kroess
Designer Company:	IBI Group
Designer Email:	andy.kroess@ibigroup.com
Designer Phone:	519-585-2255
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	60
EFO6	75
EFO8	83
EFO10	89
EFO12	92

Recommended Stormceptor EFO Model: EFO8

Estimated Net Annual Sediment (TSS) Load Reduction (%): 83

Water Quality Runoff Volume Capture (%): > 90

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THIRD-PARTY TESTING AND VERIFICATION

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

PERFORMANCE

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

PARTICLE SIZE DISTRIBUTION (PSD)

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

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

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Stormceptor® EF Sizing Report

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
0.5	9.2	9.2	2.62	157.0	33.0	100	9.2	9.2
1	20.5	29.7	5.24	314.0	67.0	100	20.5	29.7
2	16.5	46.2	10.47	628.0	134.0	92	15.2	44.9
3	11.3	57.5	15.71	942.0	201.0	83	9.4	54.3
4	9.1	66.7	20.94	1257.0	267.0	80	7.3	61.6
5	5.5	72.2	26.18	1571.0	334.0	77	4.2	65.9
6	4.5	76.7	31.42	1885.0	401.0	74	3.3	69.2
7	4.2	80.9	36.65	2199.0	468.0	71	3.0	72.2
8	3.5	84.4	41.89	2513.0	535.0	68	2.4	74.6
9	2.0	86.5	47.12	2827.0	602.0	65	1.3	75.9
10	1.5	88.0	52.36	3142.0	668.0	64	0.9	76.9
11	1.8	89.8	57.60	3456.0	735.0	64	1.2	78.1
12	1.1	90.9	62.83	3770.0	802.0	63	0.7	78.7
13	1.1	92.0	68.07	4084.0	869.0	63	0.7	79.4
14	1.4	93.4	73.30	4398.0	936.0	62	0.9	80.3
15	0.8	94.2	78.54	4712.0	1003.0	62	0.5	80.8
16	0.6	94.8	83.78	5027.0	1069.0	60	0.3	81.1
17	0.5	95.3	89.01	5341.0	1136.0	59	0.3	81.4
18	0.3	95.6	94.25	5655.0	1203.0	57	0.2	81.6
19	0.2	95.9	99.48	5969.0	1270.0	55	0.1	81.8
20	0.2	96.1	104.72	6283.0	1337.0	54	0.1	81.9
21	0.5	96.6	109.96	6597.0	1404.0	52	0.3	82.2
22	0.4	97.0	115.19	6912.0	1471.0	50	0.2	82.4
23	0.3	97.3	120.43	7226.0	1537.0	48	0.1	82.5
24	0.0	97.3	125.66	7540.0	1604.0	46	0.0	82.5
25	0.2	97.4	130.90	7854.0	1671.0	44	0.1	82.6
30	1.6	99.1	157.08	9425.0	2005.0	37	0.6	83.2
35	0.6	99.7	183.26	10996.0	2339.0	31	0.2	83.4
40	0.0	99.7	209.44	12566.0	2674.0	28	0.0	83.4
45	0.3	100.0	235.62	14137.0	3008.0	24	0.1	83.4
Estimated Net Annual Sediment (TSS) Load Reduction =								**83 %**

Climate Station ID: 6137287 *Years of Rainfall Data*: 33

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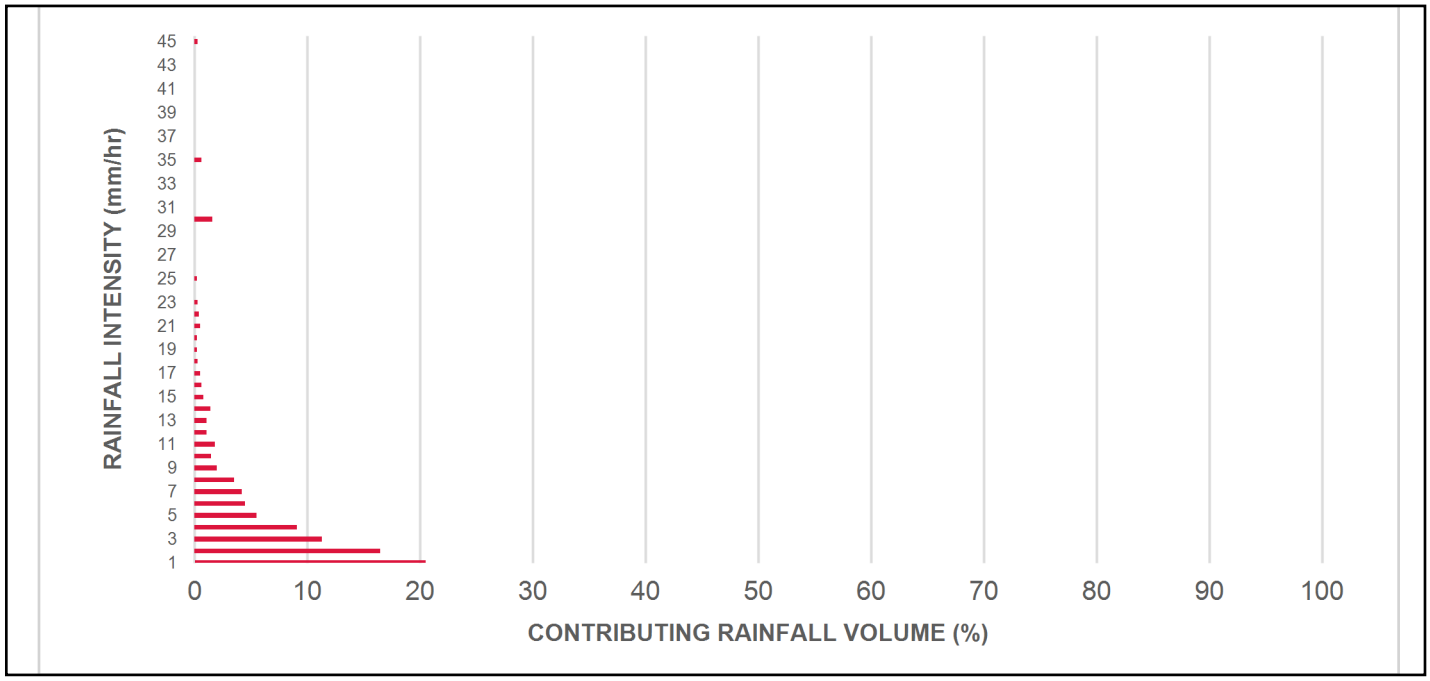
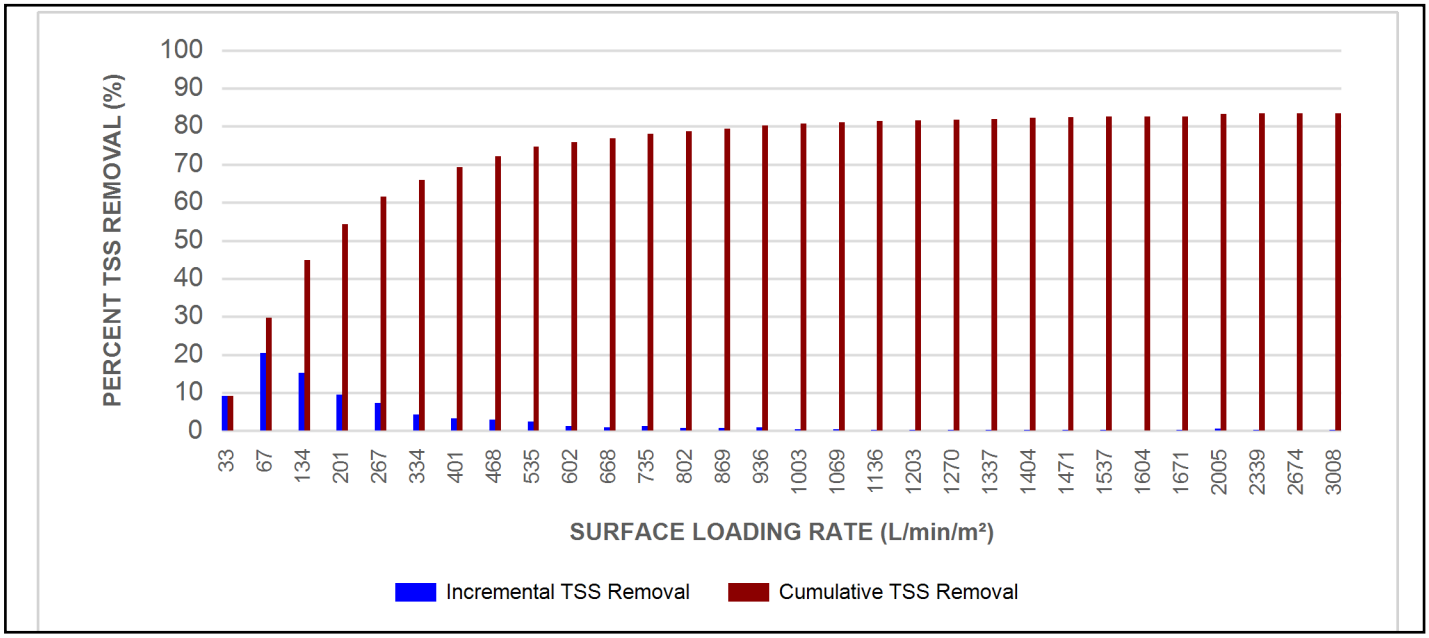
RAINFALL DATA FROM ST CATHARINES AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

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

SCOUR PREVENTION AND ONLINE CONFIGURATION

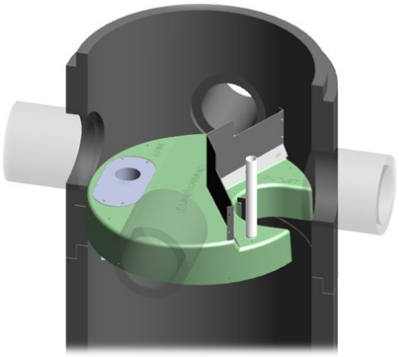
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test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

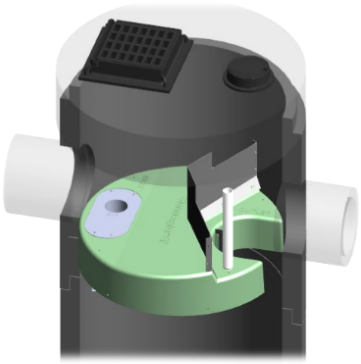
DESIGN FLEXIBILITY

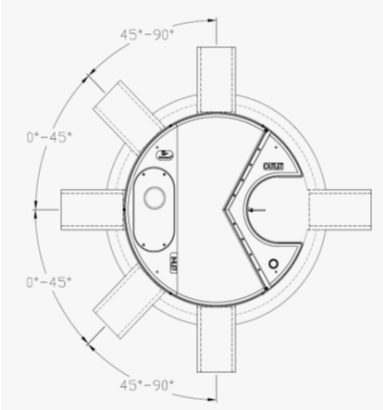
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend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

OIL CAPTURE AND RETENTION

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







INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

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

Pollutant Capacity

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

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft^3)

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

STANDARD STORMCEPTOR EF/EFO DRAWINGS

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

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

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

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

PART 1 – GENERAL

1.1 WORK INCLUDED

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

1.2 REFERENCE STANDARDS & PROCEDURES

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

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

1.3 SUBMITTALS

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

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

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

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

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

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

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall

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

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing of the OGS shall be determined by use of a minimum ten (10) years of local historical rainfall data provided by Environment Canada. Sizing shall also be determined by use of the sediment removal performance data derived from the ISO 14034 ETV third-party verified laboratory testing data from testing conducted in accordance with the Canadian ETV protocol Procedure for Laboratory Testing of Oil-Grit Separators, as follows:

3.2.1 Sediment removal efficiency for a given surface loading rate and its associated flow rate shall be based on sediment removal efficiency demonstrated at the seven (7) tested surface loading rates specified in the protocol, ranging 40 L/min/m^2 to 1400 L/min/m^2, and as stated in the ISO 14034 ETV Verification Statement for the OGS device.

3.2.2 Sediment removal efficiency for surface loading rates between 40 L/min/m^2 and 1400 L/min/m^2 shall be based on linear interpolation of data between consecutive tested surface loading rates.

3.2.3 Sediment removal efficiency for surface loading rates less than the lowest tested surface loading rate of 40 L/min/m^2 shall be assumed to be identical to the sediment removal efficiency at 40 L/min/m^2. No extrapolation shall be allowed that results in a sediment removal efficiency that is greater than that demonstrated at 40 L/min/m^2.

3.2.4 Sediment removal efficiency for surface loading rates greater than the highest tested surface loading rate of 1400 L/min/m^2 shall assume zero sediment removal for the portion of flow that exceeds 1400 L/min/m^2, and shall be calculated using a simple proportioning formula, with 1400 L/min/m^2 in the numerator and the higher surface loading rate in the denominator, and multiplying the resulting fraction times the sediment removal efficiency at 1400 L/min/m^2.

The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

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

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

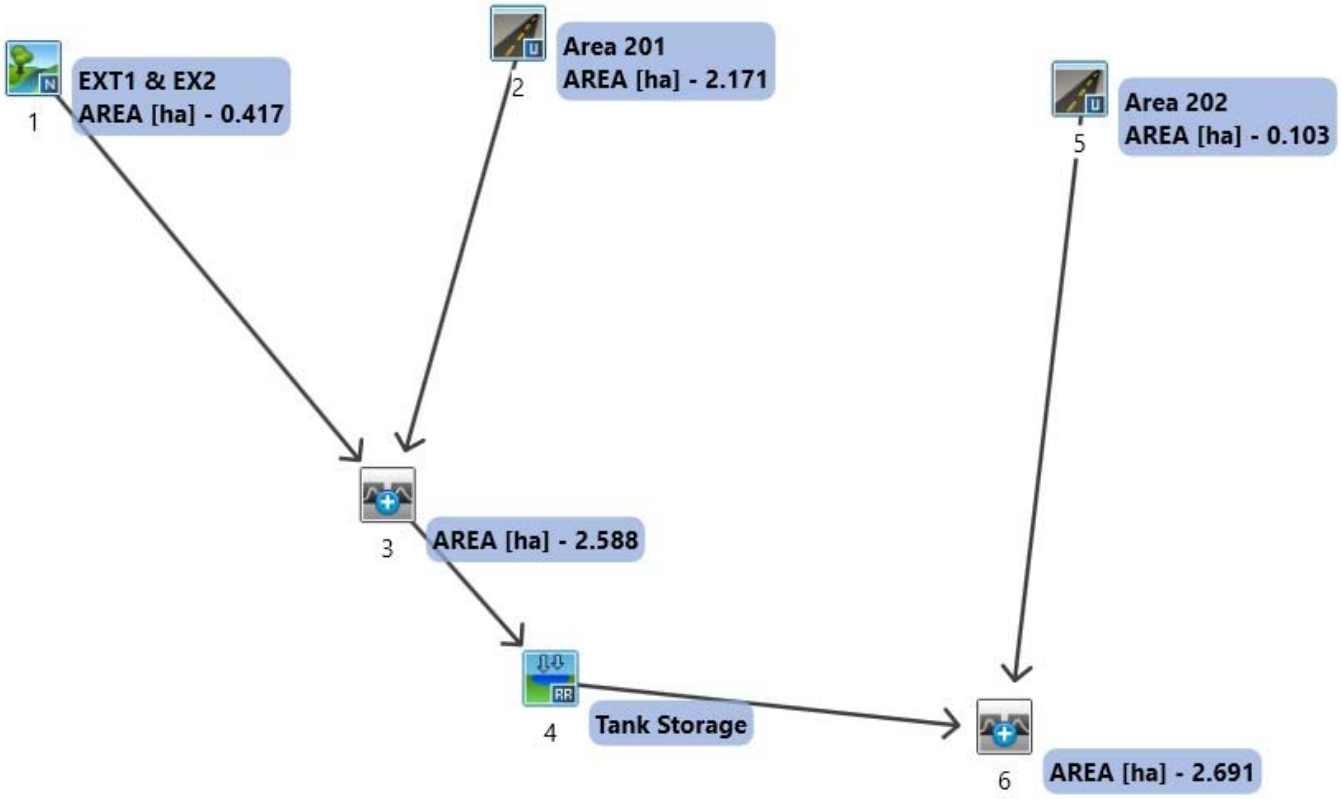
3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

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

assess whether light liquids captured after a spill are effectively retained at high flow rates.

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m^2 to 2600 L/min/m^2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.** However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

126319 - Montrose Development, Niagara Falls, ON
Visual OTTHYMO Model Schematic - Proposed Conditions



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        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

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       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
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                  *****  D E T A I L E D   O U T P U T *****


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DATE: 07-26-2022                          TIME: 11:05:04

USER:



COMMENTS: _____________________________________________________________


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  ***********************************************
  ** SIMULATION : 2 Year Niagara Falls          **
  ***********************************************


--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 521.970
| Ptotal= 29.78 mm |                          B=   5.280
--------------------                          C=   0.759
                       used in:   INTENSITY =  A / (t + B)^C

                       Duration of storm  =  3.00 hrs
                       Storm time step    =  5.00 min
                       Time to peak ratio =  0.33

                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.00    2.84 |  0.75   13.73 |  1.50    7.32 |  2.25    3.62
                0.08    3.07 |  0.83   30.30 |  1.58    6.52 |  2.33    3.44
                0.17    3.36 |  0.92   89.07 |  1.67    5.89 |  2.42    3.28
                0.25    3.72 |  1.00   38.58 |  1.75    5.38 |  2.50    3.14
                0.33    4.17 |  1.08   22.05 |  1.83    4.96 |  2.58    3.01
                0.42    4.78 |  1.17   15.48 |  1.92    4.61 |  2.67    2.89
                0.50    5.63 |  1.25   12.00 |  2.00    4.31 |  2.75    2.79
                0.58    6.91 |  1.33    9.84 |  2.08    4.05 |  2.83    2.69
```

```
                0.67    9.10 |  1.42    8.38 |  2.17    3.82 |  2.92    2.60


--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   0.42   Curve Number   (CN)= 74.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.25

     Unit Hyd Qpeak  (cms)=   0.064

     PEAK FLOW       (cms)=   0.006 (i)
     TIME TO PEAK    (hrs)=   1.333
     RUNOFF VOLUME    (mm)=   5.378
     TOTAL RAINFALL   (mm)=  29.776
     RUNOFF COEFFICIENT   =   0.181

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0002)|   Area    (ha)=   2.17
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.63         0.54
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     120.31        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      89.07     ********
               over (min)        5.00        10.00
     Storage Coeff.  (min)=       2.99 (ii)    7.75 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.28         0.13
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.35         0.01          0.357 (iii)
     TIME TO PEAK    (hrs)=       1.00         1.08           1.00
     RUNOFF VOLUME    (mm)=      28.78         6.80          23.28
     TOTAL RAINFALL   (mm)=      29.78        29.78          29.78
     RUNOFF COEFFICIENT   =       0.97         0.23           0.78

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0003)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):     0.42   0.006     1.33     5.38
      + ID2= 2 (  0002):     2.17   0.357     1.00    23.28
        ================================================
        ID = 3 (  0003):     2.59   0.358     1.00    20.40

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
```

```
--------------------
| RESERVOIR(  0004)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1447      0.0332
                          0.0450     0.0066   |   0.1590      0.0398
                          0.0891     0.0133   |   0.1721      0.0465
                          0.1108     0.0199   |   0.1843      0.0531
                          0.1289     0.0266   |   0.1897      0.0562

                                  AREA     QPEAK     TPEAK       R.V.
                                  (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0003)      2.588      0.358      1.00      20.40
   OUTFLOW: ID= 1 (  0004)      2.588      0.109      1.25      20.38

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)= 30.49
                  TIME SHIFT OF PEAK FLOW         (min)= 15.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=  0.0196

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0005)|   Area    (ha)=   0.10
|ID= 1 DT= 5.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.05         0.05
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      26.20        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      89.07         9.49
               over (min)         5.00        20.00
     Storage Coeff.  (min)=       1.20 (ii)   19.30 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=       0.33         0.06
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.01         0.00          0.013 (iii)
     TIME TO PEAK    (hrs)=       1.00         1.33           1.00
     RUNOFF VOLUME    (mm)=      28.78         6.80          17.69
     TOTAL RAINFALL   (mm)=      29.78        29.78          29.78
     RUNOFF COEFFICIENT   =       0.97         0.23           0.59

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0006)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0004):     2.59   0.109     1.25    20.38
      + ID2= 2 (  0005):     0.10   0.013     1.00    17.69
        ================================================
        ID = 3 (  0006):     2.69   0.111     1.25    20.28

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
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FINISH
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       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
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                  *****  D E T A I L E D   O U T P U T *****


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DATE: 07-26-2022                          TIME: 11:05:04

USER:



COMMENTS: _____________________________________________________________


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  ************************************************
  ** SIMULATION : 5 Year Niagara Falls          **
  ************************************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 719.500
| Ptotal= 38.74 mm |                          B=   6.340
--------------------                          C=   0.769
                       used in:   INTENSITY =  A / (t + B)^C

                       Duration of storm  =  3.00 hrs
                       Storm time step    =  5.00 min
                       Time to peak ratio =  0.33

                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.00    3.62 |  0.75   18.39 |  1.50    9.64 |  2.25    4.66
                0.08    3.93 |  0.83   40.46 |  1.58    8.55 |  2.33    4.42
                0.17    4.31 |  0.92  111.18 |  1.67    7.70 |  2.42    4.21
                0.25    4.78 |  1.00   51.30 |  1.75    7.01 |  2.50    4.02
                0.33    5.39 |  1.08   29.67 |  1.83    6.45 |  2.58    3.85
                0.42    6.20 |  1.17   20.79 |  1.92    5.97 |  2.67    3.70
                0.50    7.35 |  1.25   16.03 |  2.00    5.57 |  2.75    3.55
                0.58    9.09 |  1.33   13.09 |  2.08    5.22 |  2.83    3.42
```

```
                0.67   12.07 |  1.42   11.09 |  2.17    4.92 |  2.92    3.30


--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   0.42   Curve Number   (CN)= 74.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.25

     Unit Hyd Qpeak  (cms)=   0.064

     PEAK FLOW       (cms)=   0.010 (i)
     TIME TO PEAK    (hrs)=   1.333
     RUNOFF VOLUME    (mm)=   9.250
     TOTAL RAINFALL   (mm)=  38.745
     RUNOFF COEFFICIENT   =   0.239

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0002)|   Area    (ha)=   2.17
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.63         0.54
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     120.31        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     111.18     ********
               over (min)        5.00        10.00
     Storage Coeff.  (min)=       2.74 (ii)    7.10 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.29         0.14
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.45         0.02          0.460 (iii)
     TIME TO PEAK    (hrs)=       1.00         1.08           1.00
     RUNOFF VOLUME    (mm)=      37.74        10.97          31.05
     TOTAL RAINFALL   (mm)=      38.74        38.74          38.74
     RUNOFF COEFFICIENT   =       0.97         0.28           0.80

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0003)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):     0.42   0.010     1.33     9.25
      + ID2= 2 (  0002):     2.17   0.460     1.00    31.05
        ================================================
        ID = 3 (  0003):     2.59   0.463     1.00    27.54

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
```

```
--------------------
| RESERVOIR(  0004)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1447      0.0332
                          0.0450     0.0066   |   0.1590      0.0398
                          0.0891     0.0133   |   0.1721      0.0465
                          0.1108     0.0199   |   0.1843      0.0531
                          0.1289     0.0266   |   0.1897      0.0562

                                  AREA     QPEAK     TPEAK       R.V.
                                  (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0003)      2.588      0.463      1.00      27.54
   OUTFLOW: ID= 1 (  0004)      2.588      0.130      1.25      27.52

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)= 28.12
                  TIME SHIFT OF PEAK FLOW         (min)= 15.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=  0.0271

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0005)|   Area    (ha)=   0.10
|ID= 1 DT= 5.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.05         0.05
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      26.20        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     111.18        17.85
               over (min)         5.00        20.00
     Storage Coeff.  (min)=       1.10 (ii)   15.16 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=       0.34         0.07
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.02         0.00          0.016 (iii)
     TIME TO PEAK    (hrs)=       1.00         1.33           1.00
     RUNOFF VOLUME    (mm)=      37.74        10.97          24.26
     TOTAL RAINFALL   (mm)=      38.74        38.74          38.74
     RUNOFF COEFFICIENT   =       0.97         0.28           0.63

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0006)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0004):     2.59   0.130     1.25    27.52
      + ID2= 2 (  0005):     0.10   0.016     1.00    24.26
        ================================================
        ID = 3 (  0006):     2.69   0.135     1.25    27.40

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
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       V    V   I    SSSSS  U   U    A    L              (v 6.2.2007)
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
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84b9-dfb043734ede\


DATE: 07-26-2022                          TIME: 11:05:04

USER:



COMMENTS: _____________________________________________________________


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  ************************************************
  ** SIMULATION : 10 Year Niagara Falls         **
  ************************************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 577.900
| Ptotal= 53.23 mm |                          B=   2.480
--------------------                          C=   0.669
                       used in:   INTENSITY =  A / (t + B)^C

                       Duration of storm  =  3.00 hrs
                       Storm time step    =  5.00 min
                       Time to peak ratio =  0.33

                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.00    6.47 |  0.75   23.34 |  1.50   14.08 |  2.25    7.93
                0.08    6.92 |  0.83   45.89 |  1.58   12.82 |  2.33    7.61
                0.17    7.45 |  0.92  150.39 |  1.67   11.81 |  2.42    7.31
                0.25    8.10 |  1.00   57.25 |  1.75   10.97 |  2.50    7.05
                0.33    8.91 |  1.08   34.58 |  1.83   10.27 |  2.58    6.81
                0.42    9.96 |  1.17   25.77 |  1.92    9.67 |  2.67    6.58
                0.50   11.38 |  1.25   20.95 |  2.00    9.15 |  2.75    6.38
                0.58   13.44 |  1.33   17.86 |  2.08    8.69 |  2.83    6.19
```

```
                0.67   16.76 |  1.42   15.70 |  2.17    8.29 |  2.92    6.01


--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   0.42   Curve Number   (CN)= 74.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.25

     Unit Hyd Qpeak  (cms)=   0.064

     PEAK FLOW       (cms)=   0.017 (i)
     TIME TO PEAK    (hrs)=   1.333
     RUNOFF VOLUME    (mm)=  16.905
     TOTAL RAINFALL   (mm)=  53.228
     RUNOFF COEFFICIENT   =   0.318

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0002)|   Area    (ha)=   2.17
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.63         0.54
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     120.31        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     150.39     ********
               over (min)        5.00        10.00
     Storage Coeff.  (min)=       2.42 (ii)    6.29 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.30         0.15
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.62         0.04          0.640 (iii)
     TIME TO PEAK    (hrs)=       1.00         1.08           1.00
     RUNOFF VOLUME    (mm)=      52.23        18.98          43.91
     TOTAL RAINFALL   (mm)=      53.23        53.23          53.23
     RUNOFF COEFFICIENT   =       0.98         0.36           0.83

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0003)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):     0.42   0.017     1.33    16.90
      + ID2= 2 (  0002):     2.17   0.640     1.00    43.91
        ================================================
        ID = 3 (  0003):     2.59   0.645     1.00    39.56

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
```

```
--------------------
| RESERVOIR(  0004)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1447      0.0332
                          0.0450     0.0066   |   0.1590      0.0398
                          0.0891     0.0133   |   0.1721      0.0465
                          0.1108     0.0199   |   0.1843      0.0531
                          0.1289     0.0266   |   0.1897      0.0562

                                  AREA     QPEAK     TPEAK       R.V.
                                  (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0003)      2.588      0.645      1.00      39.56
   OUTFLOW: ID= 1 (  0004)      2.588      0.153      1.25      39.55

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)= 23.65
                  TIME SHIFT OF PEAK FLOW         (min)= 15.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=  0.0371

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0005)|   Area    (ha)=   0.10
|ID= 1 DT= 5.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.05         0.05
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      26.20        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     150.39        28.17
               over (min)         5.00        15.00
     Storage Coeff.  (min)=       0.97 (ii)   12.69 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.34         0.08
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.02         0.00          0.022 (iii)
     TIME TO PEAK    (hrs)=       1.00         1.17           1.00
     RUNOFF VOLUME    (mm)=      52.23        18.98          35.53
     TOTAL RAINFALL   (mm)=      53.23        53.23          53.23
     RUNOFF COEFFICIENT   =       0.98         0.36           0.67

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0006)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0004):     2.59   0.153     1.25    39.55
      + ID2= 2 (  0005):     0.10   0.022     1.00    35.53
        ================================================
        ID = 3 (  0006):     2.69   0.159     1.25    39.40

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
```

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================================================================================================================
=====

       V    V   I    SSSSS  U   U    A    L              (v 6.2.2007)
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
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                  *****  D E T A I L E D   O U T P U T *****


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8e7d-6a6600301915\
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8e7d-6a6600301915\


DATE: 07-26-2022                          TIME: 11:05:04

USER:



COMMENTS: _____________________________________________________________


--------------------------------------------------------------------------------------------------------------
-----
  ***********************************************
  ** SIMULATION : 25 Year Niagara Falls         **
  ***********************************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1020.700
| Ptotal= 52.51 mm |                          B=   7.290
--------------------                          C=   0.777
                       used in:   INTENSITY =  A / (t + B)^C

                       Duration of storm  =  3.00 hrs
                       Storm time step    =  5.00 min
                       Time to peak ratio =  0.33

                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.00    4.84 |  0.75   25.54 |  1.50   13.24 |  2.25    6.27
                0.08    5.27 |  0.83   55.79 |  1.58   11.70 |  2.33    5.94
                0.17    5.79 |  0.92  145.32 |  1.67   10.50 |  2.42    5.65
                0.25    6.44 |  1.00   70.40 |  1.75    9.54 |  2.50    5.39
                0.33    7.28 |  1.08   41.24 |  1.83    8.75 |  2.58    5.16
                0.42    8.41 |  1.17   28.91 |  1.92    8.09 |  2.67    4.95
                0.50   10.01 |  1.25   22.23 |  2.00    7.53 |  2.75    4.75
                0.58   12.45 |  1.33   18.08 |  2.08    7.05 |  2.83    4.57
```

```
                0.67   16.65 |  1.42   15.27 |  2.17    6.63 |  2.92    4.41


--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   0.42   Curve Number   (CN)= 74.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.25

     Unit Hyd Qpeak  (cms)=   0.064

     PEAK FLOW       (cms)=   0.018 (i)
     TIME TO PEAK    (hrs)=   1.333
     RUNOFF VOLUME    (mm)=  16.489
     TOTAL RAINFALL   (mm)=  52.505
     RUNOFF COEFFICIENT   =   0.314

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0002)|   Area    (ha)=   2.17
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.63         0.54
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     120.31        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     145.32     ********
               over (min)        5.00        10.00
     Storage Coeff.  (min)=       2.46 (ii)    6.37 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.30         0.15
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.60         0.04          0.624 (iii)
     TIME TO PEAK    (hrs)=       1.00         1.08           1.00
     RUNOFF VOLUME    (mm)=      51.51        18.55          43.26
     TOTAL RAINFALL   (mm)=      52.51        52.51          52.51
     RUNOFF COEFFICIENT   =       0.98         0.35           0.82

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0003)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):     0.42   0.018     1.33    16.49
      + ID2= 2 (  0002):     2.17   0.624     1.00    43.26
        ================================================
        ID = 3 (  0003):     2.59   0.628     1.00    38.95

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
```

```
--------------------
| RESERVOIR(  0004)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1447      0.0332
                          0.0450     0.0066   |   0.1590      0.0398
                          0.0891     0.0133   |   0.1721      0.0465
                          0.1108     0.0199   |   0.1843      0.0531
                          0.1289     0.0266   |   0.1897      0.0562

                                  AREA     QPEAK     TPEAK       R.V.
                                  (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0003)      2.588      0.628      1.00      38.95
   OUTFLOW: ID= 1 (  0004)      2.588      0.160      1.33      38.94

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)= 25.39
                  TIME SHIFT OF PEAK FLOW         (min)= 20.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=  0.0403

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0005)|   Area    (ha)=   0.10
|ID= 1 DT= 5.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.05         0.05
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      26.20        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     145.32        30.43
               over (min)         5.00        15.00
     Storage Coeff.  (min)=       0.98 (ii)   12.34 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.34         0.08
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.02         0.00          0.022 (iii)
     TIME TO PEAK    (hrs)=       1.00         1.25           1.00
     RUNOFF VOLUME    (mm)=      51.51        18.55          34.95
     TOTAL RAINFALL   (mm)=      52.51        52.51          52.51
     RUNOFF COEFFICIENT   =       0.98         0.35           0.67

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0006)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0004):     2.59   0.160     1.33    38.94
      + ID2= 2 (  0005):     0.10   0.022     1.00    34.95
        ================================================
        ID = 3 (  0006):     2.69   0.166     1.25    38.79

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
```

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================================================================================================================
=====

       V    V   I    SSSSS  U   U    A    L              (v 6.2.2007)
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
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                  *****  D E T A I L E D   O U T P U T *****


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bfe2-f5417dcd297d\


DATE: 07-26-2022                          TIME: 11:05:04

USER:



COMMENTS: _____________________________________________________________


----------------------------------------------------------------------------------------------------------------
-----
  ************************************************
  ** SIMULATION : 100 Year Niagara Falls        **
  ************************************************

--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1264.600
| Ptotal= 63.59 mm |                          B=   7.720
--------------------                          C=   0.781
                       used in:   INTENSITY =  A / (t + B)^C

                       Duration of storm  =  3.00 hrs
                       Storm time step    =  5.00 min
                       Time to peak ratio =  0.33

                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.00    5.82 |  0.75   31.25 |  1.50   16.11 |  2.25    7.56
                0.08    6.34 |  0.83   68.05 |  1.58   14.22 |  2.33    7.16
                0.17    6.98 |  0.92  173.52 |  1.67   12.75 |  2.42    6.81
                0.25    7.77 |  1.00   85.70 |  1.75   11.57 |  2.50    6.49
                0.33    8.80 |  1.08   50.47 |  1.83   10.60 |  2.58    6.21
                0.42   10.18 |  1.17   35.39 |  1.92    9.79 |  2.67    5.95
                0.50   12.14 |  1.25   27.18 |  2.00    9.11 |  2.75    5.71
                0.58   15.15 |  1.33   22.07 |  2.08    8.52 |  2.83    5.49
```

```
                0.67   20.31 |  1.42   18.61 |  2.17    8.01 |  2.92    5.29


--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0001)|   Area    (ha)=   0.42   Curve Number   (CN)= 74.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.25

     Unit Hyd Qpeak  (cms)=   0.064

     PEAK FLOW       (cms)=   0.026 (i)
     TIME TO PEAK    (hrs)=   1.333
     RUNOFF VOLUME    (mm)=  23.201
     TOTAL RAINFALL   (mm)=  63.590
     RUNOFF COEFFICIENT   =   0.365

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0002)|   Area    (ha)=   2.17
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  75.00
--------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.63         0.54
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     120.31        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     173.52     ********
               over (min)          5.00        10.00
     Storage Coeff.  (min)=       2.29 (ii)    5.94 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.30         0.15
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.73         0.06          0.761 (iii)
     TIME TO PEAK    (hrs)=       1.00         1.08           1.00
     RUNOFF VOLUME    (mm)=      62.59        25.47          53.31
     TOTAL RAINFALL   (mm)=      63.59        63.59          63.59
     RUNOFF COEFFICIENT   =       0.98         0.40           0.84

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0003)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0001):     0.42   0.026     1.33    23.20
      + ID2= 2 (  0002):     2.17   0.761     1.00    53.31
        ================================================
        ID = 3 (  0003):     2.59   0.768     1.00    48.46

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
```

```
--------------------
| RESERVOIR(  0004)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1447      0.0332
                          0.0450     0.0066   |   0.1590      0.0398
                          0.0891     0.0133   |   0.1721      0.0465
                          0.1108     0.0199   |   0.1843      0.0531
                          0.1289     0.0266   |   0.1897      0.0562

                                  AREA     QPEAK     TPEAK       R.V.
                                  (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0003)      2.588      0.768      1.00      48.46
   OUTFLOW: ID= 1 (  0004)      2.588      0.182      1.33      48.45

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)= 23.66
                  TIME SHIFT OF PEAK FLOW         (min)= 20.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=  0.0518

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0005)|   Area    (ha)=   0.10
|ID= 1 DT= 5.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.05         0.05
     Dep. Storage     (mm)=       1.00         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      26.20        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     173.52        50.32
               over (min)         5.00        15.00
     Storage Coeff.  (min)=       0.92 (ii)   10.21 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.34         0.09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.02         0.00          0.026 (iii)
     TIME TO PEAK    (hrs)=       1.00         1.25           1.00
     RUNOFF VOLUME    (mm)=      62.59        25.47          43.97
     TOTAL RAINFALL   (mm)=      63.59        63.59          63.59
     RUNOFF COEFFICIENT   =       0.98         0.40           0.69

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  74.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0006)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0004):     2.59   0.182     1.33    48.45
      + ID2= 2 (  0005):     0.10   0.026     1.00    43.97
        ================================================
        ID = 3 (  0006):     2.69   0.189     1.33    48.27

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
```

Appendix F
Background Documents

RR98 - PP-01

IMAGES:

X-REFERENCES:

GEOGRAPHIC PROJECTION: U.T.M. NAD 83 ZONE 17
VERTICAL MONUMENT: Vertical Monument description - xxxxxxxxxx ELEV. #####
DATUM: Datum description - xxxxxxxxxx ELEV. #####

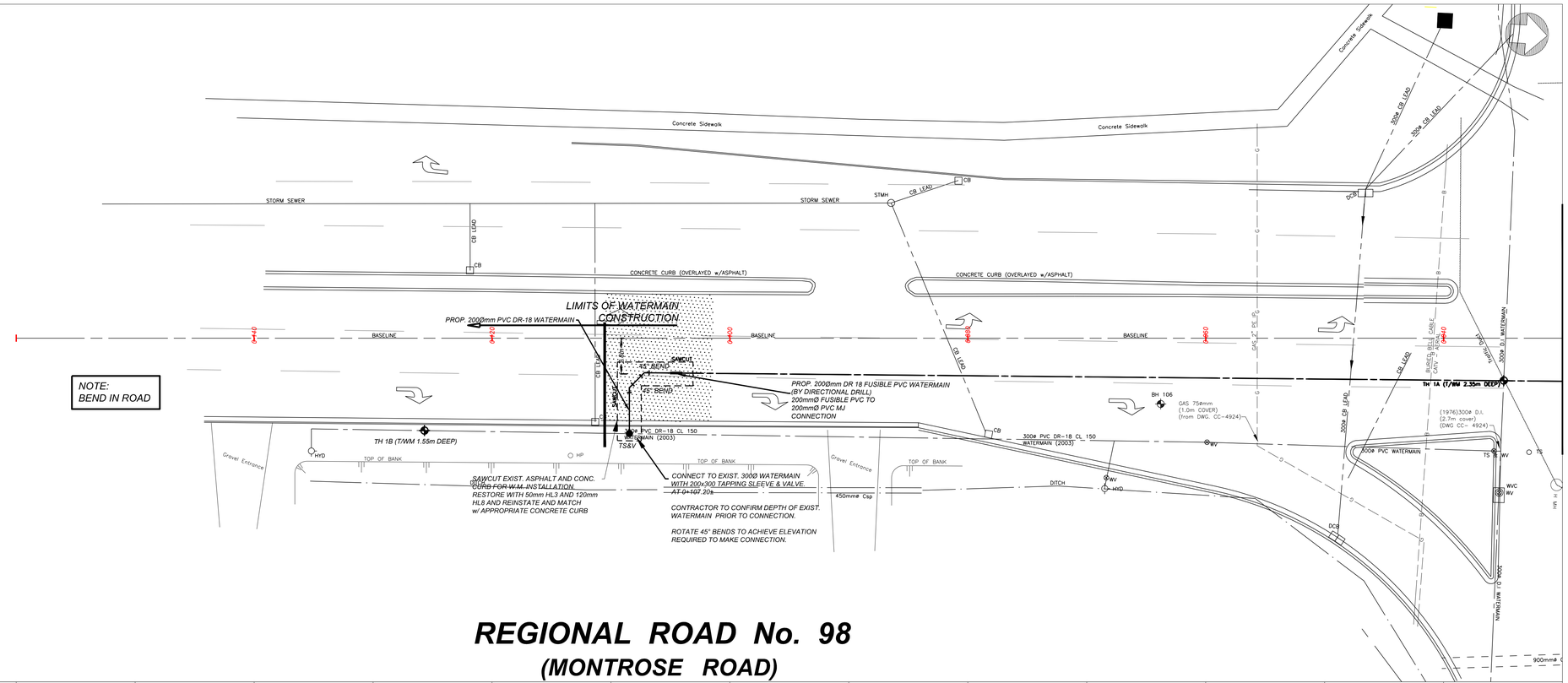
DWG NAME:
FILE FORMAT: Autodesk Civil 3D 2015 BOUNDING COORDINATES UPPER LEFT: Northing, Easting BOUNDING COORDINATES LOWER LEFT: Northing, Easting BOUNDING COORDINATES LOWER RIGHT: Northing, Easting

AS-BUILTS

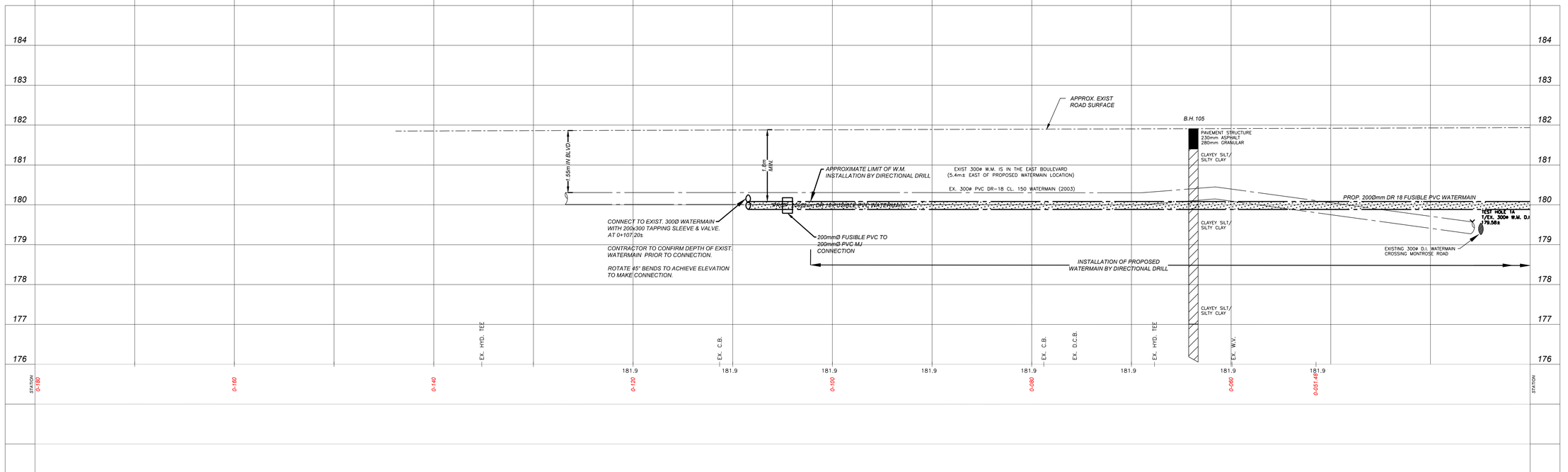
MOE	YYYY/MM/DD
MTO	YYYY/MM/DD
REGION	YYYY/MM/DD
CNR	YYYY/MM/DD

UTILITIES

ENBIN	YYYY/MM/DD
BELL	YYYY/MM/DD
ENBIN HYDRO	YYYY/MM/DD
COGECO HYDRO	YYYY/MM/DD
BELL	YYYY/MM/DD
CNR	YYYY/MM/DD



REGIONAL ROAD No. 98
(MONTROSE ROAD)



NO.	REVISION	DATE	INIT.
J	AS BUILT	2020/11/11	A.A.V.
H	ISSUED FOR CONSTRUCTION	2019/06/07	Y.W.
G	ISSUED FOR TENDERING	2019/01/09	Y.W.
F	ISSUED FOR TENDERING REVIEW	2018/11/30	Y.W.
E	ISSUED FOR 90% REVIEW	2018/10/22	Y.W.
D	ISSUED FOR UTILITY REVIEW (90%)	2017/04/12	R.B.
C	ISSUED FOR 70% REVIEW	2017/09/21	Y.W.
B	ISSUED FOR REVIEW	2017/07/05	R.B.
A	ISSUED FOR UTILITY TEST HOLES	2017/04/24	R.B.

NOTES/LEGEND

1 THE POSITION OF POLE LINES, CONDUITS, WATERMAINS, SEWER AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS AND, WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

CAD	R.B.B.
DESIGN	Y.W.
CHECKED BY	N.B.
APPROVED BY	

BENCH MARK

MONUMENT No: 90036061

Concrete box culvert under Montrose Road located at the intersection of Montrose Road and McLeod Road. 15.2m east from the centre line of Montrose Road, and 23.6m north from the centre line of McLeod Road. Brass Tablet set vertically in the top of the culvert 2.35m south from the north edge of culvert and 1.12m west from the east edge of culvert.

ELEVATION: 181.508m

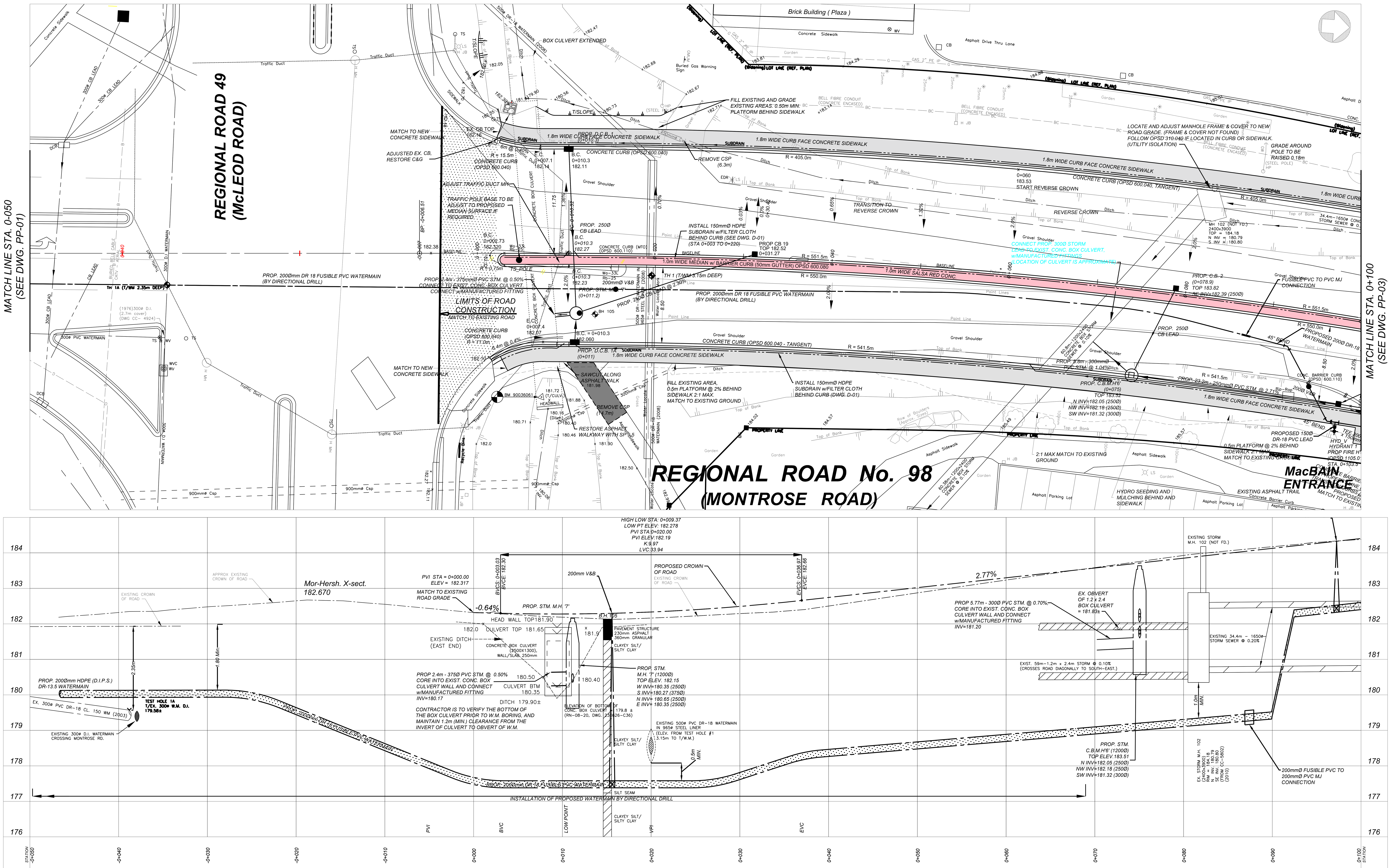
Niagara Region PUBLIC WORKS

PARSONS

RN19-05
ROAD RECONSTRUCTION AND WIDENING
REGIONAL ROAD 98 (MONTROSE ROAD)
NIAGARA FALLS
PLAN & PROFILE
FROM STA. 0-050 TO STA. 0-150

CONSULTANT FILE No.	603119
DATE	2019/06/07
SCALE	HORIZ. 1:200 VERT. 1:50
REF. No.	RR98 - PP-01
DWG No.	RR98 - PP-01
REV.	H

RR98 - PP-02



STATION	-0+050	-0+040	-0+030	-0+020	-0+010	0+000	0+010	0+020	0+030	0+040	0+050	0+060	0+070	0+080	0+090	0+100
EX. CROWN							182.19	182.16	182.29	182.50	182.87	183.23	183.58	183.93	184.17	184.38
PR. CROWN						182.32	182.28	182.33	182.49	182.74	183.02	183.30	183.57	183.85	184.13	184.40
PR. W. E/P							182.120	182.248	182.486	182.816	183.175	183.535	183.805	184.085	184.365	184.635
PR. E. E/P							182.060	182.130	182.290	182.540	182.820	183.100	183.370	183.650	183.930	184.200

NO.	REVISION	DATE	INIT.
J	AS BUILT	2020/11/11	A.A.V
1	ISSUED FOR ADDENDUM	2019/11/18	Y.W.
I	ISSUED FOR CONSTRUCTION	2019/06/07	Y.W.

NOTES/LEGEND

1 THE POSITION OF POLE LINES, CONDUITS, WATERMAINS, SEWER AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS AND, WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

ADDENDUM

CAD R.B.B.
DESIGN Y.W.
CHECKED BY N.B.
APPROVED BY

BENCH MARK

MONUMENT No: 90036061

Concrete box culvert under Montrose Road located at the intersection of Montrose Road and McLeod Road. 15.2m east from the centre line of Montrose Road, and 23.6m north from the centre line of McLeod Road. Brass Tablet set vertically in the top of the culvert 2.35m south from the north edge of culvert and 1.12m west from the east edge of culvert.

ELEVATION: 181.508m

Niagara Region PUBLIC WORKS

PARSONS

RN19-05
ROAD RECONSTRUCTION AND WIDENING
REGIONAL ROAD 98 (MONTROSE ROAD)
NIAGARA FALLS
PLAN & PROFILE
FROM STA. 0-050 TO STA. 0+100

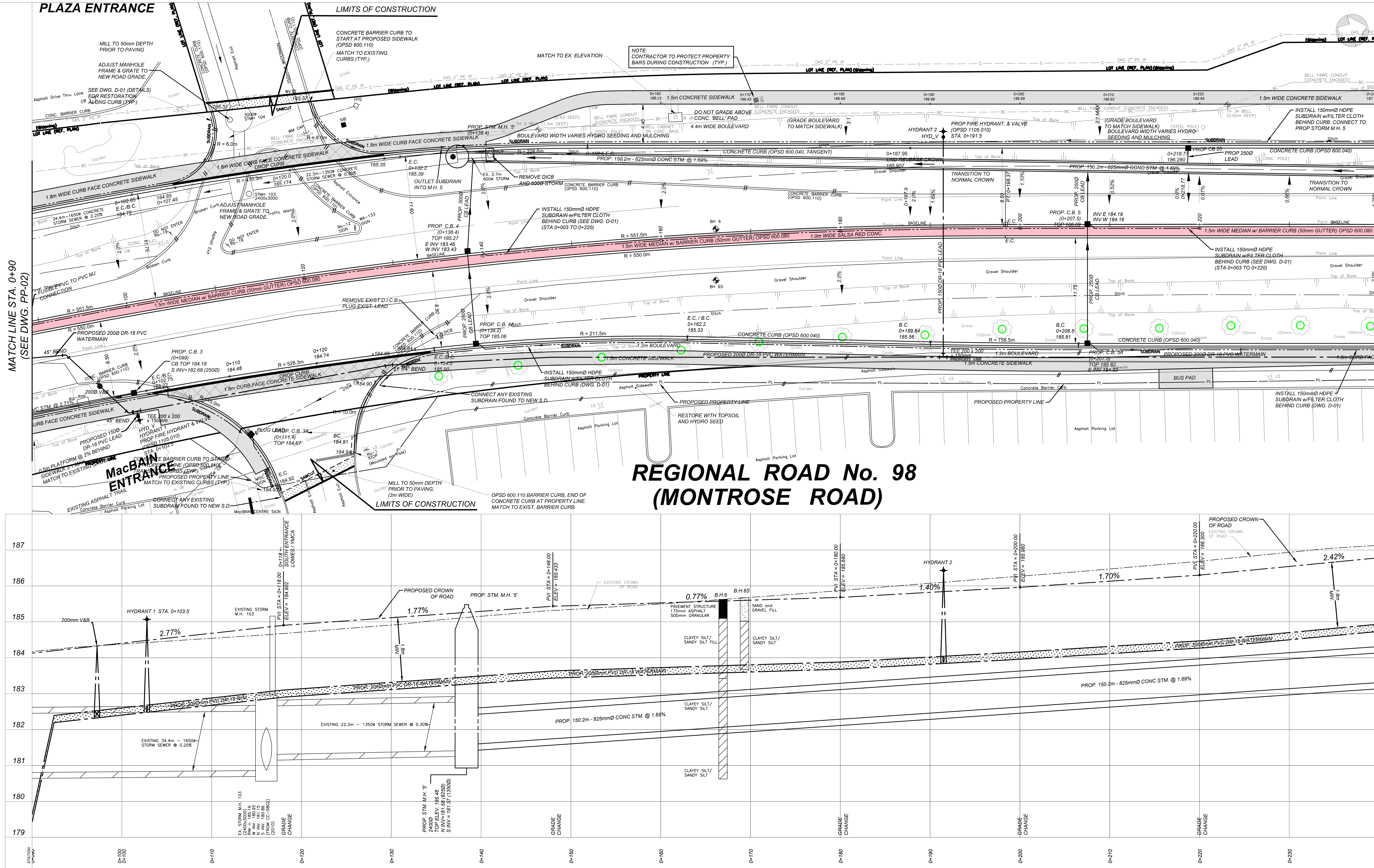
CONSULTANT FILE No. 603119
DATE 2019/06/07
SCALE HORIZ. 1:200 VERT. 1:50
REF. No. RR98 - PP-02
DWG No. RR98 - PP-02
REV. I

GEOGRAPHIC PROJECTION: U.T.M. NAD 83 ZONE 17
VERTICAL MONUMENT: Vertical Monument description XXXXXXXXXX ELEV. ###.###
DATUM: DATUM description XXXXXXXXXX ELEV. ###.###
DWG NAME:
FILE FORMAT: Autodesk Civil 3D 2015

APPROVALS
MOE YYYY/MM/DD
MTO YYYY/MM/DD
REGION YYYY/MM/DD
CNR YYYY/MM/DD
CPR YYYY/MM/DD

UTILITIES
NRBN YYYY/MM/DD
CNP YYYY/MM/DD
LOCAL HYDRO YYYY/MM/DD
ONTARIO HYDRO YYYY/MM/DD
GAS YYYY/MM/DD
BELL YYYY/MM/DD
CATV YYYY/MM/DD

RR98 - PP-03



STATION	0+090	0+100	0+100	0+110	0+120	0+130	0+140	0+150	0+160	0+170	0+180	0+190	0+200	0+210	0+220	0+230	0+240
EX. CROWN	184.17	184.38	184.38	184.54	184.71	184.91	185.15	185.34	185.50	185.68	185.87	186.07	186.27	186.47	186.69	186.93	187.13
PR. CROWN	184.13	184.40	184.40	184.68	184.94	185.11	185.29	185.45	185.53	185.60	185.68	185.82	185.96	186.13	186.30	186.54	186.78
PR. W. E/P	365	184.635	184.635	184.915	185.174	185.342	185.516	185.661	185.727	185.784	185.856	185.964	186.054	186.174	186.294	186.484	186.674
PR. E. E/P	930	184.200	184.200	184.480	184.740	184.910	185.088	185.241	185.307	185.360	185.427	185.560	185.695	185.865	186.035	186.275	186.515

NO.	REVISION	DATE	INIT.
J	AS BUILT	2020/11/11	A.A.V
J	ADDENDUM 1	2019/06/28	Y.W.
I	ISSUED FOR CONSTRUCTION	2019/06/07	Y.W.
H	ISSUED FOR TENDERING	2019/01/09	Y.W.
G	ISSUED FOR TENDERING REVIEW	2018/11/30	Y.W.
F	ISSUED FOR 90% REVIEW	2018/10/22	Y.W.
E	ISSUED FOR UTILITY REVIEW (90%)	2017/04/12	R.B.
D	ISSUED FOR 70% REVIEW	2017/09/21	Y.W.
C	ISSUED FOR REVIEW	2017/07/05	R.B.
B	ISSUED FOR UTILITY TEST HOLES	2017/03/24	R.B.
A	ISSUED FOR UTILITY REVIEW	2017/01/06	R.B.

NOTES/LEGEND

1. THE POSITION OF POLE LINES, CONDUITS, WATERMAINS, SEWER AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS AND, WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

2. EXISTING RED MAPLE TREES BETWEEN STA 0+130 AND 0+255 TO BE SALVAGED AND RELOCATED. SEE SHEET L3.

3. ○ EXISTING TREES TO BE RELOCATED

4. ADDENDUM

CAD: R.B.B.
DESIGN: Y.W.
CHECKED BY: N.B.
APPROVED BY:

BENCH MARK

MONUMENT No: 90036061

Concrete box culvert under Montrose Road located at the intersection of Montrose Road and McLeod Road. 15.2m east from the centre line of Montrose Road, and 23.6m north from the centre line of McLeod Road. Brass Tablet set vertically in the top of the culvert 2.35m south from the north edge of culvert and 1.12m west from the east edge of culvert.

ELEVATION: 181.508m

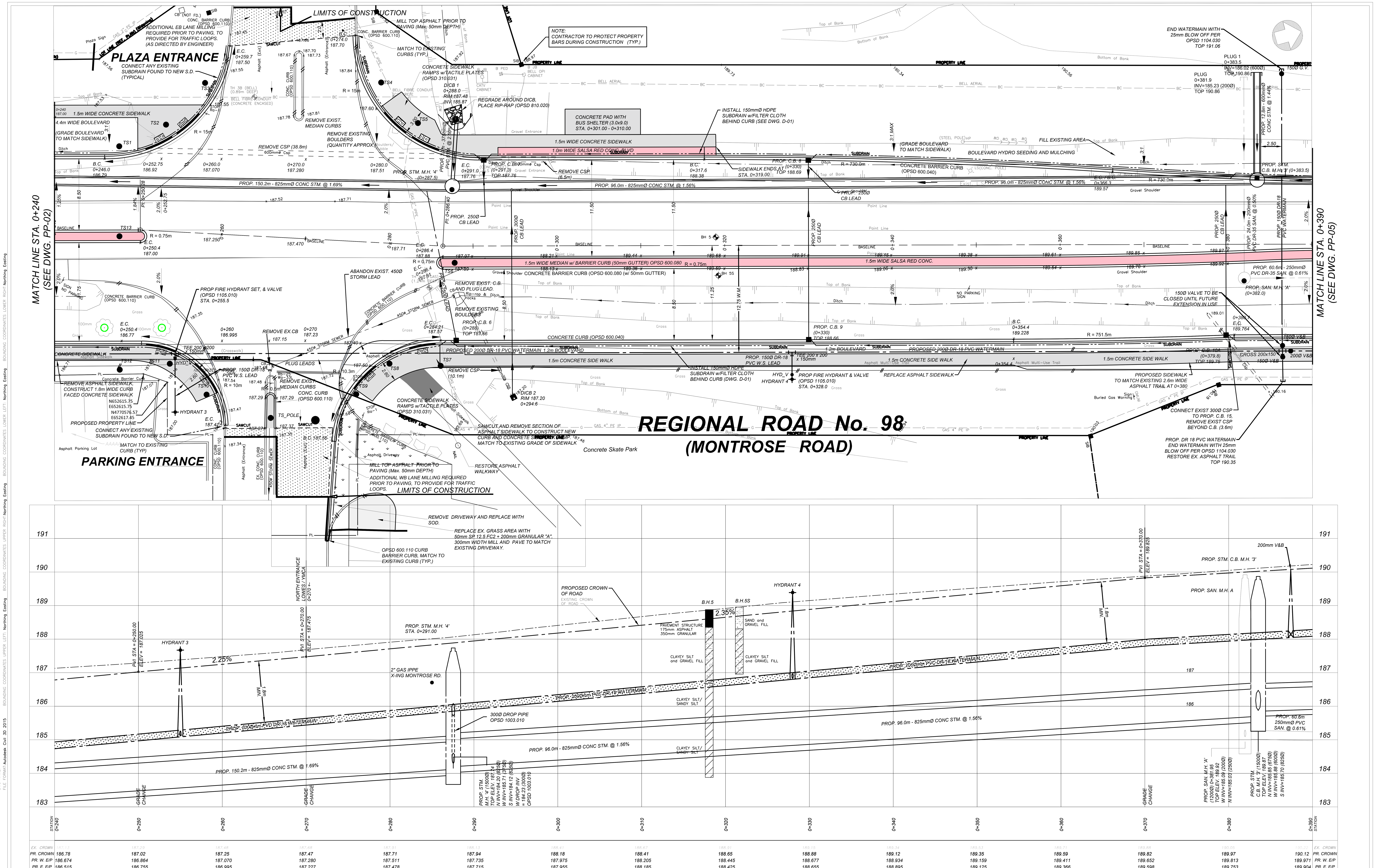
Niagara Region PUBLIC WORKS

PARSONS

RN19-05
ROAD RECONSTRUCTION AND WIDENING
REGIONAL ROAD 98 (MONTROSE ROAD)
NIAGARA FALLS
PLAN & PROFILE
FROM STA. 0+100 TO STA. 0+240

CONSULTANT FILE No. 603119
DATE 2019/06/07
SCALE HORIZ. 1:200 VERT. 1:50
REF. No. RR98 - PP-03
DWG No. RR98 - PP-03
REV. I

RR98 - PP-04



NOTES/LEGEND

1. THE POSITION OF POLE LINES, CONDUITS, WATERMAINS, SEWER AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS AND, WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

2. EXISTING TREES TO BE RELOCATED

3. ADDENDUM

NO.	REVISION	DATE	INIT.
J	AS BUILT	2020/11/11	A.A.V.
2	ADDENDUM	2019/11/18	Y.W.
1	ADDENDUM 1	2019/06/28	Y.W.
1	ISSUED FOR CONSTRUCTION	2019/06/07	Y.W.

CAD: R.B.B.
DESIGN: Y.W.
CHECKED BY: N.B.
APPROVED BY:

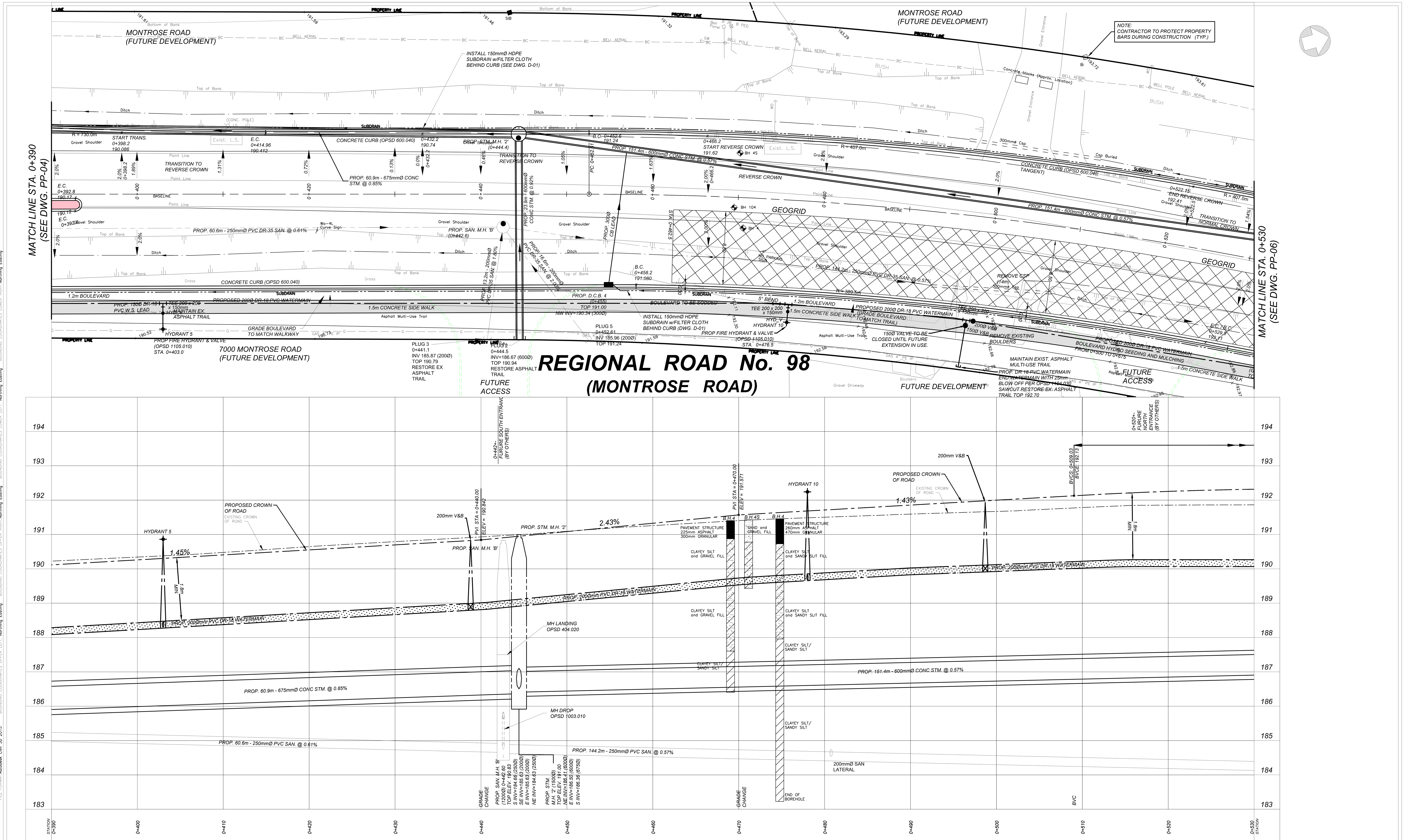
BENCH MARK
MONUMENT No: 90036061
Concrete box culvert under Montrose Road located at the intersection of Montrose Road and McLeod Road. 15.2m east from the centre line of Montrose Road, and 23.6m north from the centre line of McLeod Road. Brass Tablet set vertically in the top of the culvert 2.35m south from the north edge of culvert and 1.12m west from the east edge of culvert.
ELEVATION: 181.508m

Niagara Region PUBLIC WORKS
PARSONS

RN19-05
ROAD RECONSTRUCTION AND WIDENING
REGIONAL ROAD 98 (MONTROSE ROAD)
NIAGARA FALLS
PLAN & PROFILE
FROM STA. 0+240 TO STA. 0+390

CONSULTANT FILE No. 603119
DATE 2019/06/07
SCALE HORIZ. 1:200 VERT. 1:50
REF. No. RR98 - PP-04
DWG No. RR98 - PP-04
REV. I

RR98 - PP-05



STATION	0+390	0+400	0+410	0+420	0+430	0+440	0+450	0+460	0+470	0+480	0+490	0+500	0+510	0+520	0+530
EX. CROWN	190.22	190.34	190.48	190.65	190.79	190.93	191.09	191.26	191.40	191.50	191.59	191.67	191.78	191.85	191.86
PR. CROWN	190.12	190.26	190.41	190.55	190.70	190.84	191.09	191.33	191.57	191.71	191.86	192.00	192.14	192.26	192.32
PR. W. E/P	189.971	190.124	190.318	190.500	190.691	190.872	191.164	191.444	191.710	191.840	192.000	192.140	192.280	192.400	192.428
PR. E. E/P	189.904	190.046	190.196	190.336	190.488	190.627	190.878	191.120	191.360	191.500	191.650	191.790	191.930	192.050	192.110

NO.	REVISION	DATE	INIT.
J	AS BUILT	2020/11/11	A.A.V
J	ADDENDUM 1	2019/06/28	Y.W.
I	ISSUED FOR CONSTRUCTION	2019/06/07	Y.W.
H	ISSUED FOR TENDERING	2019/01/09	Y.W.
G	ISSUED FOR TENDERING REVIEW	2018/11/30	Y.W.
F	ISSUED FOR 90% REVIEW	2018/10/22	Y.W.
E	ISSUED FOR UTILITY REVIEW (90%)	2017/04/12	R.B.
D	ISSUED FOR 70% REVIEW	2017/09/21	Y.W.
C	ISSUED FOR REVIEW	2017/07/05	R.B.
B	ISSUED FOR UTILITY TEST HOLES	2017/03/24	R.B.
A	ISSUED FOR UTILITY REVIEW	2017/01/06	R.B.

NOTES/LEGEND

1 THE POSITION OF POLE LINES, CONDUITS, WATERMAINS, SEWER AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS AND, WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

2. ◯ EXISTING TREES TO BE RELOCATED

3. REVISION OF ADDENDUM 1

CAD R.B.B.
DESIGN Y.W.
CHECKED BY N.B.
APPROVED BY

BENCH MARK

MONUMENT No: 90036061

Concrete box culvert under Montrose Road located at the intersection of Montrose Road and McLeod Road. 15.2m east from the centre line of Montrose Road, and 23.6m north from the centre line of McLeod Road. Brass Tablet set vertically in the top of the culvert 2.35m south from the north edge of culvert and 1.12m west from the east edge of culvert.

ELEVATION: 181.508m

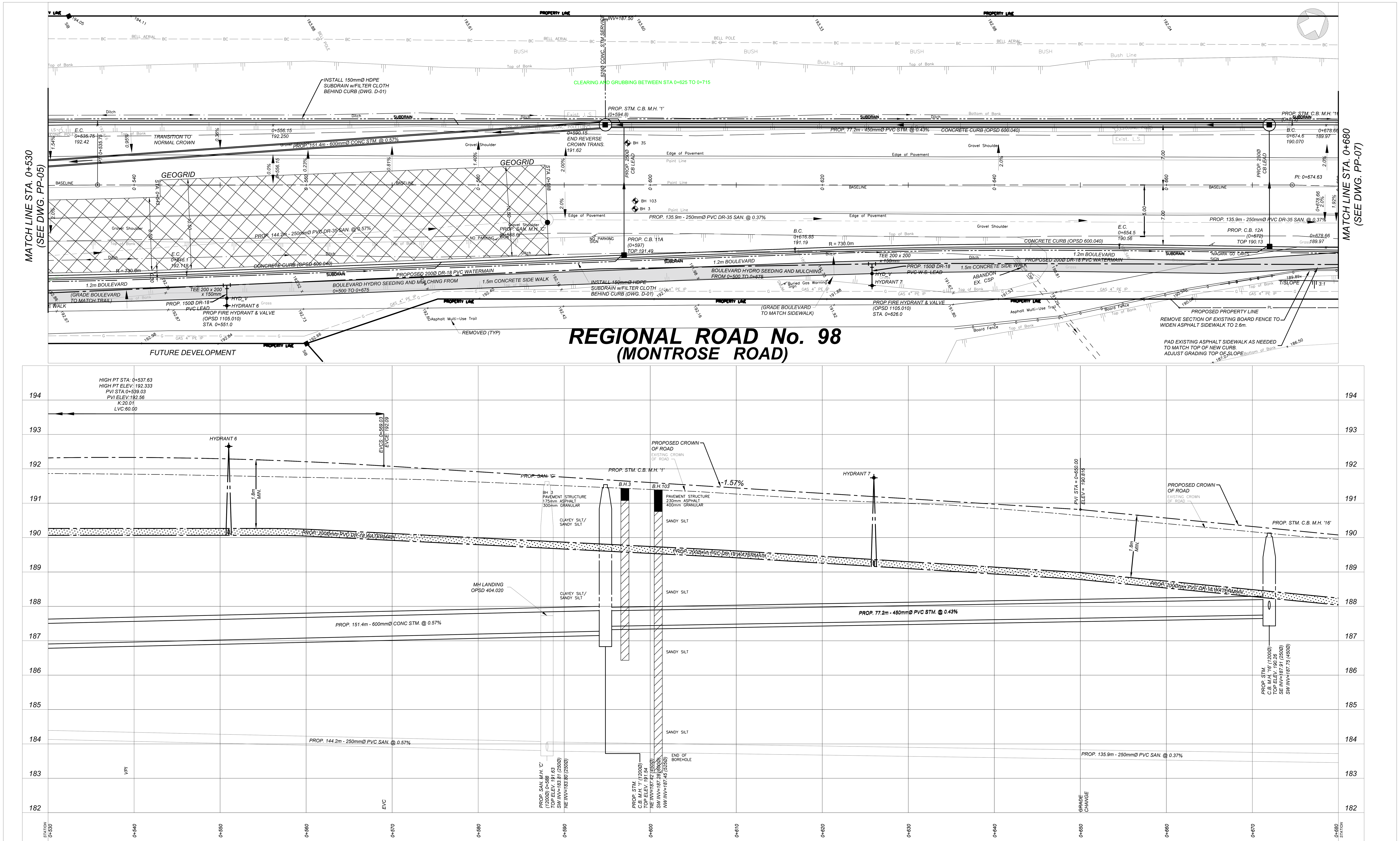
Niagara Region PUBLIC WORKS

PARSONS

RN19-05
ROAD RECONSTRUCTION AND WIDENING
REGIONAL ROAD 98 (MONTROSE ROAD)
NIAGARA FALLS
PLAN & PROFILE
FROM STA. 0+390 TO STA. 0+540

CONSULTANT FILE No. 603119
DATE 2019/06/07
SCALE HORIZ. 1:200 VERT. 1:50
REF. No. RR98 - PP-05
DWG No. RR98 - PP-05
REV. I

RR98 - PP-06



STATION	0+530	0+540	0+550	0+560	0+570	0+580	0+590	0+600	0+610	0+620	0+630	0+640	0+650	0+660	0+670	0+680
EX. CROWN	191.86	191.84	191.80	191.75	191.70	191.62	191.51	191.40	191.27	191.10	191.00	190.85	190.64	190.41	190.17	189.95
PR. CROWN	192.32	192.33	192.29	192.21	192.07	191.91	191.76	191.60	191.44	191.29	191.13	190.97	190.82	190.57	190.32	190.08
PR. W. E/P	192.428	192.397	192.315	192.194	192.013	191.812	191.620	191.460	191.300	191.150	190.990	190.830	190.680	190.430	190.180	189.940
PR. E. E/P	192.110	192.124	192.090	192.019	191.885	191.733	191.592	191.438	191.288	191.144	190.990	190.832	190.682	190.430	190.176	189.942

NO.	REVISION	DATE	INIT.
J	AS BUILT	2020/11/11	A.A.V
I	ISSUED FOR CONSTRUCTION	2019/06/07	Y.W.
H	ISSUED FOR TENDERING	2019/01/09	Y.W.
G	ISSUED FOR TENDERING REVIEW	2018/11/30	Y.W.
F	ISSUED FOR 90% REVIEW	2018/10/22	Y.W.
E	ISSUED FOR UTILITY REVIEW (90%)	2017/04/12	R.B.
D	ISSUED FOR 70% REVIEW	2017/09/21	Y.W.
C	ISSUED FOR REVIEW	2017/07/05	R.B.
B	ISSUED FOR UTILITY TEST HOLES	2017/03/24	R.B.
A	ISSUED FOR UTILITY REVIEW	2017/01/06	R.B.

NOTES/LEGEND

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CAD R.B.B.
DESIGN Y.W.
CHECKED BY N.B.
APPROVED BY

BENCH MARK

MONUMENT No: 90036061

Concrete box culvert under Montrose Road located at the intersection of Montrose Road and McLeod Road. 15.2m east from the centre line of Montrose Road, and 23.6m north from the centre line of McLeod Road. Brass Tablet set vertically in the top of the culvert 2.35m south from the north edge of culvert and 1.12m west from the east edge of culvert.

ELEVATION: 181.508m

Niagara Region PUBLIC WORKS

PARSONS

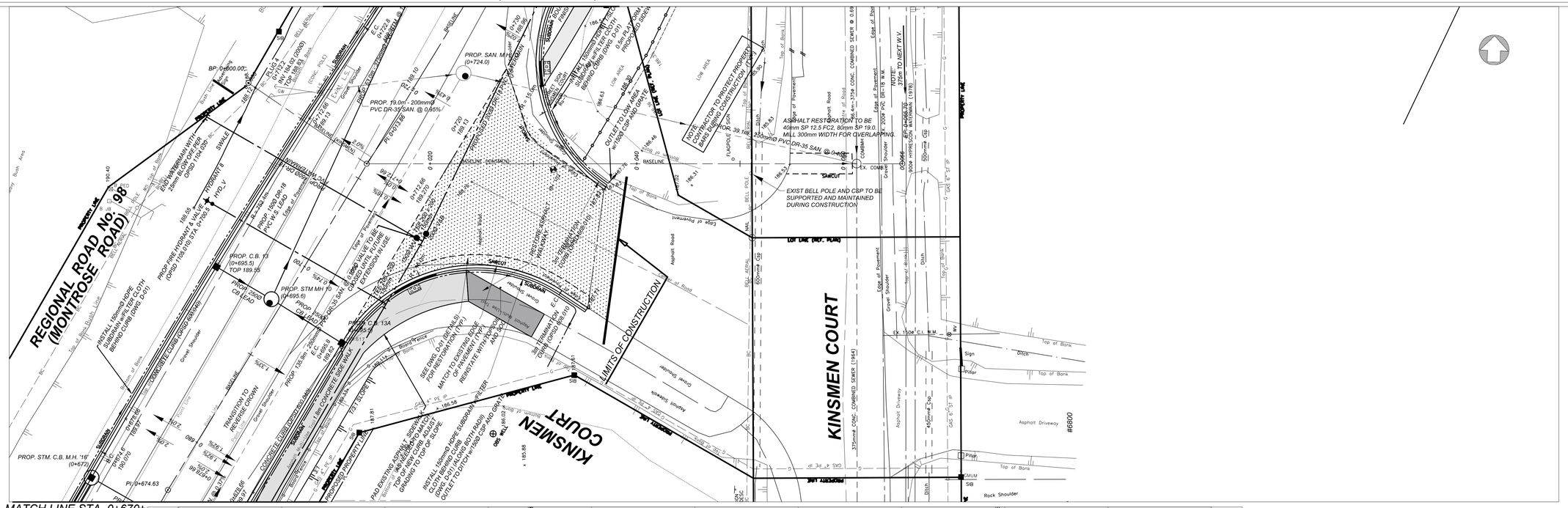
RN19-05
ROAD RECONSTRUCTION AND WIDENING

REGIONAL ROAD 98 (MONTROSE ROAD)
NIAGARA FALLS
PLAN & PROFILE
FROM STA. 0+530 TO STA. 0+680

CONSULTANT FILE No. 603119
DATE 2019/06/07
SCALE HORIZ. 1:200 VERT. 1:50
REF. No. RR98 - PP-06
DWG No. RR98 - PP-06
REV. I

RR98 - PP-07

MATCH LINE STA. 0+730± (SEE DWG. PP-08)



MATCH LINE STA. 0+670± (SEE DWG. PP-06)

J	AS BUILT	2020/11/11	A.A.V.
J	ADDENDUM 1	2019/06/28	Y.W.
I	ISSUED FOR CONSTRUCTION	2019/06/07	Y.W.
H	ISSUED FOR TENDERING	2019/01/09	Y.W.
G	ISSUED FOR TENDERING REVIEW	2018/11/30	Y.W.
F	ISSUED FOR 90% REVIEW	2018/10/22	Y.W.
E	ISSUED FOR UTILITY REVIEW (90%)	2017/04/12	R.B.
D	ISSUED FOR 70% REVIEW	2017/09/21	Y.W.
C	ISSUED FOR REVIEW	2017/07/05	R.B.
NO.	REVISION	DATE	INIT.

NOTES/LEGEND

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2. REVISION OF ISSUED FOR CONSTRUCTION

CAD	R.B.B.
DESIGN	Y.W.
CHECKED BY	N.B.
APPROVED BY	

BENCH MARK

MONUMENT No: 90036061

Concrete box culvert under Montrose Road located at the intersection of Montrose Road and McLeod Road. 15.2m east from the centre line of Montrose Road, and 23.6m north from the centre line of McLeod Road. Brass Tablet set vertically in the top of the culvert 2.35m south from the north edge of culvert and 1.12m west from the east edge of culvert.

ELEVATION: 181.508m

Niagara Region PUBLIC WORKS

PARSONS

RN19-05

ROAD RECONSTRUCTION AND WIDENING

REGIONAL ROAD 98 (MONTROSE ROAD)

NIAGARA FALLS

PLAN & PROFILE

KINSMEN COURT (FROM STA. 0+000 TO STA. 0+050)

CONSULTANT FILE No.	603119
DATE	2019/6/07
SCALE	HORIZ. 1:200 VERT. 1:50
REF. No.	RR98 - PP-07
DWG No.	RR98 - PP-07
REV.	I

X-REFERENCES:

IMAGES:

GEOGRAPHIC PROJECTION: U.T.M. NAD 83 ZONE 17
VERTICAL MONUMENT: Vertical Monument description XXXXXXXXX ELEV. #####
DATUM: Datum description XXXXXXXX ELEV. #####

DWG NAME:
FILE FORMAT: Autodesk Civil 3D 2015 BOUNDING COORDINATES: UPPER LEFT: Northing Easting BOUNDING COORDINATES: UPPER RIGHT: Northing Easting BOUNDING COORDINATES: LOWER LEFT: Northing Easting BOUNDING COORDINATES: LOWER RIGHT: Northing Easting

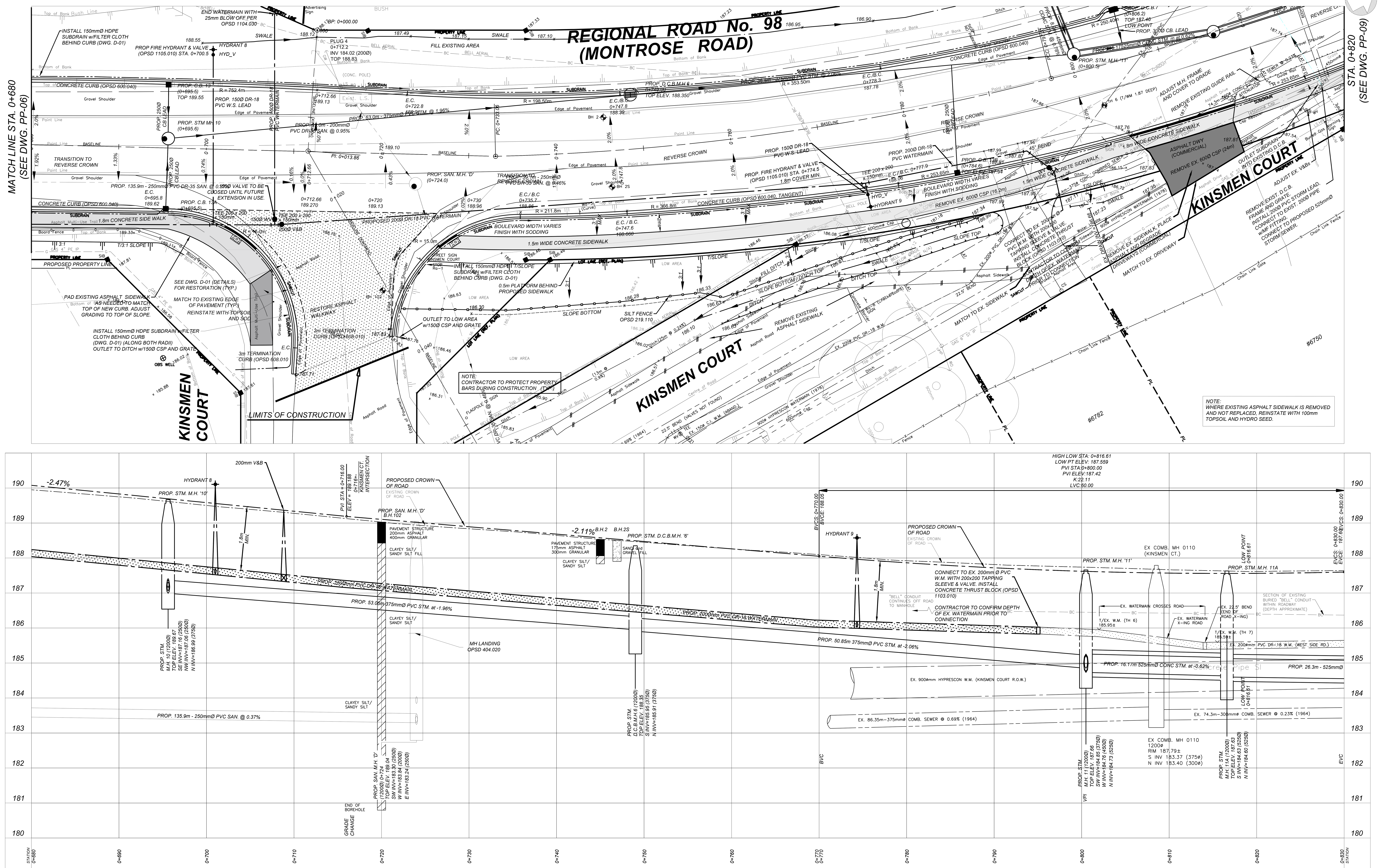
ASSESSMENTS

MOE	YYY/MM/DD
MTO	YYY/MM/DD
REGION	YYY/MM/DD
CNR	YYY/MM/DD

UTILITIES

NMBN	YYY/MM/DD
NIAGARA HYDRO	YYY/MM/DD
ENBRIDGE	YYY/MM/DD
BELL	YYY/MM/DD
CATV	YYY/MM/DD

RR98 - PP-08



STATION	0+680	0+690	0+700	0+710	0+720	0+730	0+740	0+750	0+760	0+770	0+770	0+780	0+790	0+800	0+810	0+820	0+830
EX. CROWN	189.95	189.75	189.50	189.28	189.03	188.84	188.65	188.45	188.26	188.10	188.10	187.92	187.81	187.74	187.66	187.62	187.64
PR. CROWN	190.08	189.83	189.58	189.34	189.10	188.89	188.68	188.47	188.26	188.05	188.05	187.86	187.72	187.62	187.57	187.56	187.60
PR. W. E/P	189.940	189.690	189.440	189.198	188.956	188.758	188.551	188.346	188.140	187.937	187.937	187.754	187.618	187.520	187.470	187.460	187.500
PR. E. E/P	189.942	189.737	189.529	189.329	189.195	188.958	188.787	188.611	188.406	188.202	188.202	188.019	187.884	187.784	187.736	187.726	187.765

NO.	REVISION	DATE	INIT.
J	AS BUILT	2020/11/11	A.A.V
J	ADDENDUM 1	2019/06/28	Y.W.
I	ISSUED FOR CONSTRUCTION	2019/06/07	Y.W.
H	ISSUED FOR TENDERING	2019/01/09	Y.W.
G	ISSUED FOR TENDERING REVIEW	2018/11/30	Y.W.
F	ISSUED FOR 90% REVIEW	2018/10/22	Y.W.
E	ISSUED FOR UTILITY REVIEW (90%)	2017/04/12	R.B.
D	ISSUED FOR 70% REVIEW	2017/09/21	Y.W.
C	ISSUED FOR REVIEW	2017/07/05	R.B.
B	ISSUED FOR UTILITY TEST HOLES	2017/03/24	R.B.
A	ISSUED FOR UTILITY REVIEW	2017/01/06	R.B.

NOTES/LEGEND

1. THE POSITION OF POLE LINES, CONDUITS, WATERMAINS, SEWER AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS AND, WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

2. REVISION OF ADDENDUM 1

CAD: R.B.B.
DESIGN: Y.W.
CHECKED BY: N.B.
APPROVED BY:

BENCH MARK

MONUMENT No: 90036061

Concrete box culvert under Montrose Road located at the intersection of Montrose Road and McLeod Road. 15.2m east from the centre line of Montrose Road, and 23.6m north from the centre line of McLeod Road. Brass Tablet set vertically in the top of the culvert 2.35m south from the north edge of culvert and 1.12m west from the east edge of culvert.

ELEVATION: 181.508m

Niagara Region PUBLIC WORKS

PARSONS

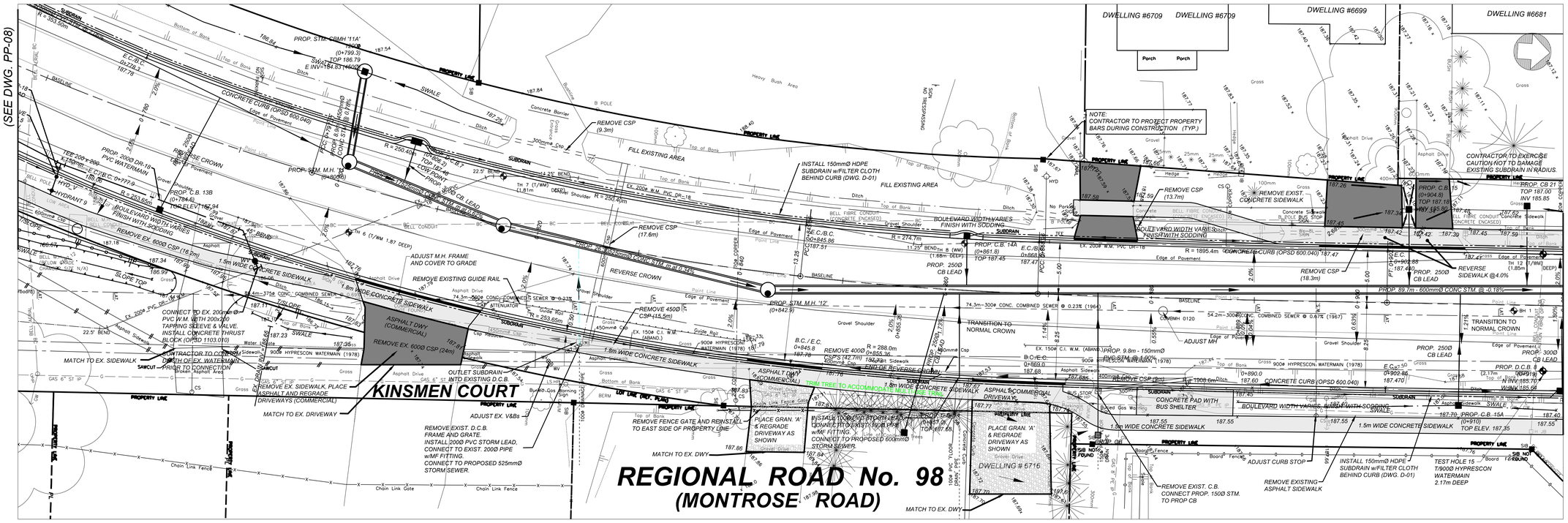
RN19-05
ROAD RECONSTRUCTION AND WIDENING
REGIONAL ROAD 98 (MONTROSE ROAD)
NIAGARA FALLS
PLAN & PROFILE
FROM STA. 0+680 TO STA. 0+770

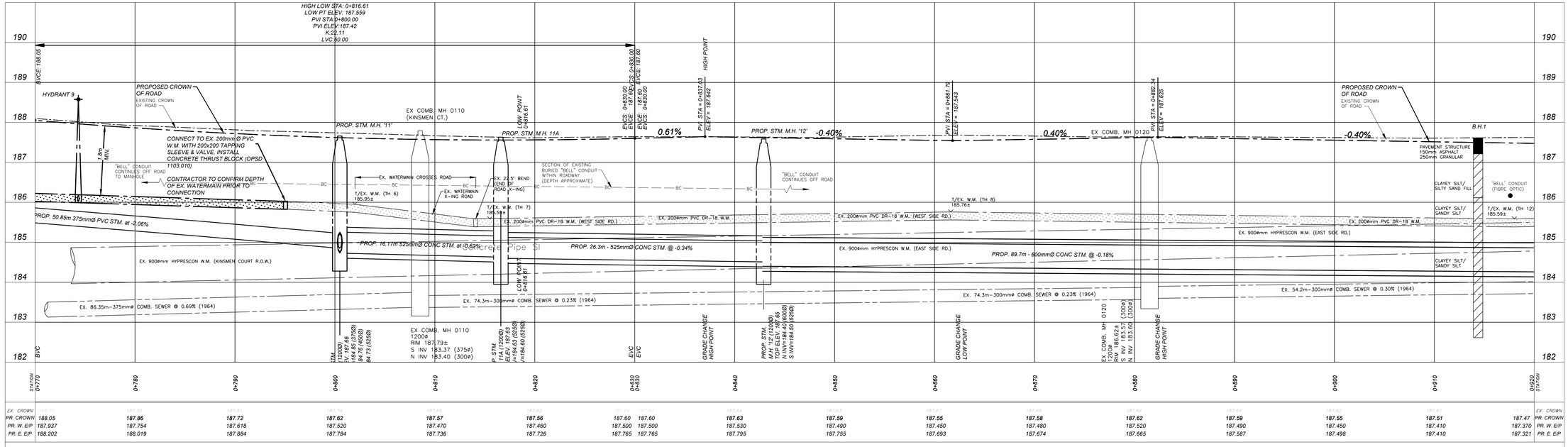
CONSULTANT FILE No. 603119
DATE 2019/06/07
SCALE HORIZ. 1:200 VERT. 1:50
REF. No. RR98 - PP-08
DWG No. RR98 - PP-08
REV. I

RR98 - PP-09

MATCH LINE STA. 0+770 (SEE DWG. PP-08)

MATCH LINE STA. 0+920 (SEE DWG. PP-10)





J	AS BUILT	2020/11/11	A.A.V
I	ISSUED FOR CONSTRUCTION	2019/06/07	Y.W.
H	ISSUED FOR TENDERING	2019/01/09	Y.W.
G	ISSUED FOR TENDERING REVIEW	2018/11/30	Y.W.
F	ISSUED FOR 90% REVIEW	2018/10/22	Y.W.
E	ISSUED FOR UTILITY REVIEW (90%)	20017/04/12	R.B.
D	ISSUED FOR 70% REVIEW	2017/09/21	Y.W.
C	ISSUED FOR REVIEW	2017/07/05	R.B.
B	ISSUED FOR UTILITY TEST HOLES	2017/03/24	R.B.
A	ISSUED FOR UTILITY REVIEW	2017/01/06	R.B.
NO.	REVISION	DATE	INIT.

NOTES/LEGEND

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CAD	R.B.B.
DESIGN	Y.W.
CHECKED BY	N.B.
APPROVED BY	

BENCH MARK

MONUMENT No: 90036061

Concrete box culvert under Montrose Road located at the intersection of Montrose Road and McLeod Road. 15.2m east from the centre line of Montrose Road, and 23.6m north from the centre line of McLeod Road. Brass Tablet set vertically in the top of the culvert 2.35m south from the north edge of culvert and 1.12m west from the east edge of culvert.

ELEVATION: 181.508m

Niagara Region PUBLIC WORKS

PARSONS

RN19-05
ROAD RECONSTRUCTION AND WIDENING
REGIONAL ROAD 98 (MONTROSE ROAD)
NIAGARA FALLS
PLAN & PROFILE
FROM STA. 0+770 TO STA. 0+920

CONSULTANT FILE No.	603119
DATE	2019/06/07
SCALE	HORIZ. 1:200 VERT. 1:50
REF. No.	RR98 - PP-09
DWG No.	RR98 - PP-09
REV.	I

X-REFERENCES:

IMAGES:

ABBREVIALS

MADE	YYYY/MM/DD
CHKD	YYYY/MM/DD
REVD	YYYY/MM/DD
APPD	YYYY/MM/DD

UTILITIES

BELL	YYYY/MM/DD
CNTV	YYYY/MM/DD
DATA	YYYY/MM/DD
HYDRO	YYYY/MM/DD
GAS	YYYY/MM/DD
WATER	YYYY/MM/DD

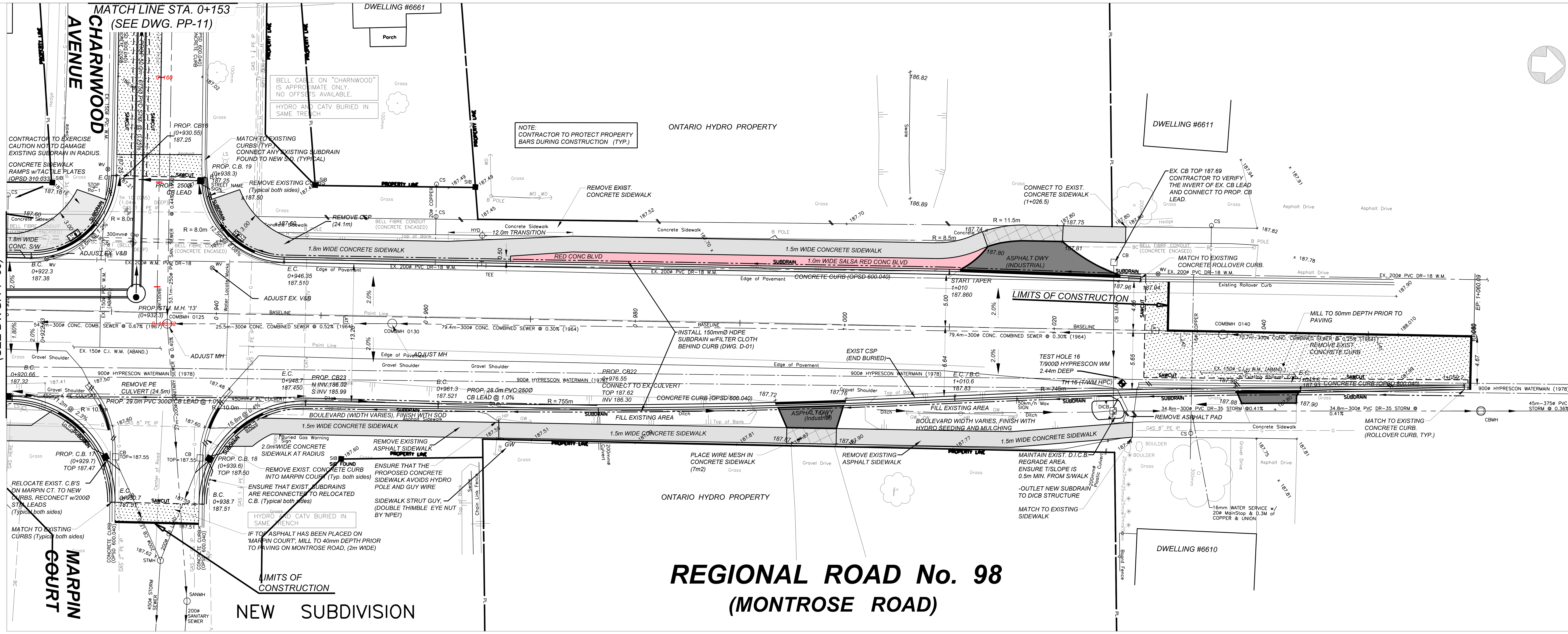
GEOGRAPHIC PROJECTION: U.T.M. NAD 83 ZONE 17
VERTICAL MONUMENT: Vertical Monument description XXXXXXXXX ELEV. #####
DATUM: DATUM description XXXXXXXXX ELEV. #####

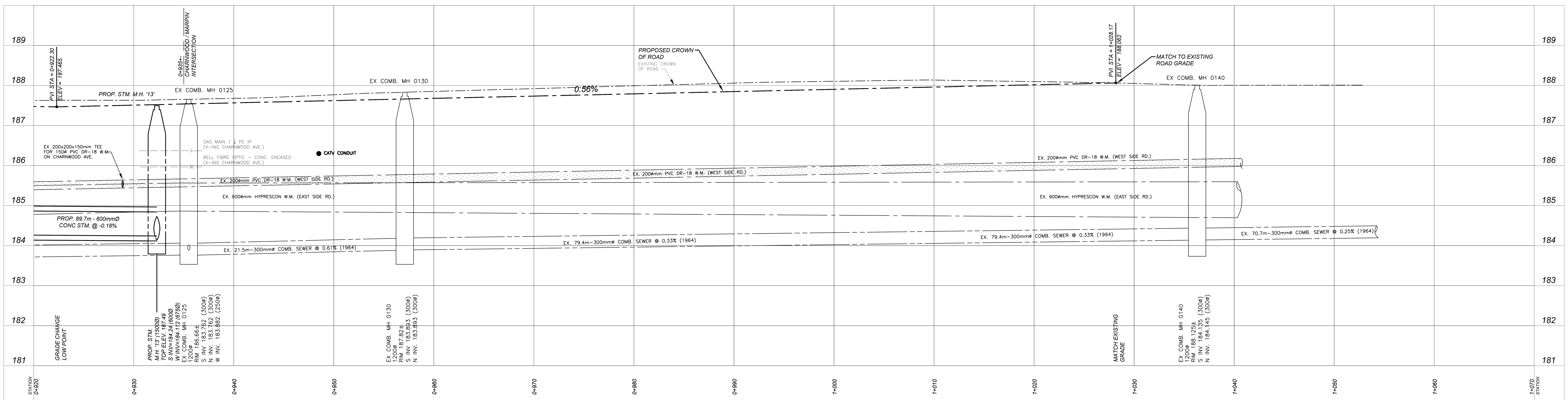
DWG NAME:
FILE FORMAT: Autodesk Civil 3D 2015

BOUNDING COORDINATES UPPER LEFT: Northing Easting BOUNDING COORDINATES UPPER RIGHT: Northing Easting

BOUNDING COORDINATES LOWER LEFT: Northing Easting BOUNDING COORDINATES LOWER RIGHT: Northing Easting

RR98 - PP-10





	0+920	0+930	0+940	0+950	0+960	0+970	0+980	0+990	1+000	1+010	1+020	1+030
PR. CROWN	187.47	187.51	187.57	187.62	187.68	187.73	187.79	187.85	187.90	187.96	188.02	188.062
PR. W. E/P	187.370	187.410	187.470	187.520	187.580	187.630	187.690	187.750	187.800	187.860	187.924	187.969
PR. E. E/P	187.321	187.345	187.406	187.456	187.516	187.567	187.631	187.696	187.756	187.826	187.900	187.949

NO.	REVISION	DATE	INIT.
J	AS BUILT	2020/11/11	A.A.V
I	ISSUED FOR CONSTRUCTION	2019/06/07	Y.W.
H	ISSUED FOR TENDERING	2019/01/09	Y.W.
G	ISSUED FOR TENDERING REVIEW	2018/11/30	Y.W.
F	ISSUED FOR 90% REVIEW	2018/10/22	Y.W.
E	ISSUED FOR UTILITY REVIEW (90%)	2017/04/12	R.B.
D	ISSUED FOR 70% REVIEW	2017/09/21	Y.W.
C	ISSUED FOR REVIEW	2017/07/05	R.B.
B	ISSUED FOR UTILITY TEST HOLES	2017/03/24	R.B.
A	ISSUED FOR UTILITY REVIEW	2017/01/06	R.B.

NOTES/LEGEND

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CAD: R.B.B.
DESIGN: Y.W.
CHECKED BY: N.B.
APPROVED BY:

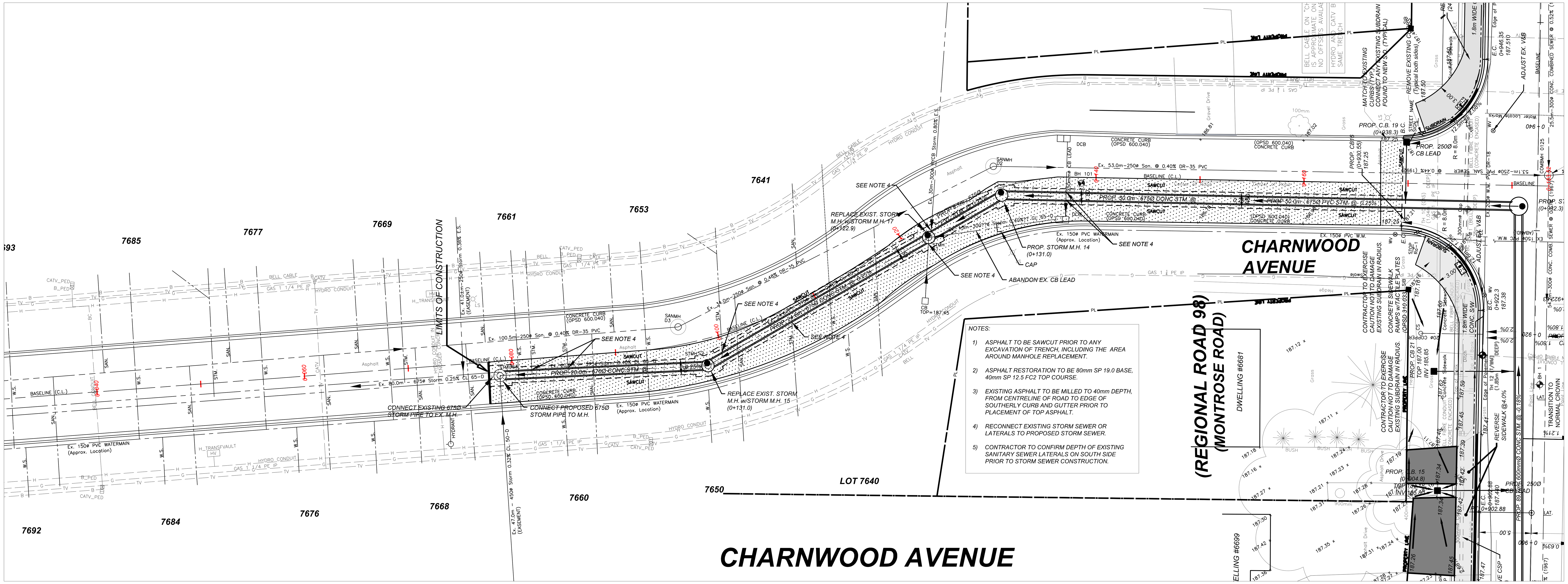
BENCH MARK
MONUMENT No: 90036061
Concrete box culvert under Montrose Road located at the intersection of Montrose Road and McLeod Road. 15.2m east from the centre line of Montrose Road, and 23.6m north from the centre line of McLeod Road. Brass Tablet set vertically in the top of the culvert 2.35m south from the north edge of culvert and 1.12m west from the east edge of culvert.
ELEVATION: 181.508m

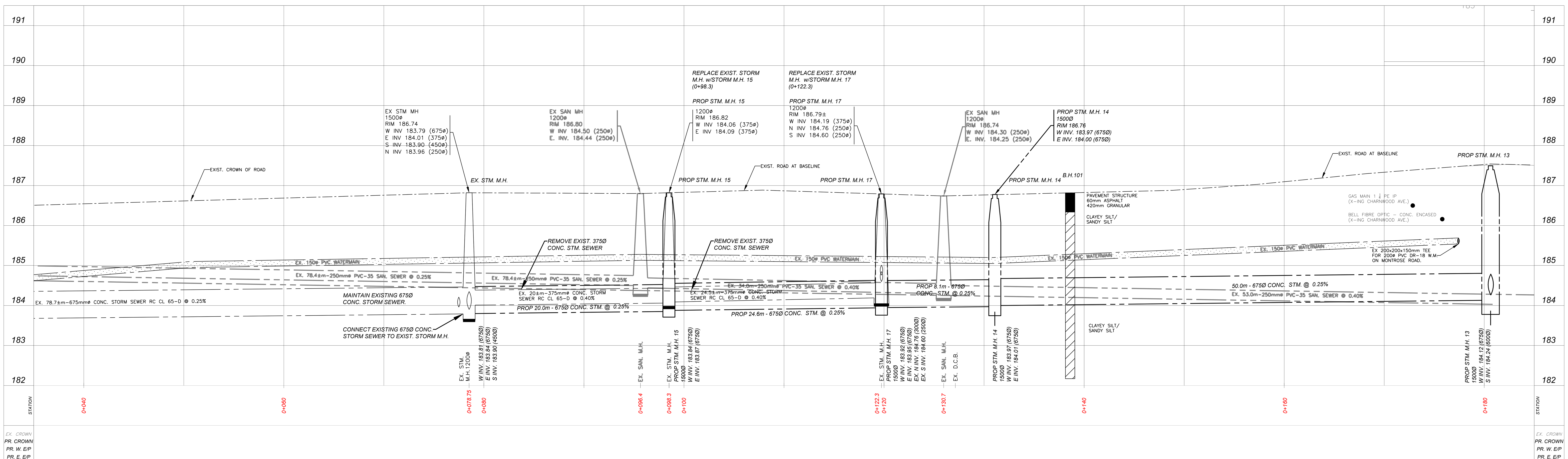
Niagara Region PUBLIC WORKS
PARSONS

RN19-05
ROAD RECONSTRUCTION AND WIDENING
REGIONAL ROAD 98 (MONTROSE ROAD)
NIAGARA FALLS
PLAN & PROFILE
FROM STA. 0+920 TO STA. 1+060

CONSULTANT FILE No. 603119
DATE: 2019/06/07
SCALE: HORIZ. 1:200 VERT. 1:50
REF. No. RR98 - PP-10
DWG No. RR98 - PP-10
REV. I

RR98 - PP-11





NO.	REVISION	DATE	INIT.
J	AS BUILT	2020/11/11	A.A.V
I	ISSUED FOR CONSTRUCTION	2019/06/07	Y.W.
H	ISSUED FOR TENDERING	2019/01/09	Y.W.
G	ISSUED FOR TENDERING REVIEW	2018/11/30	Y.W.
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CAD R.B.B.
DESIGN Y.W.
CHECKED BY N.B.
APPROVED BY

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Niagara Region PUBLIC WORKS
PARSONS

RN19-05
ROAD RECONSTRUCTION AND WIDENING
REGIONAL ROAD 98 (MONTROSE ROAD)
NIAGARA FALLS
PLAN & PROFILE
CHARNWOOD AVENUE STORM SEWERS

CONSULTANT FILE No. 603119
DATE 2019/06/07
SCALE HORIZ. 1:200 VERT. 1:50
REF. No. RR98 - PP-11
DWG No. RR98 - PP-11
REV. I