Functional Servicing and Stormwater Management Report for the Helena Street Residential Development in the Town of Fort Erie

Submitted to: Town of Fort Erie

Prepared for SS Fort Erie Inc.
by IBI Group
February 18, 2022

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HISTORY:	

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1 INTRODUCTION

IBI Group was retained by “SS Fort Erie Inc.” (the “Owner”) to prepare a site-specific Functional Servicing and Stormwater Management Report (FSSR), for a proposed residential development at 613 Helena Street (the “Subject Lands”), in accordance with the Town of Fort Erie (the Town”) and the Regional Municipality of Niagara (the “Region”) development guidelines.

The total development area is approximately 8.2 ha and located near the intersection of Washington Road, and Albany Street.

Refer to **Plate 1** for an aerial view of the site and **Plate 2 and 3** for landscape views along Helena Street.

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

PLATE 2: Helena Street looking southwest at subject lands (Source: maps.google.ca)

PLATE 3: Helena Street looking northwest at the subject lands (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 8.20 ha mainly greenfield with five (5) existing buildings and bounded by wetlands to the north and south, Helena Street to the east and Kraft Road to the west.

The subject lands are presently located outside the current Fort Erie urban boundary, but within the potential boundary expansion area of the Town of Fort Erie, Niagara Region.

2.1 Roads

Currently, the subject lands are only accessible from Helena Street, which is a township rural street with two (2) lanes of traffic and a right-of-way width of 20m.

2.2 Topography and Drainage

The subject land is generally flat and gently sloping to the west towards the existing adjacent wetland. See **Figure 3** in **Appendix A**, which shows the existing catchment boundary and drainage flow directions of the subject land.

The existing roadside ditches on both sides of Helena Street flow south and outlet at the intersection of Washington Road and Albany Street.

2.3 Sanitary Infrastructure

The proposed development is within the service area of the Dominion Road Sewage Pumping Station (SPS). Based on the research information, the Dominion Road pumping station has been recently upgraded according to the Region’s comments, dated January 18, 2019. In this memorandum, Region of Niagara staff have confirmed that the proposed sanitary flow from the fully developed site can readily be accommodated by the receiving infrastructure. Their preliminary review of the downstream sanitary sewer system indicates that capacity is available within the system to convey the flows from the proposed development.

Based on the as-constructed drawings provided by the Region, a 200 mm diameter sanitary sewer exists at the intersection of the Helena and Albany Street. The existing sanitary manhole (#22) is located approx. 465 m south of the subject lands.

2.4 Water Supply and Distribution

Presently There is no existing watermain servicing the subject site. Based on the as-constructed drawing provided by the Town, the nearest existing municipal watermain is a 150/200 mm diameter pipe located approximately 450 m south of the development at the intersection of Helena Street and Albany Street.

There is also a fire hydrant located at 100m north of the subject site on Helena Street that has a fire flow around 50 L/s according to the Niagara Region 2016 Water and Wastewater Master Servicing Plan.

2.5 Utilities

The nearest residential development is located just south of Albany Street where 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.

3 PROPOSED CONDITIONS

The proposed residential development will consist of 17 townhome blocks, municipal roadways, landscaped areas, and a designated SWM pond block.

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

3.1 Roads

The proposed development will have two (2) vehicular accesses from Helena Street. The internal roadway will consist of a standard 20.0m R.O.W. which will be designed as a two-lane standard local roadway per the Town of Fort Erie's Typical Urban Road Cross-Section, Standard Drawing No. PW-501 FE.

3.2 Grading

The grading strategy for the proposed development will respect the existing grades along the property lines. 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 municipal ROW, rear lot swales, and ultimately into the proposed storm sewers.

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

As a general guideline for the proposed site grading, the following Town 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; and,
- Minimum – maximum driveway grade of 2% to 6%;

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 alternation will not have negative effect on the neighbouring properties. The majority of the overland flows from the residential development will be conveyed towards the Kraft drain Wetland Complex.

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 9.83 L/s as per the design guidelines of the Town of Fort Erie's **Subdivision Control Guidelines 2021**.

The proposed sanitary sewer network consists of 200mm diameter pipe which collects and conveys sewage towards the south of the site along Helena Street with cover ranging from 1.5m – 4.50m. The sewers have slope ranging from of 0.35%-0.50% with 1.0% for the initial sewer leg. The sanitary sewer along Helena Street was designed with 0.35% slope to maintain frost cover and minimum velocity.

A sanitary outlet for the subject lands will connect to the existing sewer along Helena Street. The preferred sanitary outlet is via a 200mm diameter gravity trunk sewer to the existing sanitary manhole #22 located at south of the subject site along Helena Street.

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

A minimum of 1.5m of depth on local sanitary sewers have been provided to allow gravity connections to slab on grade residential dwellings and to minimize fill on site.

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

In accordance with the Town's Subdivision Control Guidelines, residential sewage flows shall be calculated on the basis of the following for residential areas:

- Residential Average Daily Domestic Flow – 320 litres/person/day (lpcd)
- Infiltration Allowance for new subdivision – 0.15 litres/sec/hectare; and,
- Peaking factor – minimum 2.0 and maximum 4.0
- Velocity – minimum 0.6 m/s and maximum 3.0 m/s

All sanitary sewer shall be sized to handle the theoretical daily peak flow per the town'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**

Table 3.1 Population Densities – Known Lot Configuration

Type of Housing	Persons/Unit
Townhouses, Semi-Detached, Duplex	4.0

Refer to the **Sanitary Design Sheet**, in **Appendix B**.

3.4 Stormwater Management

This report provides a brief stormwater management (SWM) review of the pre-development conditions, post-development conditions, and addresses opportunities to reduce peak flows to meet Town and Niagara Peninsula Conservation Authority (NPCA) criteria.

Refer to **Appendix E** for calculations and **Appendix A** for drainage area plans.

The Town of Fort Erie and Niagara Peninsula Conservation Authority have the following requirements for stormwater management:

- Mitigate the erosion impacts of downstream: Attenuate the proposed conditions peak flows for the 2-year, 5-year and 100-year design storm to existing conditions levels.
- 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 from Area A1-Post will convey stormwater into a proposed SWM pond (Area A4-Post) at the northwest corner of the site. Two sections of storm sewer draining Street A (Areas A5-Post and A6-Post) and draining toward Helena Street will be oversized to capture the 100-year design storm runoff and provide storage as part of the SWM control requirements.

See **Figure 4** for proposed drainage catchments.

The storm sewers for Area A1-Post are sized between 300mm to 525mm diameter with a slope of 0.5% and with a minimum cover of 1.5 m. The super-pipe (MH1 to CBMH2) for Area A2-Post will be 825mm diameter with a slope of 0.5% and a minimum cover of 1.1 metres to the springline at MH02, which will require frost protection. The super-pipe (MH9 to CBMH10) for Area A3-Post will be 1200mm diameter with a slope of 0.5% and a minimum cover of 1.6 metres to the springline at MH10. An Oil Grit Separator (OGS) will be provided at each outlet into Helena Street road ditch.

The proposed SWM pond will be designed to provide stormwater quantity control as a dry pond with an OGS providing pre-treatment as part of the treatment train approach.

Storm Figure in **Appendix A** shows the proposed stormwater catchment areas and flow directions.

3.4.1 Existing Drainage Condition

Under existing conditions, runoff from the subject land generally slope to the west of the site towards to the existing Beaver Creek with mostly greenfield covering the property. **Table 3.2** summarizes the existing drainage condition of the site.

Table 3.2 – Existing Drainage Area and Runoff Coefficients

Drainage Area ID	Description	Total Area (ha)	Runoff Coefficient
A1 Pre	Agricultural Land	4.32	0.25

Refer to **Figure 3** following this report for the pre-development drainage area plan.

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 pond. As per the proposed grading/servicing plans for the site, the development will be comprised of a total of seven (7) internal drainage areas.

Table 3.3 provides a summary of the runoff coefficients for each proposed drainage area. Runoff coefficient calculations applied a runoff coefficient of 0.90 for impervious areas and a runoff coefficient of 0.25 for pervious areas. Refer to **Figure 4** following this report for the post-development drainage area plan.

Table 3.3 – Drainage Area and Runoff Coefficients

Drainage Area ID	Description	Total Area (ha)	Runoff Coefficient
A1 Post	Residential to Pond - Controlled	2.27	0.60
A2 Post	Residential Roof + Landscape South - Uncontrolled	0.46	0.45
A3 Post	Residential Roof + Landscape North - Uncontrolled	0.39	0.45
A4 Post	SWM Pond Block	0.53	0.25
A5 Post	Residential to Roadside Ditch #1-Controlled	0.24	0.60
A6 Post	Residential to Roadside Ditch #2-Controlled	0.35	0.60

Drainage Area ID	Description	Total Area (ha)	Runoff Coefficient
A7 Post	Easement-Uncontrolled	0.08	0.60
Site - Total		**4.32**	**0.53**

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 generally capture minor runoff from the majority of the site into the proposed on-site storm system. There are three (3) outlets for the minor drainage system. Minor runoff from drainage area A1-Post will ultimately discharge to the proposed SWM pond at the northwest corner. Minor runoff from A5-Post and A6 Post will be captured and conveyed respectively to the roadside ditches along Helena St on the east.

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 drainage area A1 Post (100-year storm event) will be ultimately directed overland along the road surface to the proposed SWM pond (Area A4-Post) and controlled. Major runoff from A5 and A6 Post will ultimately drain overland to the ditches respectively. Smaller perimeter areas of the site (A2, A3 and A7 Post) which cannot be contained on site via grading or servicing will drain uncontrolled towards the wetland areas on the north and south and the roadside ditches on the east via overland flow.

3.4.5 Stormwater Quality Control

Stormwater quality controls are required to meet Enhanced (Level 1) Protection with 80% total TSS removal, as defined by the Ministry of the Environment, Conservation and Parks (MOECP) 2003 Stormwater Management Planning and Design (SWMPD) Manual. Quality controls will be provided by a treatment train approach designed to treat flows prior to discharging from the site.

For Area A1-Post the treatment train will consist of a Stormceptor EFO8 oil-grit separator (OGS) (or approved equivalent) followed by the SWM pond at Outlet #1. For the roadside ditch at Outlet 2 (Area A5-Post) and Outlet 3 (Area A6-Post) the approach will include individual OGS units discharging to the natural swales.

The Stormceptor EFO8 treatment unit has been sized to provide 60% TSS removal, as certified by the ETV. The OGS unit will be installed downstream of the orifice control, at each outlet and the treatment train approach will include the treatment associated with natural swales to help polish the storm runoff. Stormceptor EFO sizing parameters are summarized in **Table 3.4** below. Refer to **Appendix E** for sizing results and a detailed drawing of the Stormceptor EFO10 and EFO6.

Table 3.4 – Stormceptor EFO8 Sizing Parameter Summary

OGS ID	Outlet Location	Drainage Area (Ha)	Runoff Coefficient	Percent Impervious	CDS Model
OGS 1	SWM Pond	2.27	0.60	60%	Stormceptor EFO10
OGS 2	Roadside Ditch	0.24	0.60	60%	Stormceptor EFO6
OGS 3	Roadside Ditch	0.35	0.60	60%	Stormceptor EFO6

For the uncontrolled areas A2-Post and A3-Post the runoff will include only a combination of rooftop and landscaped areas from the site which are considered clean. Combined with the proposed treatment train at each outlet as noted above this will provide an overall TSS removal of 80% for the subject site. Therefore, the combination of rooftop and landscaped areas as well as the treatment train approach can meet the requirement for an "Enhanced" level (80% TSS removal) of water quality control.

3.4.6 Stormwater Quantity Control

As per Town of Fort Erie's storm design criteria in the beginning of this section, the total post-development flows from the site should not exceed pre-development peak flows for corresponding storm events. Since the proposed development will increase the overall imperviousness of the site, quantity controls are required to achieve the target flow rates. Stormwater management quantity controls for the site will be provided by the use of super pipes with orifice controls upstream of the roadside ditches at outlets 2 and 3 on the east as well as the orifice control associated with the SWM pond (Outlet 1) located at the northwest corner of the site.

Using the stormwater management hydrologic modeling software VISUAL OTTHYMO, the subject site was modeled for existing and proposed conditions using variables as shown in **Appendix E** for a 4-hr duration Chicago style 2-year, 5-year and 100-year storm event with rainfall intensity values derived from the Township of Fort Erie Subdivision Control Guidelines 2016.

The model determined the pond volume required to reduce proposed development flows from drainage area A1+A4 Post to the existing condition levels for corresponding storm events. The proposed SWM pond will have a total available active storage volume of 3876 m^3, of which 1472 m^3 will be required to control the 100-year storm event. A 75 mm orifice opening at the pond outlet structure will control for 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 pond and orifice control.

Table 3.5 - A1 and A4 Post- SWM Pond – Controlled Peak Discharges

Return Event	Proposed Conditions Prior to Pond Routing (m^3/s)	Proposed Conditions After Pond Routing (m^3/s)	Underground Storage Required (m^3)	Pond Storage Provided (m^3)
2-yr	0.260	0.007	485	3876 (75mm Orifice Plate)
5-yr	0.354	0.009	734	
100-yr	0.621	0.013	1472	

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

As summarized in **Table 3.6** below, proposed runoff from drainage area A5 Post will be controlled by a 825mm superpipe with a 75mm orifice control prior to discharging to the roadside ditch. Superpipes upstream of CBMH2 will provide 31 m³ of pipe storage volume to control 2-year to 100-year peak flows.

Table 3.6 - A5 Post – Roadside Ditch – Controlled Peak Discharges

Return Event	Proposed Conditions Prior to Super Pipe (m^3/s)	Proposed Conditions After Super Pipe (m^3/s)	Pipe Storage Required (m^3)	Pipe Storage Provided (m^3)
2-yr	0.027	0.009	15	31
5-yr	0.035	0.011	23	
100-yr	0.059	0.036	31	

Meanwhile, proposed runoff from drainage area A6 Post will be controlled by a 1200mm superpipe with a 90mm orifice control prior to discharging to the roadside ditch. Superpipes upstream of CBMH10 will provide 64 m³ of pipe storage volume to control 2-year to 100-year peak flows, as summarized in **Table 3.6** below. Super pipe storage volumes are generated in the hydrologic model and detailed results are provided in **Appendix E**.

Table 3.7 - A6 Post - Roadside Ditch – Controlled Peak Discharges

Return Event	Proposed Conditions Prior to Super Pipe (m^3/s)	Proposed Conditions After Super Pipe (m^3/s)	Pipe Storage Required (m^3)	Pipe Storage Provided (m^3)
2-yr	0.039	0.012	23	64
5-yr	0.051	0.015	34	
100-yr	0.087	0.032	60	

Table 3.8 - Total Release Discharge Rates – Proposed vs. Existing

Return Event	Existing Conditions-Total (m^3/s)	Proposed Conditions - Controlled (m^3/s)	Proposed Conditions - Uncontrolled (m^3/s)	Proposed Conditions-Total (m^3/s)	Change in Total (m^3/s)
2yr	0.101	0.108	0.081	0.055	+0.007
5yr	0.173	0.142	0.108	0.071	-0.031
100yr	0.422	0.278	0.191	0.108	-0.144

As shown in **Table 3.8** above, the total 2-year release rate is slightly increased by 0.008m^3/s which is negligible. Therefore, the proposed total release rates that consist of the controlled flow rates from the SWM pond and superpipes and the uncontrolled flow rates from A2, A3 and A7 Post do not exceed the existing total release rates for corresponding storm events.

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 existing conditions levels as illustrated **Table 3.8**. This satisfies the stormwater management quantity control requirement set by the Town of Fort Erie.

- Sufficient storage volume is provided by the SWM pond as well as within the super pipes to contain stormwater as illustrated within tables above.

3.5 Water Supply and Distribution

The proposed development is to be serviced by the pressure zone 241m water distribution system, in the Town of Fort Erie.

As suggested by the Town, the proposed development will receive water supply from a connection to the existing municipal 200 mm watermain located at the intersection of Helena Street and Albany Street.

Approximately 116 residential units are to be developed within the subject land with the ground elevations ranging from 182 to 186 m.

The estimated water consumption for the proposed residential development is anticipated to be approximately 2 L/s, 3 L/s and 5 L/s for the average day, maximum day and peak hour condition, respectively. **Appendix D** shows the water demand estimations and the design guidelines of the Town of Fort Erie's Subdivision Control Guidelines 2021.

As per Town's Subdivision Control Guidelines 2021, 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.
- The floor area for each unit is approximately 163 m2 (1750 ft2)
- Based on the above assumptions, the required fire flow using the FUS method (see **Appendix D** for details) is approximately 133L/s for the subject development.

For watermain sizing, a 200mm watermain is proposed within the subject land. Two (2) watermain sizing options for the proposed section along Helena Street, from Albany Street and subject site connection, have been considered and evaluated to provide water servicing to the subject site:

Option 1 – A 200 mm watermain along Helen Street: As shown in Appendix D, the required system head (HGL) 240m is at the proposed watermain connection located at Albany Street and Helena Street. It is slightly below the existing system HGL 241 m (at the water tower location). With the additional head losses along the existing watermains in the distribution system. Option 1 appeared not feasible to provide sufficient flow to the subject lands under maximum day plus fire flow conditions; and,

Option 2 – A 250 mm watermain along Helena Street. The required system head (HGL) 210m is at the proposed watermain connection located at Albany Street and Helena Street. The required system head is significantly reduced, in comparison with Option 1 and Option 2 is a preferable option.

In addition, water turnover rates for the proposed watermain Option 2 have been analyzed as shown in **Appendix D**. The turnover rates (under average day demand) are less than 2 hours along the watermains within the subject lands and less than 5 hours for the proposed watermains including a 250mm watermain along Helena Street, which meets the typical water turnover requirement of 24 hours.

As shown in **Appendix D**, the water turnover rates along the proposed 200 mm watermain within the subject lands meet the typical water turnover rate requirements. A larger 200mm watermain significantly reduces the head losses for the watermains within the subject lands under the fire flow conditions. Therefore, a 200 mm watermain within the subject lands is recommended.

Refer to **Figure 6** in **Appendix A** for details of the proposed water servicing. Please note that a 200 mm watermain along Helena Street is currently shown in **Figure 6**. Further detailed analysis will be conducted by the Town's consultant to assess the available system capacity and/or confirm the size requirement for the proposed watermain along Helena Street.

The Town may consider performing hydrant fire flow tests along the existing watermains in the vicinity of the subject lands to confirm the available system pressures near the proposed watermain connection.

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 intersection of Helena Street and Albany Street.

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 Town of Fort Erie, 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

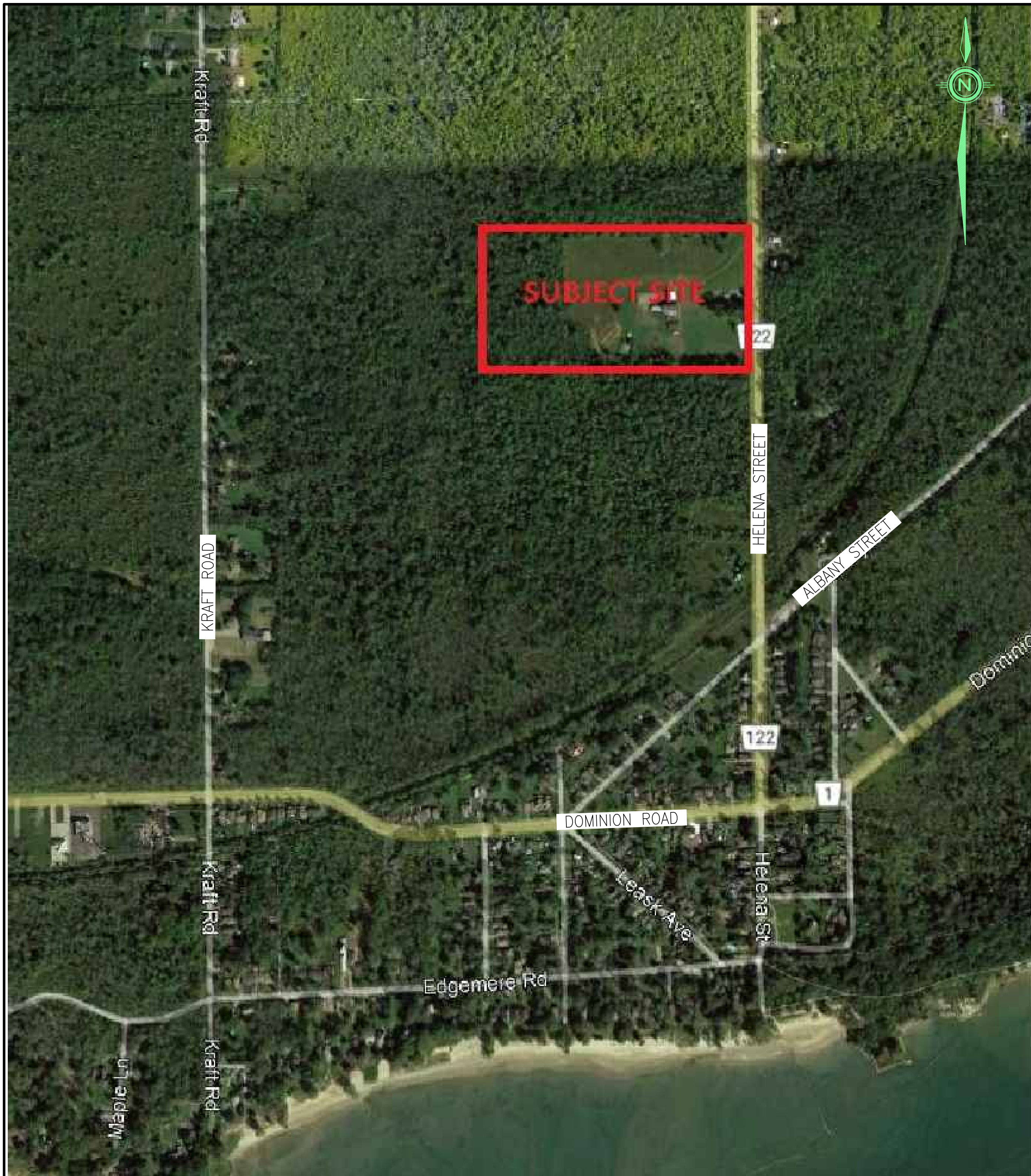
This report demonstrates that the proposed Helena Street Residential Development is feasible from a civil engineering perspective in accordance with the Town of Fort Erie Subdivision Control Guideline. The following summarizes key aspects of the design:

- 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 extending the sewer and connecting to the existing Dominion Road Sewage Pumping Station.
- Stormwater management design for the proposed development incorporates quality and quantity control at an enhanced protection level utilizing a wetland facility. The proposed development will attenuate the proposed conditions under 5-year and 100-year storm events to pre-development levels.
- The proposed Helena Street Residential Development will connect to the existing 200mm diameter watermain on Helena Street satisfying domestic water demand.

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 IBI Group.

Appendix A - Drawings



LOCATION PLAN
HELENA STREET RESIDENTIAL DEVELOPMENT
613 HELENA STREET , FORT ERIE
REGIONAL MUNICIPALITY OF NIAGARA

CLIENT:	SS FORT ERIE INC.
DATE: FEBRUARY 2022	PROJECT No.: 131951
SCALE: N.T.S.	FIGURE No.: 1

Niagara Region

FORT ERIE ONTARIO
Our Focus: Your Future

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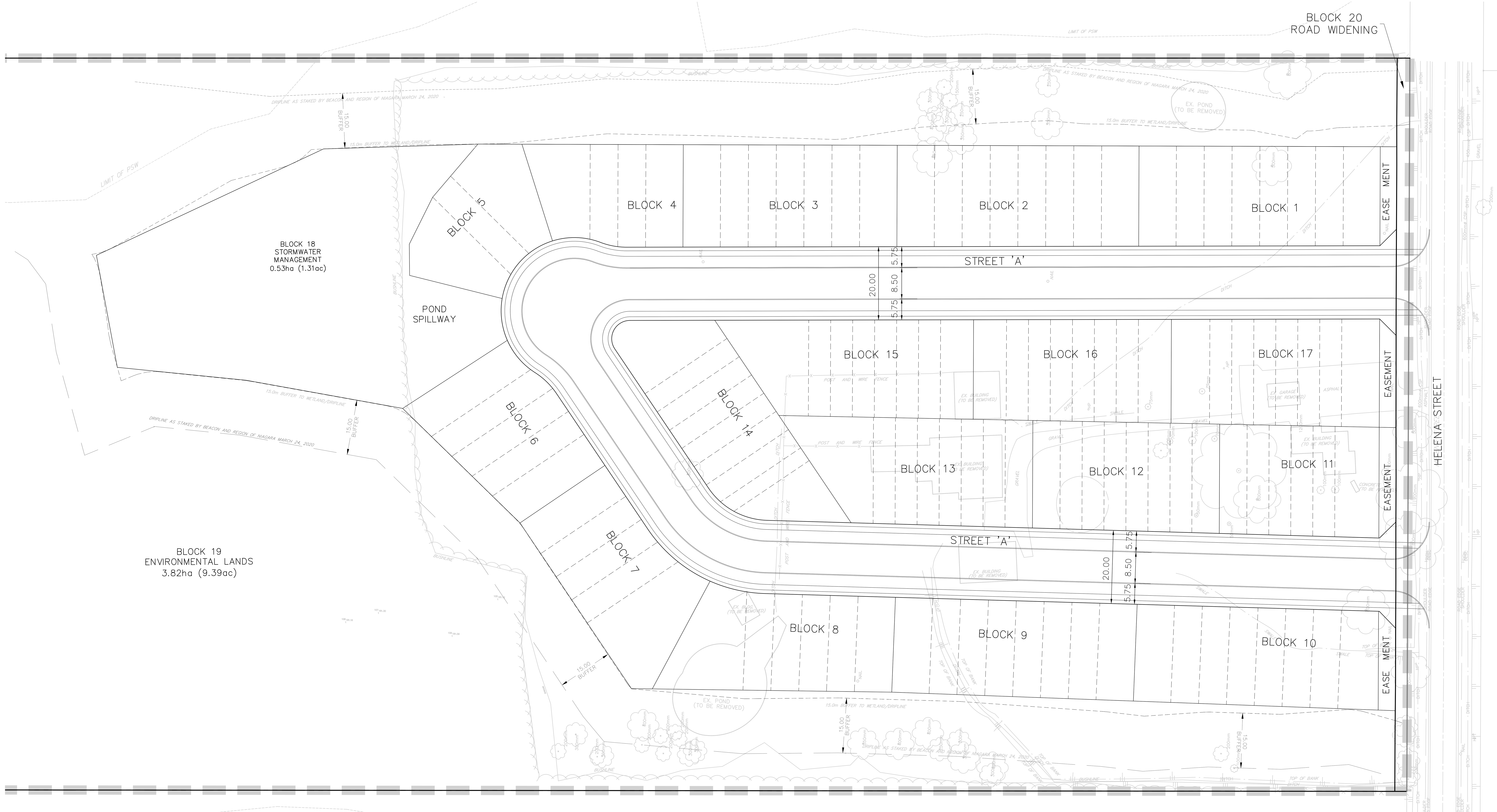
\\caneast.ibigroup.com\J\HM\131951_613_Helen\7.0_Production\7.03_Design\04_Civil\FSR\SHEETS\LOCATION PLAN.dwg (Location Plan)



SITE PLAN

HELENA STREET RESIDENTIAL DEVELOPMENT

613 HELENA STREET , FORT ERIE
REGIONAL MUNICIPALITY OF NIAGARA

CLIENT:	SS FORT ERIE INC.		
DATE:	FEBRUARY 2022	PROJECT No.:	131951
SCALE:	1:500	FIGURE No.:	2

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LEGEND

SITE BOUNDARY

EXISTING DRAINAGE CATCHMENTS

HELENA STREET RESIDENTIAL DEVELOPMENT

613 HELENA STREET , FORT ERIE
REGIONAL MUNICIPALITY OF NIAGARA

CLIENT:	SS FORT ERIE INC.		
DATE:	FEBRUARY 2022	PROJECT No.:	131951
SCALE:	1:500	FIGURE No.:	3

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LEGEND

- DRAINAGE AREA BOUNDARY
- OVERLAND FLOW DIRECTION
- SITE BOUNDARY

A1Pre — DRAINAGE AREA ID
4.32ha — AREA (HECTARES)
C=0.25 — RUNOFF COEFFICIENTS

PROPOSED DRAINAGE CATCHMENTS

HELENA STREET RESIDENTIAL DEVELOPMENT

613 HELENA STREET , FORT ERIE
REGIONAL MUNICIPALITY OF NIAGARA

CLIENT:	SS FORT ERIE INC.		
DATE:	FEBRUARY 2022	PROJECT No.:	131951
SCALE:	1:500	FIGURE No.:	4

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LEGEND

- EX. CONTOURS
- PROPOSED STORM SEWER
- DRAINAGE AREA BOUNDARY
- OVERLAND FLOWING TO THE STREET
- OVERLAND FLOWING TO THE BACK OF LOT
- OVERLAND FLOWING TO THE POND
- A1Post / 2.27ha / C=0.6 — DRAINAGE AREA ID / AREA (HECTARES) / % IMPERVIOUS
- SITE BOUNDARY
- PROP. HEAD WALL


PRELIMINARY FUNCTIONAL SANITARY SERVICING
HELENA STREET RESIDENTIAL DEVELOPMENT
613 HELENA STREET , FORT ERIE
REGIONAL MUNICIPALITY OF NIAGARA
CLIENT: SS FORT ERIE INC.
DATE: FEBRUARY 2022
PROJECT No.: 131951
SCALE: 1:500
FIGURE No.: 5
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LEGEND
PROP. SANITARY SEWER
PROP. SAN MANHOLE
PROP. SANITARY DRAINAGE AREA
EX. SANITARY SEWER
EX. SAN MANHOLE
SITE BOUNDARY
AREA
UNITS
P/UNIT
POPULATION
REFER TO THIS DRAWING
REFER TO THIS DRAWING
BLOCK 18 STORMWATER MANAGEMENT 0.53ha (1.31ac)
POND SPILLWAY
BLOCK 1
BLOCK 2
BLOCK 3
BLOCK 4
BLOCK 5
BLOCK 6
BLOCK 7
BLOCK 8
BLOCK 9
BLOCK 10
BLOCK 11
BLOCK 12
BLOCK 13
BLOCK 14
BLOCK 15
BLOCK 16
BLOCK 17
STREET 'A'
STREET 'A'
HELENA STREET
HELENA STREET
HELENA STREET
ALBANY STREET
WASHINGTON RD.
EASEMENT
EASEMENT
EASEMENT
EASEMENT
200ø SAN @ 0.5%
200ø SAN @ 1.0%
200ø SAN @ 0.35%
EX. 200ø SAN
PROP. MH01A TOP = 184.05 N. INV. 181.95 (200ø) SE. INV. 182.05 (200ø)
PROP. MH02A TOP = 184.13 SW. INV. 181.77 (200ø) E. INV. 181.74 (200ø)
PROP. MH03A TOP = 184.83 W. INV. 181.36 (200ø) E. INV. 181.36 (200ø)
PROP. MH04A TOP = 185.66 W. INV. 180.94 (200ø) E. INV. 180.94 (200ø)
PROP. MH05A TOP = 182.25 W. INV. 180.61 (200ø) S. INV. 180.55 (200ø)
PROP. MH06A TOP = 184.00 NW. INV. 181.46 (200ø) SE. INV. 181.43 (200ø)
PROP. MH07A TOP = 183.97 NW. INV. 181.35 (200ø) E. INV. 181.32 (200ø)
PROP. MH08A TOP = 185.13 W. INV. 180.68 (200ø) E. INV. 180.68 (200ø)
PROP. MH09 TOP = 182.15 W. INV. 180.35 (200ø) S. INV. 180.29 (200ø) N. INV. 180.29 (200ø)
PROP. MH10 TOP = 182.12 N. INV. 180.19 (200ø) S. INV. 180.19 (200ø)
PROP. MH11A TOP = 181.93 N. INV. 179.84 (200ø) S. INV. 179.84 (200ø)
PROP. MH12A TOP = 181.78 N. INV. 179.49 (200ø) S. INV. 179.49 (200ø)
PROP. MH13A TOP = 181.42 N. INV. 179.14 (200ø) S. INV. 179.14 (200ø)
EX. SAN. MH22 EX. INV. 178.80
15.0m BUFFER TO WETLAND/DRIPLINE
15.00 BUFFER

PRELIMINARY FUNCTIONAL WATER DISTRIBUTION

HELENA STREET RESIDENTIAL DEVELOPMENT

613 HELENA STREET , FORT ERIE
REGIONAL MUNICIPALITY OF NIAGARA

CLIENT:	SS FORT ERIE INC.		
DATE:	FEBRUARY 2022	PROJECT No.:	131951
SCALE:	1:500	FIGURE No.:	6

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IBI GROUP
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Markham ON L6G 1B3 Canada
tel 905 763 2322 fax 905 763 9983
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LEGEND

- 200mmØ WATERMAIN
- EXISTING 200mmØ WATERMAIN
- PROPOSED FIRE HYDRANT
- EXISTING 150mmØ WATERMAIN
- ABANDONED 100mmØ WATERMAIN
- SITE BOUNDARY

PRELIMINARY FUNCTIONAL STORMWATER MANAGEMENT

HELENA STREET RESIDENTIAL DEVELOPMENT

613 HELENA STREET , FORT ERIE
REGIONAL MUNICIPALITY OF NIAGARA

CLIENT:	SS FORT ERIE INC.		
DATE:	FEBRUARY 2022	PROJECT No.:	131951
SCALE:	1:500	FIGURE No.:	7

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LEGEND

- EX. CONTOURS
- PROPOSED STORM SEWER
- STORM DRAINAGE AREA
- OVERLAND FLOWING TO THE STREET
- OVERLAND FLOWING TO THE BACK OF LOT
- OVERLAND FLOWING TO THE POND
- 0.60 / 0.35ha — RUNOFF COEFFICIENT AREA
- SITE BOUNDARY
- PROP. HEAD WALL

PRELIMINARY GRADING PLAN

HELENA STREET RESIDENTIAL DEVELOPMENT

613 HELENA STREET , FORT ERIE
REGIONAL MUNICIPALITY OF NIAGARA

CLIENT:	SS FORT ERIE INC.		
DATE:	FEBRUARY 2022	PROJECT No.:	131951
SCALE:	1:500	FIGURE No.:	8

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LEGEND

EX. CONTOURS	SLOPE ARROW	PROP. STM MANHOLE
EX. ELEVATION	TRANSITION SLOPE	PROP. CB MANHOLE
PROP. ELEVATION	SEWER FLOW DIRECTION	PROP. HEAD WALL
PROP. CATCHBASIN	OVERLAND FLOWING TO THE STREET	
PROP. SAN MANHOLE	OVERLAND FLOWING TO THE BACK OF LOT	
SITE BOUNDARY	OVERLAND FLOWING TO THE POND	
BUFFER LINE		

Appendix B – Sanitary Calculations

SANITARY SEWER DESIGN SHEET

Project - Helena Street Residential Development, SS Fort Erie Inc.

Town of Fort Erie
Niagara Regional

Minimum Dia. = 200 mm
Mannings "n"= 0.013
Minimum Velocity = 0.60 m/s
Minimum Grade = 0.60 %
Avg. Domestic Flow = 320 l/c/d
Infiltration = 0.15 l/s/ha
Max. Peaking Factor= 4.5
Min. Peaking Factor= 2.0
Maximum Velocity = 3.65 m/s

Project: Helena Street Residential Development
Project No: 131951
Date: FEB. 18, 2022
Designed by: J.M.
NOMINAL PIPE SIZE USED

\\caneast.ibigroup.com\J\HM\131951_613_Helen\7.0_Production\7.03_Design\04_Civil\FSR\Sewer Design Sheets\SAN\[131951_Helena_SAN_FSR-20220214.xls]Design

			RESIDENTIAL							MEDIUM DENSITY					FLOW CALCULATIONS						PIPE DATA				
STREET	FROM MH	TO MH	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)
Street A	MH01A	MH02A	0.24	0.24	5		4.00	20	20	0	0	0	0	0	0.04	20	4.38	0.32	0.0	0.36	200	1.00	32.8	1.04	0.33
Street A	MH02A	MH03A	0.47	0.71	14		4.00	56	76	0	0	0	0	0	0.1	76	4.27	1.2	0.0	1.31	200	0.50	23.2	0.74	0.40
Street A	MH03A	MH04A	0.64	1.35	22		4.00	88	164	0	0	0	0	0	0.2	164	4.18	2.5	0.0	2.74	200	0.50	23.2	0.74	0.49
Street A to Helena Street	MH04A	MH05A	0.41	1.76	13		4.00	52	216	0	0	0	0	0	0.3	216	4.14	3.3	0.0	3.57	200	0.50	23.2	0.74	0.53
Street A	MH01A	MH06A	0.45	0.45	14		4.00	56	56	0	0	0	0	0	0.1	56	4.30	0.9	0.0	0.96	200	1.00	32.8	1.04	0.44
Street A	MH06A	MH07A	0.23	0.68	6		4.00	24	80	0	0	0	0	0	0.1	80	4.27	1.3	0.0	1.37	200	0.50	23.2	0.74	0.40
Street A	MH07A	MH08A	0.9	1.58	31		4.00	124	204	0	0	0	0	0	0.2	204	4.14	3.1	0.0	3.37	200	0.50	23.2	0.74	0.52
Street A to Helena Street	MH08A	MH09A	0.41	1.99	12		4.00	48	252	0	0	0	0	0	0.3	252	4.11	3.8	0.0	4.13	200	0.50	23.2	0.74	0.55
Helena Street	MH05A	MH09A	0.1	1.86	0			0	216	0	0	0	0	0	0.3	216	4.14	3.3	0.0	3.59	200	0.35	19.4	0.62	0.47
Helena Street	MH09A	MH10A	0.02	3.87	0			0	468	0	0	0	0	0	0.6	632	3.92	9.2	0.0	9.76	200	0.35	19.4	0.62	0.62
Helena Street	MH10A	MH11A	0.15	4.02	0			0	468	0	0	0	0	0	0.6	632	3.92	9.2	0.0	9.78	200	0.35	19.4	0.62	0.62
Helena Street	MH11A	MH12A	0.12	4.14	0			0	468	0	0	0	0	0	0.6	632	3.92	9.2	0.0	9.80	200	0.35	19.4	0.62	0.62
Helena Street	MH12A	MH13A	0.12	4.26	0			0	468	0	0	0	0	0	0.6	632	3.92	9.2	0.0	9.81	200	0.35	19.4	0.62	0.62
Helena Street	MH13A	EX. MH22	0.13	4.39	0			0	468	0	0	0	0	0	0.7	632	3.92	9.2	0.0	9.83	200	0.35	19.4	0.62	0.62

Appendix C – Storm Calculations

5 yr Storm Sewer Design Sheet

Town of Fort Erie
Niagara Region

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

	5-YEAR	100-YEAR
A=	747.93	1083.55
B=	6.8	6.618
c=	0.768	0.735

Starting Tc = 10 min

File Location: \\caneast.ibigroup.com\J\HM\131951_613_Helen\7.0_Production\7.03_Design\04_Civil\FSR\Sewer Design Sheets\STM\[131951_Helena_STM_FSR-20220216.xls]5yr

Project: Helena Street Residential Development, SS Fort Erie Inc.
Project No: 131951
Date: Feb. 18, 2022
Designed by: J.M.

STREET	FROM MH	TO MH	5-YR AREA (ha)	5-YR RUNOFF COEFFICIENT "R"	5-YR "AR"	5-YR ACCUM. "AR"	5-YR RAINFALL INTENSITY (mm/hr)	5-YR ACCUM. FLOW (m^3/s)	LENGTH (m)	SLOPE (%)	PIPE DIAMETER (mm)	FULL FLOW CAPACITY (m3/s)	FULL FLOW VELOCITY (m/s)	TIME OF TRAVEL (min)	ACC. TIME OF CONC. (min)
Street A	*STMH 01*	*STMH 02*	*0.24*	*0.60*	*0.14*	*0.14*	*85.67*	*0.034*	*45.0*	*0.50*	*825*	*1.014*	*1.899*	*0.395*	*10.395*
Street A to Helena Street	*STMH 02*	*DITCH1*	*0*	*0.60*	*0.00*	*0.14*	*84.15*	*0.034*	*10.0*	*0.50*	*300*	*0.068*	*0.967*	*0.172*	*10.567*
Street A	*STMH 09*	*STMH 10*	*0.35*	*0.60*	*0.21*	*0.21*	*85.67*	*0.050*	*66.9*	*0.50*	*1200*	*2.755*	*2.438*	*0.457*	*10.457*
Street A to Helena Street	*STMH 10*	*DITCH2*	*0*	*0.60*	*0.00*	*0.21*	*83.92*	*0.049*	*10.4*	*0.50*	*300*	*0.068*	*0.967*	*0.179*	*10.637*
Street A	*STMH 01S*	*STMH 04*	*0.44*	*0.60*	*0.26*	*0.26*	*85.67*	*0.063*	*83.8*	*0.50*	*375*	*0.124*	*1.123*	*1.244*	*11.244*
Street A	*STMH 04*	*STMH 05*	*0.43*	*0.60*	*0.26*	*0.52*	*81.09*	*0.118*	*83.8*	*0.50*	*450*	*0.201*	*1.268*	*1.102*	*12.346*
Street A	*STMH 05*	*STMH 06*	*0.07*	*0.60*	*0.04*	*0.56*	*77.49*	*0.121*	*14.2*	*0.50*	*450*	*0.201*	*1.268*	*0.187*	*12.533*
Street A	*STMH 09S*	*STMH 08*	*0.76*	*0.60*	*0.46*	*0.46*	*85.67*	*0.109*	*107.9*	*0.50*	*375*	*0.124*	*1.123*	*1.602*	*11.602*
Street A	*STMH 08*	*STMH 07*	*0.21*	*0.60*	*0.13*	*0.58*	*79.88*	*0.129*	*17.7*	*0.50*	*450*	*0.201*	*1.268*	*0.233*	*11.835*
Street A	*STMH 07*	*STMH 06*	*0.28*	*0.60*	*0.17*	*0.75*	*79.11*	*0.165*	*70.1*	*0.50*	*450*	*0.201*	*1.268*	*0.922*	*12.756*
SPILLWAY	*STMH 06*	*OGS*	*0*	*0.60*	*0.00*	*1.31*	*76.23*	*0.278*	*43.4*	*0.50*	*525*	*0.304*	*1.405*	*0.515*	*13.271*
POND	*OGS*	*HW 01*	*0*	*0.60*	*0.00*	*1.31*	*74.73*	*0.273*	*7.1*	*0.50*	*525*	*0.304*	*1.405*	*0.084*	*13.356*

Appendix D – Estimated Water Demand

Estimated Water Demand

Project: Helena Residential Development , Town of Fort Eric

Date: February 2022

File: 131951_Helen St Water Demand.xls

Town's Subdivision Control Guidelines 2021

Landuse		Persons/unit (PPU)
Residential		4
Average Day Consumption (L/d/Capita)		320
Maximum Day Consumption (L/d/Capita)		570
Peak Hour Consumption (L/d/Capita)		860

			Estimated Water Demand (L/s)		
			Ave Day	**Max Day**	**Peak Hour**
Landuse	**No of units**	**Population**			
Residential	116	464	2	3	5

Fire Flow Estimation using FUS Method

Based on Part II of Water Supply for Public Fire Protection 1999 (Page 17 to 20 Guide for determination of required fire flow)

Project: Helena Residential Development , Town of Fort Eric
Date: February 2022
File: 131951_Helen St Fire Flow estimation.xls

Item A to D, P20) Fire flow rate based on type of construction (Rounded off to nearest 1000 L/min)
Item 1, P17 F1=220C1A^.5 Fire Flow Formula
F1= Required fire Flow (L/min)
A= **488** m^2

		Area (ft2)	Area (m^2)
Floor area (8 units)		14,000	1,301
Fire Wall, every 2 units		3,500	325
Fire Wall, every 3 units		5,250	**488**

C1 = 1.5 Type of construction (Page 17)

C1=1.5	for wood frame construction (structure essentially all combustible)
C1=1.0	for ordinary construction (brick or other masonry walls, combustibles floor and interior)
C1=0.8	for non-combustible construction (unprotected metal structural components, masonry or metal walls)
C1=0.6	for fire-resistive construction (fully protected frame, floors, roof)

a) fire-resistive construction with vertical opening inadequately protected:
two largest floors plus 50% of each of any floors immediately above up to eight
b) fire-resistive construction with vertical opening and exterior communications adequately protected (one hour rating):
one largest floors plus 25% of each of the two immediately adjoining floors

F1= **7000** L/min

Item E, P20) Determine the increase or decrease for type of occupancies (Do not round off the answer)
Item 2, P18)

F2=	F1 * C2	Adjusted Fire Flow rate (L/s)
C2=	-25%	C2=-25% Non-Combustible, P18
F2=	**5250** L/min	C2=-15% Limited Combustible, P18

No percentage increase or decrease for occupancy in commercial building

Item F, P20) Determine the decrease for automatic sprinkler system protection and standard design
Item 3, P18) (Do not round off the answer)

F3 =	F2 *C3	C3=0	No sprinkler system
C3=	0%	C3=-50%	Complete automatic sprinkler System (total credits of 50% as shown below), P18
F3=	**0** L/min	C3=-30%	Adequately designed system conforming to NFPA 13 and other NFPA Sprinkler standards

Item G, P20) Determine the increase for structure exposure distance, P18 (Do not round off the answer)
Item 4, p18)

F4 =	F2 *C4	Exposure to the other buildings,
C4=	60%	C4 = 0% if >45 m
F4=	**3150** L/min	C4 = 25 % (if 0 to 3 m)
		C4 = 20 % (if 3 to 10 m)
		C4 = 15 % (if 10 to 20 m)
		C4 = 10 % (if 20 to 30 m)
		C4 = 5 % (if 30 to 45 m)

Side	Exposure Distance (m)	Percentage Charge (%)
North	20	15
South	20	15
East	3	20
West	Fire wall	10
	Total	60

Item H, P20) Adjust the Fire Flow Value (Rounded off to nearest 1000 L/min)
F5= F2+F3+F4
F5= 8400 L/min
F5= 8000 L/min
F5= **133** L/s

Watermain Head Losses Estimation and System Head Requirement

Project: Helena Residential Development , Town of Fort Eric

Date: February 2022

File: 131951_head loss.xls

Watermain Head Losses Estimation

Pipeline Section	From	To	Length	Diameter	Area	Pipe Flow	Velocity	"C"	Head Loss
			L	D	A	Q	V	Factor	Hf[1]
			(m)	(m)	(m2)	(m3/s)	(m/s)	-	(m)
Option 1 - 200 mm along Helen St									
Along Helen Street	Albany Street Connection	Subject Site Connection	450	0.20	0.03	0.136	4.3	130	37.4
Internal Watermain Section[2]	Subject Site Connection	Far End Hydrant near Block 5	130	0.20	0.03	0.068	2.2	130	3.0
Total Head losses (from Albany St to far end hydrant near Block 5 within Subject Site)									40.4
Option 2 - 250 mm along Helen St									
Along Helen Street	Albany Street Connection	Subject Site Connection	450	0.25	0.05	0.136	2.8	130	12.6
Internal Watermain Section[2]	Subject Site Connection	Far End Hydrant near Block 5	130	0.20	0.03	0.068	2.2	130	3.0
Total Head losses (from Albany St to far end hydrant near Block 5 within Subject Site)									15.6

Note: [1] Hf=10.7*(Q/C)^1.85*(1/D^4.87)*L; [2] Only one branch of the internal watermain (and half of the fire flow) was used to estimate the head losses.

Water Turnover Rate Estimation

Average Day Demand	
L/s	2
M^3/d	148
Volume (m3)	Water Turnover Rate (hrs)
22	3.6
8	1.3
30	4.9

System Head Requirement

Given:	
Target HGL 241 m or Existing Tower Top Water Level (m)	241
Elevation within Site (m)	186
Required pressure under Fire Flow condition (140kPa or 14m)	14
Required HGL at Helen St and Albany St (m)	
Option 1 - Required HGL at Helen St and Albany St	**240**
Option 2 - Required HGL at Helen St and Albany St	**210**

Appendix E – Stormwater Management

Prepared by: Chris Zhang		Active Storage (Stage - Storage - Discharge) SWM Pond 613 Helena File No. LD12-0605 Date: Feb, 2022

Description	"c"	Dia./ Height	Dia. / Width	Control Elevation	Invert Elevation	
Bottom Draw + Circular Orifice	0.63	0.075	0.075	181.59	181.55	Circular orifice

Description	Depth above NWL (m)	Elevation (m)	Volume Above NWL (m2)	Incremental Volume (m3)	Active Storage Volume (m3)	Circular Orifice (cms)	Rectangular Orifice (cms)	Emergency Spillway (cms)	Total Outflow (cms)	Total Outflow (L/s)	VO Model Inputs Discharge (m3/s)	VO Model Inputs Storage (m-ha)
Bottom of Pond	0.00	181.55	1012.48	0.00	0.00	0.000			0.000	0.0	0.0000	0.0000
	0.50	182.05	1225.58	558.67	558.67	0.008			0.008	8.4	0.0084	0.0559
	1.00	182.55	1455.51	669.45	1228.12	0.012			0.012	12.1	0.0121	0.1228
	1.50	183.05	1702.27	788.64	2016.76	0.015			0.015	14.9	0.0149	0.2017
	2.00	183.55	1965.88	916.25	2933.01	0.017			0.017	17.3	0.0173	0.2933
Top of Pond	2.45	184.00	2226.66	942.71	3875.72	0.019			0.019	19.1	0.0191	0.3876

Project No.:	131951	IBI		Diameter	X-Sect Area	Invert	Horizontal(y/n)	Cd	
Project:	613 Helena St		Orifice 1	75	0.0044	181.37	n	0.61	orifice Plste
Description:	CBMH2 Outlet Stage-Storage-Discha		Orifice 2		0.0000		n	0.62	

Water Surface EL (m)	Pipe Storage (m^3)	Surface Storage (m^3)	Total Storage (m^3)	Orifice 1 (m^3/s)	Orifice 2 (m^3/s)	Total Discharge (m^3/s)	
181.370	0.0	0	0.0	0.000	0.00	0.000	invert of CBMH2
181.470	2.3	0	2.3	0.004	0.00	0.004	825mm Super pipe (MH1 to CBMH2)
181.570	4.5	0	4.5	0.005	0.00	0.005	
181.670	4.8	0	4.8	0.007	0.00	0.007	
181.770	8.2	0	8.2	0.008	0.00	0.008	
181.870	12.2	0	12.2	0.008	0.00	0.008	
181.970	16.2	0	16.2	0.009	0.00	0.009	
182.070	20.1	0	20.1	0.010	0.00	0.010	
182.170	23.4	0	23.4	0.011	0.00	0.011	
182.270	25.1	0	25.1	0.011	0.00	0.011	
182.370	26.5	0	26.5	0.012	0.00	0.012	
182.470	27.5	0	27.5	0.013	0.00	0.013	
182.570	27.8	0	27.8	0.013	0.00	0.013	
182.670	27.8	0	27.8	0.014	0.00	0.014	
182.770	27.8	0	27.8	0.014	0.00	0.014	
182.850	28.0	0	28.0	0.015	0.00	0.015	MH Top - Outlet Control Manhole = 182.85

Project No.:	131951	IBI		Diameter	X-Sect Area	Invert	Horizontal(y/n)	Cd	
Project:	613 Helena St		Orifice 1	90	0.0064	181.08	n	0.61	orifice Plste
Description:	CBMH10 Outlet Stage-Storage-Dis		Orifice 2		0.0000		n	0.62	

Water Surface EL (m)	Pipe Storage (m^3)	Surface Storage (m^3)	Total Storage (m^3)	Orifice 1 (m^3/s)	Orifice 2 (m^3/s)	Total Discharge (m^3/s)	
181.080	0.0	0	0.0	0.000	0.00	0.000	invert of CBMH10
181.180	4.8	0	4.8	0.005	0.00	0.005	1200mm Super pipe (MH9 to CBMH10)
181.280	9.6	0	9.6	0.008	0.00	0.008	
181.380	5.9	0	5.9	0.009	0.00	0.009	
181.480	10.3	0	10.3	0.011	0.00	0.011	
181.580	15.4	0	15.4	0.012	0.00	0.012	
181.680	21.0	0	21.0	0.013	0.00	0.013	
181.780	26.8	0	26.8	0.014	0.00	0.014	
181.880	32.7	0	32.7	0.015	0.00	0.015	
181.980	38.4	0	38.4	0.016	0.00	0.016	
182.080	43.8	0	43.8	0.017	0.00	0.017	
182.180	48.6	0	48.6	0.018	0.00	0.018	
182.280	52.3	0	52.3	0.019	0.00	0.019	
182.380	54.5	0	54.5	0.020	0.00	0.020	
182.480	56.1	0	56.1	0.020	0.00	0.020	
182.580	56.5	0	56.5	0.021	0.00	0.021	
182.680	56.5	0	56.5	0.022	0.00	0.022	
183.360	63.6	0	63.6	0.026	0.00	0.026	MH Top - Outlet Control Manhole = 183.36

Prepared by: Chris Zhang

Post-Development Visual Otthymo Model Input Parameters (NASHYD)

613 Helena St
File No. 131951
Date: Feb, 2022

Pre-Development Drainage Area (OTTHYMO)

Parameter	Unit	Description	Pre A1	Post A4	EX-4
Area	ha	Watershed Area	4.32	0.53	
TP	hr	Unit Hydrograph Time to Peak	0.17	0.20	
DT	min	Time Step Increment	5		
DWF	cms	Dry Weather Flow (Base Flow)	0		
CN	-	SCS Modified Curve Number[1]	74		
IA	mm	Initial Abstraction	1.5		
N	-	Number of Linear Reservior	2		
Rain	mm/hr	Optional Rainfall Intensities	0-Without Rainfall		

Note: 1 - Based on AMC II

Time of Concentration Calculation

Area Number	Area (ha)	Cpre	CN	L (m)	Elevation Change (m)	Sw (%)	Tp (Airport) (hr)
Pre A1	4.32	0.25	74	245	0.8	0.3	0.17
Post A4	0.53	0.25	74	86	2.5	2.9	0.20

IBI

Prepared by: Chris Zhang

Post-Development Visual Otthymo Model Input Parameters (STANDHYD)

613 Helena St
File No. 131951
Date: Feb, 2022

Parameter	Description	Post A-201	Post A-202	Post A-203	Post A-205	Post A-206	Post A-207
AREA		2.27	0.46	0.39	0.24	0.35	0.08
XIMP	Impervious Area (Direct Connection)	60%	60%	60%	60%	60%	60%
TIMP	Total Impervious Area	60%	60%	60%	60%	60%	60%
LGI	Overland Flow Length (Impervious)	123.0	75.3		40.0	48.3	23.09
SLPI	Average Slope (Impervious)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
DT	Time Step Increment	5	5	5	5	5	5
DWF	Dry Weather Flow (Base Flow)	0	0	0	0	0	0
LOSS	Rainfall Loss Method	Loss = 2 (SCS Curve Method) CN = 74, IA = 1.5mm					
SLPP	Average Slope (Pervious)	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
LGP	Overland Flow Length (Pervious)	40	40	40	40	40	40
MNP	Manning's Roughness Coefficient (Pervious)	0.25	0.25	0.25	0.25	0.25	0.25
DPSI	Depression Storage (Impervious)	1.5 mm	1.5 mm	1.5 mm	1.5 mm	1.5 mm	1.5 mm
MNI	Manning's Roughness Coefficient	0.013	0.013	0.013	0.013	0.013	1.013

```
  ********************************
  ** SIMULATION:Fort Erie       **
  ********************************
  --------------------
  | CHICAGO STORM    |    IDF curve parameters: A=1083.550
  | Ptotal= 75.61 mm |                          B=   6.618
  --------------------                          C=   0.735
                          used in:   INTENSITY =  A / (t + B)^C

                          Duration of storm  =  4.00 hrs
                          Storm time step    = 10.00 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    6.10 |  1.00   39.99 |  2.00   13.50 |  3.00    7.16
                   0.17    6.92 |  1.17  137.32 |  2.17   11.63 |  3.17    6.69
                   0.33    8.05 |  1.33   51.10 |  2.33   10.27 |  3.33    6.28
                   0.50    9.73 |  1.50   28.93 |  2.50    9.22 |  3.50    5.93
                   0.67   12.55 |  1.67   20.61 |  2.67    8.39 |  3.67    5.62
                   0.83   18.40 |  1.83   16.22 |  2.83    7.72 |  3.83    5.34


  --------------------------------------------------------------------------------
  --------------------
  | CALIB            |
  | NASHYD   (  0001)|   Area    (ha)=   4.32   Curve Number   (CN)= 74.0
  |ID= 1 DT= 5.0 min |   Ia      (mm)=   1.50   # of Linear Res.(N)= 3.00
  --------------------   U.H. Tp(hrs)=   0.17

           NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                  ---- TRANSFORMED HYETOGRAPH ----
                   TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                    hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                  0.083    6.10 | 1.083   39.99 | 2.083   13.50 |  3.08    7.16
                  0.167    6.10 | 1.167   39.99 | 2.167   13.50 |  3.17    7.16
                  0.250    6.92 | 1.250  137.32 | 2.250   11.63 |  3.25    6.69
                  0.333    6.92 | 1.333  137.32 | 2.333   11.63 |  3.33    6.69
                  0.417    8.05 | 1.417   51.10 | 2.417   10.27 |  3.42    6.28
                  0.500    8.05 | 1.500   51.10 | 2.500   10.27 |  3.50    6.28
                  0.583    9.73 | 1.583   28.93 | 2.583    9.22 |  3.58    5.93
                  0.667    9.73 | 1.667   28.93 | 2.667    9.22 |  3.67    5.93
                  0.750   12.55 | 1.750   20.61 | 2.750    8.39 |  3.75    5.62
                  0.833   12.55 | 1.833   20.61 | 2.833    8.39 |  3.83    5.62
                  0.917   18.40 | 1.917   16.22 | 2.917    7.72 |  3.92    5.34
                  1.000   18.40 | 2.000   16.22 | 3.000    7.72 |  4.00    5.34

       Unit Hyd Qpeak  (cms)=   0.994

       PEAK FLOW       (cms)=   0.422 (i)
       TIME TO PEAK    (hrs)=   1.417
       RUNOFF VOLUME    (mm)=  33.493
       TOTAL RAINFALL   (mm)=  75.614
       RUNOFF COEFFICIENT   =   0.443

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

  --------------------------------------------------------------------------------
  ********************************
  ** SIMULATION:Fort Erie-2yr   **
  ********************************
  --------------------
  | CHICAGO STORM    |    IDF curve parameters: A= 628.050
  | Ptotal= 31.32 mm |                          B=   6.652
  --------------------                          C=   0.796
                          used in:   INTENSITY =  A / (t + B)^C

                          Duration of storm  =  4.00 hrs
                          Storm time step    = 10.00 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    2.03 |  1.00   16.99 |  2.00    4.94 |  3.00    2.42
                   0.17    2.33 |  1.17   66.94 |  2.17    4.17 |  3.17    2.25
                   0.33    2.76 |  1.33   22.29 |  2.33    3.63 |  3.33    2.10
                   0.50    3.42 |  1.50   11.71 |  2.50    3.22 |  3.50    1.96
                   0.67    4.55 |  1.67    7.97 |  2.67    2.90 |  3.67    1.85
                   0.83    7.02 |  1.83    6.08 |  2.83    2.64 |  3.83    1.75

  --------------------------------------------------------------------------------
```

```
--------------------
| CALIB              |
| NASHYD   (  0001)|   Area    (ha)=   4.32   Curve Number   (CN)= 74.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   1.50   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.17
```

NOTE: RAINFALL WAS TRANSFORMED TO 5.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	2.03	1.083	16.99	2.083	4.94	3.08	2.42
0.167	2.03	1.167	16.99	2.167	4.94	3.17	2.42
0.250	2.33	1.250	66.94	2.250	4.17	3.25	2.25
0.333	2.33	1.333	66.94	2.333	4.17	3.33	2.25
0.417	2.76	1.417	22.29	2.417	3.63	3.42	2.10
0.500	2.76	1.500	22.29	2.500	3.63	3.50	2.10
0.583	3.42	1.583	11.71	2.583	3.22	3.58	1.96
0.667	3.42	1.667	11.71	2.667	3.22	3.67	1.96
0.750	4.55	1.750	7.97	2.750	2.90	3.75	1.85
0.833	4.55	1.833	7.97	2.833	2.90	3.83	1.85
0.917	7.02	1.917	6.08	2.917	2.64	3.92	1.75
1.000	7.02	2.000	6.08	3.000	2.64	4.00	1.75

```
Unit Hyd Qpeak  (cms)=   0.994

PEAK FLOW       (cms)=   0.101 (i)
TIME TO PEAK    (hrs)=   1.500
RUNOFF VOLUME    (mm)=   7.439
TOTAL RAINFALL   (mm)=  31.319
RUNOFF COEFFICIENT   =   0.238

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

```
--------------------------------------------------------------------------------
********************************
** SIMULATION:Fort Erie-5yr   **
********************************
--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 747.930
| Ptotal= 43.50 mm |                          B=   6.800
--------------------                          C=   0.768
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  =  4.00 hrs
                        Storm time step    = 10.00 min
                        Time to peak ratio =  0.33
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.00	3.14	1.00	23.44	2.00	7.32	3.00	3.73
0.17	3.59	1.17	85.67	2.17	6.24	3.17	3.46
0.33	4.22	1.33	30.36	2.33	5.47	3.33	3.24
0.50	5.16	1.50	16.55	2.50	4.88	3.50	3.05
0.67	6.77	1.67	11.51	2.67	4.41	3.67	2.88
0.83	10.20	1.83	8.91	2.83	4.04	3.83	2.73

```
--------------------------------------------------------------------------------
--------------------
| CALIB              |
| NASHYD   (  0001)|   Area    (ha)=   4.32   Curve Number   (CN)= 74.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   1.50   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.17
```

NOTE: RAINFALL WAS TRANSFORMED TO 5.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	3.14	1.083	23.44	2.083	7.32	3.08	3.73
0.167	3.14	1.167	23.44	2.167	7.32	3.17	3.73
0.250	3.59	1.250	85.67	2.250	6.24	3.25	3.46
0.333	3.59	1.333	85.67	2.333	6.24	3.33	3.46
0.417	4.22	1.417	30.36	2.417	5.47	3.42	3.24
0.500	4.22	1.500	30.36	2.500	5.47	3.50	3.24
0.583	5.16	1.583	16.55	2.583	4.88	3.58	3.05
0.667	5.16	1.667	16.55	2.667	4.88	3.67	3.05
0.750	6.77	1.750	11.51	2.750	4.41	3.75	2.88
0.833	6.77	1.833	11.51	2.833	4.41	3.83	2.88
0.917	10.20	1.917	8.91	2.917	4.04	3.92	2.73
1.000	10.20	2.000	8.91	3.000	4.04	4.00	2.73

```
     Unit Hyd Qpeak  (cms)=   0.994

     PEAK FLOW       (cms)=   0.173 (i)
     TIME TO PEAK    (hrs)=   1.500
     RUNOFF VOLUME    (mm)=  13.385
     TOTAL RAINFALL   (mm)=  43.495
     RUNOFF COEFFICIENT   =   0.308

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

------------------------------------------------------------------------------
```

```
********************************
** SIMULATION:2yr-control     **
********************************
--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 628.050
| Ptotal= 31.32 mm |                          B=   6.652
--------------------                          C=   0.796
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  =  4.00 hrs
                        Storm time step    = 10.00 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    2.03 |  1.00   16.99 |  2.00    4.94 |  3.00    2.42
                  0.17    2.33 |  1.17   66.94 |  2.17    4.17 |  3.17    2.25
                  0.33    2.76 |  1.33   22.29 |  2.33    3.63 |  3.33    2.10
                  0.50    3.42 |  1.50   11.71 |  2.50    3.22 |  3.50    1.96
                  0.67    4.55 |  1.67    7.97 |  2.67    2.90 |  3.67    1.85
                  0.83    7.02 |  1.83    6.08 |  2.83    2.64 |  3.83    1.75


--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0010)|   Area    (ha)=   0.85
|ID= 1 DT= 5.0 min |   Total Imp(%)=  45.00   Dir. Conn.(%)=  45.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.38         0.47
     Dep. Storage     (mm)=       1.50         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      75.28        40.00
     Mannings n          =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                 ---- TRANSFORMED HYETOGRAPH ----
                  TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                   hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.083    2.03 | 1.083   16.99 | 2.083    4.94 |  3.08    2.42
                 0.167    2.03 | 1.167   16.99 | 2.167    4.94 |  3.17    2.42
                 0.250    2.33 | 1.250   66.94 | 2.250    4.17 |  3.25    2.25
                 0.333    2.33 | 1.333   66.94 | 2.333    4.17 |  3.33    2.25
                 0.417    2.76 | 1.417   22.29 | 2.417    3.63 |  3.42    2.10
                 0.500    2.76 | 1.500   22.29 | 2.500    3.63 |  3.50    2.10
                 0.583    3.42 | 1.583   11.71 | 2.583    3.22 |  3.58    1.96
                 0.667    3.42 | 1.667   11.71 | 2.667    3.22 |  3.67    1.96
                 0.750    4.55 | 1.750    7.97 | 2.750    2.90 |  3.75    1.85
                 0.833    4.55 | 1.833    7.97 | 2.833    2.90 |  3.83    1.85
                 0.917    7.02 | 1.917    6.08 | 2.917    2.64 |  3.92    1.75
                 1.000    7.02 | 2.000    6.08 | 3.000    2.64 |  4.00    1.75

     Max.Eff.Inten.(mm/hr)=      66.94        10.07
               over (min)         5.00        25.00
     Storage Coeff.  (min)=       2.53 (ii)   20.21 (ii)
     Unit Hyd. Tpeak (min)=       5.00        25.00
     Unit Hyd. peak  (cms)=       0.29         0.05
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.07         0.01         0.072 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.67          1.33
     RUNOFF VOLUME    (mm)=      29.82         7.47         17.51
     TOTAL RAINFALL   (mm)=      31.32        31.32         31.32
     RUNOFF COEFFICIENT   =       0.95         0.24          0.56

***** 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.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0013)|   Area    (ha)=   0.53   Curve Number   (CN)= 74.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   1.50   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.20

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

```
                                  ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
               0.083    2.03 | 1.083   16.99 | 2.083    4.94 |  3.08    2.42
               0.167    2.03 | 1.167   16.99 | 2.167    4.94 |  3.17    2.42
               0.250    2.33 | 1.250   66.94 | 2.250    4.17 |  3.25    2.25
               0.333    2.33 | 1.333   66.94 | 2.333    4.17 |  3.33    2.25
               0.417    2.76 | 1.417   22.29 | 2.417    3.63 |  3.42    2.10
               0.500    2.76 | 1.500   22.29 | 2.500    3.63 |  3.50    2.10
               0.583    3.42 | 1.583   11.71 | 2.583    3.22 |  3.58    1.96
               0.667    3.42 | 1.667   11.71 | 2.667    3.22 |  3.67    1.96
               0.750    4.55 | 1.750    7.97 | 2.750    2.90 |  3.75    1.85
               0.833    4.55 | 1.833    7.97 | 2.833    2.90 |  3.83    1.85
               0.917    7.02 | 1.917    6.08 | 2.917    2.64 |  3.92    1.75
               1.000    7.02 | 2.000    6.08 | 3.000    2.64 |  4.00    1.75

     Unit Hyd Qpeak  (cms)=   0.101

     PEAK FLOW       (cms)=   0.011 (i)
     TIME TO PEAK    (hrs)=   1.500
     RUNOFF VOLUME    (mm)=   7.453
     TOTAL RAINFALL   (mm)=  31.319
     RUNOFF COEFFICIENT   =   0.238

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

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0005)|   Area    (ha)=   2.27
|ID= 1 DT= 5.0 min |   Total Imp(%)=  60.00   Dir. Conn.(%)=  60.00
--------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        1.36          0.91
     Dep. Storage     (mm)=        1.50          1.50
     Average Slope     (%)=        1.00          2.00
     Length            (m)=      123.02         40.00
     Mannings n           =       0.013         0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                  ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
               0.083    2.03 | 1.083   16.99 | 2.083    4.94 |  3.08    2.42
               0.167    2.03 | 1.167   16.99 | 2.167    4.94 |  3.17    2.42
               0.250    2.33 | 1.250   66.94 | 2.250    4.17 |  3.25    2.25
               0.333    2.33 | 1.333   66.94 | 2.333    4.17 |  3.33    2.25
               0.417    2.76 | 1.417   22.29 | 2.417    3.63 |  3.42    2.10
               0.500    2.76 | 1.500   22.29 | 2.500    3.63 |  3.50    2.10
               0.583    3.42 | 1.583   11.71 | 2.583    3.22 |  3.58    1.96
               0.667    3.42 | 1.667   11.71 | 2.667    3.22 |  3.67    1.96
               0.750    4.55 | 1.750    7.97 | 2.750    2.90 |  3.75    1.85
               0.833    4.55 | 1.833    7.97 | 2.833    2.90 |  3.83    1.85
               0.917    7.02 | 1.917    6.08 | 2.917    2.64 |  3.92    1.75
               1.000    7.02 | 2.000    6.08 | 3.000    2.64 |  4.00    1.75

     Max.Eff.Inten.(mm/hr)=      66.94         18.67
                over (min)        5.00         20.00
     Storage Coeff.  (min)=       3.40 (ii)    17.21 (ii)
     Unit Hyd. Tpeak (min)=       5.00         20.00
     Unit Hyd. peak  (cms)=       0.26          0.06
                                                             *TOTALS*
     PEAK FLOW       (cms)=       0.24          0.03           0.253 (iii)
     TIME TO PEAK    (hrs)=       1.33          1.58            1.33
     RUNOFF VOLUME    (mm)=      29.82         11.91           22.65
     TOTAL RAINFALL   (mm)=      31.32         31.32           31.32
     RUNOFF COEFFICIENT   =       0.95          0.38            0.72

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

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  85.0    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  (  0009)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
```

```
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0013):      0.53   0.011     1.50     7.45
      + ID2= 2 (  0005):      2.27   0.253     1.33    22.65
        ====================================================
        ID = 3 (  0009):      2.80   0.260     1.33    19.77

     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   |   0.0149      0.2017
                         0.0084      0.0559   |   0.0173      0.2933
                         0.0121      0.1228   |   0.0191      0.3876

                               AREA     QPEAK     TPEAK       R.V.
                               (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0009)      2.800      0.260      1.33      19.77
   OUTFLOW: ID= 1 (  0004)      2.800      0.007      4.08      19.17

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=  2.80
                   TIME SHIFT OF PEAK FLOW         (min)=165.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0485

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0018)|   Area    (ha)=   0.08
|ID= 1 DT= 5.0 min |   Total Imp(%)=  60.00   Dir. Conn.(%)=  60.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.05          0.03
     Dep. Storage     (mm)=       1.50          1.50
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      23.09         40.00
     Mannings n          =      0.013         0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                ---- TRANSFORMED HYETOGRAPH ----
                   TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                    hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                  0.083    2.03 | 1.083   16.99 | 2.083    4.94 |  3.08    2.42
                  0.167    2.03 | 1.167   16.99 | 2.167    4.94 |  3.17    2.42
                  0.250    2.33 | 1.250   66.94 | 2.250    4.17 |  3.25    2.25
                  0.333    2.33 | 1.333   66.94 | 2.333    4.17 |  3.33    2.25
                  0.417    2.76 | 1.417   22.29 | 2.417    3.63 |  3.42    2.10
                  0.500    2.76 | 1.500   22.29 | 2.500    3.63 |  3.50    2.10
                  0.583    3.42 | 1.583   11.71 | 2.583    3.22 |  3.58    1.96
                  0.667    3.42 | 1.667   11.71 | 2.667    3.22 |  3.67    1.96
                  0.750    4.55 | 1.750    7.97 | 2.750    2.90 |  3.75    1.85
                  0.833    4.55 | 1.833    7.97 | 2.833    2.90 |  3.83    1.85
                  0.917    7.02 | 1.917    6.08 | 2.917    2.64 |  3.92    1.75
                  1.000    7.02 | 2.000    6.08 | 3.000    2.64 |  4.00    1.75

     Max.Eff.Inten.(mm/hr)=      66.94         10.07
                over (min)        5.00         20.00
     Storage Coeff.  (min)=       1.24 (ii)    18.92 (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          0.009 (iii)
     TIME TO PEAK    (hrs)=       1.33          1.58           1.33
     RUNOFF VOLUME    (mm)=      29.82          7.47          20.74
     TOTAL RAINFALL   (mm)=      31.32         31.32          31.32
     RUNOFF COEFFICIENT   =       0.95          0.24           0.66

***** 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  (  0016)|
|   1 +  2 =  3    |          AREA    QPEAK    TPEAK     R.V.
--------------------          (ha)    (cms)    (hrs)     (mm)
```

```
          ID1= 1 (  0010):     0.85   0.072     1.33    17.51
        + ID2= 2 (  0018):     0.08   0.009     1.33    20.74
          ===================================================
          ID = 3 (  0016):     0.93   0.081     1.33    17.79

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

--------------------
| ADD HYD  (  0016)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 3 (  0016):     0.93   0.081     1.33    17.79
        + ID2= 2 (  0004):     2.80   0.007     4.08    19.17
          ===================================================
          ID = 1 (  0016):     3.73   0.084     1.33    18.83

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
********************************
** SIMULATION:Fort Erie-100yr **
********************************
--------------------
| CHICAGO STORM    |    IDF curve parameters: A=1083.550
| Ptotal= 75.61 mm |                          B=   6.618
--------------------                          C=   0.735
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  =  4.00 hrs
                        Storm time step    = 10.00 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    6.10 |  1.00   39.99 |  2.00   13.50 |  3.00    7.16
                 0.17    6.92 |  1.17  137.32 |  2.17   11.63 |  3.17    6.69
                 0.33    8.05 |  1.33   51.10 |  2.33   10.27 |  3.33    6.28
                 0.50    9.73 |  1.50   28.93 |  2.50    9.22 |  3.50    5.93
                 0.67   12.55 |  1.67   20.61 |  2.67    8.39 |  3.67    5.62
                 0.83   18.40 |  1.83   16.22 |  2.83    7.72 |  3.83    5.34


--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0010)|   Area    (ha)=   0.85
|ID= 1 DT= 5.0 min |   Total Imp(%)=  45.00   Dir. Conn.(%)=  45.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.38         0.47
     Dep. Storage     (mm)=       1.50         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      75.28        40.00
     Mannings n          =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    6.10 | 1.083   39.99 | 2.083   13.50 |  3.08    7.16
                0.167    6.10 | 1.167   39.99 | 2.167   13.50 |  3.17    7.16
                0.250    6.92 | 1.250  137.32 | 2.250   11.63 |  3.25    6.69
                0.333    6.92 | 1.333  137.32 | 2.333   11.63 |  3.33    6.69
                0.417    8.05 | 1.417   51.10 | 2.417   10.27 |  3.42    6.28
                0.500    8.05 | 1.500   51.10 | 2.500   10.27 |  3.50    6.28
                0.583    9.73 | 1.583   28.93 | 2.583    9.22 |  3.58    5.93
                0.667    9.73 | 1.667   28.93 | 2.667    9.22 |  3.67    5.93
                0.750   12.55 | 1.750   20.61 | 2.750    8.39 |  3.75    5.62
                0.833   12.55 | 1.833   20.61 | 2.833    8.39 |  3.83    5.62
                0.917   18.40 | 1.917   16.22 | 2.917    7.72 |  3.92    5.34
                1.000   18.40 | 2.000   16.22 | 3.000    7.72 |  4.00    5.34

     Max.Eff.Inten.(mm/hr)=     137.32        55.45
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       1.90 (ii)   10.83 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.32         0.09
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.15         0.04         0.170 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.50          1.33
     RUNOFF VOLUME    (mm)=      74.11        33.62         51.84
     TOTAL RAINFALL   (mm)=      75.61        75.61         75.61
```

```
     RUNOFF COEFFICIENT   =       0.98         0.44           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.

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| NASHYD   (  0013)|   Area    (ha)=   0.53   Curve Number   (CN)= 74.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   1.50   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.20

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
               0.083    6.10 | 1.083   39.99 | 2.083   13.50 |  3.08    7.16
               0.167    6.10 | 1.167   39.99 | 2.167   13.50 |  3.17    7.16
               0.250    6.92 | 1.250  137.32 | 2.250   11.63 |  3.25    6.69
               0.333    6.92 | 1.333  137.32 | 2.333   11.63 |  3.33    6.69
               0.417    8.05 | 1.417   51.10 | 2.417   10.27 |  3.42    6.28
               0.500    8.05 | 1.500   51.10 | 2.500   10.27 |  3.50    6.28
               0.583    9.73 | 1.583   28.93 | 2.583    9.22 |  3.58    5.93
               0.667    9.73 | 1.667   28.93 | 2.667    9.22 |  3.67    5.93
               0.750   12.55 | 1.750   20.61 | 2.750    8.39 |  3.75    5.62
               0.833   12.55 | 1.833   20.61 | 2.833    8.39 |  3.83    5.62
               0.917   18.40 | 1.917   16.22 | 2.917    7.72 |  3.92    5.34
               1.000   18.40 | 2.000   16.22 | 3.000    7.72 |  4.00    5.34

     Unit Hyd Qpeak  (cms)=   0.101

     PEAK FLOW       (cms)=   0.048 (i)
     TIME TO PEAK    (hrs)=   1.500
     RUNOFF VOLUME    (mm)=  33.560
     TOTAL RAINFALL   (mm)=  75.614
     RUNOFF COEFFICIENT   =   0.444

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

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0005)|   Area    (ha)=   2.27
|ID= 1 DT= 5.0 min |   Total Imp(%)=  60.00   Dir. Conn.(%)=  60.00
--------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.36         0.91
     Dep. Storage     (mm)=       1.50         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     123.02        40.00
     Mannings n           =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
               0.083    6.10 | 1.083   39.99 | 2.083   13.50 |  3.08    7.16
               0.167    6.10 | 1.167   39.99 | 2.167   13.50 |  3.17    7.16
               0.250    6.92 | 1.250  137.32 | 2.250   11.63 |  3.25    6.69
               0.333    6.92 | 1.333  137.32 | 2.333   11.63 |  3.33    6.69
               0.417    8.05 | 1.417   51.10 | 2.417   10.27 |  3.42    6.28
               0.500    8.05 | 1.500   51.10 | 2.500   10.27 |  3.50    6.28
               0.583    9.73 | 1.583   28.93 | 2.583    9.22 |  3.58    5.93
               0.667    9.73 | 1.667   28.93 | 2.667    9.22 |  3.67    5.93
               0.750   12.55 | 1.750   20.61 | 2.750    8.39 |  3.75    5.62
               0.833   12.55 | 1.833   20.61 | 2.833    8.39 |  3.83    5.62
               0.917   18.40 | 1.917   16.22 | 2.917    7.72 |  3.92    5.34
               1.000   18.40 | 2.000   16.22 | 3.000    7.72 |  4.00    5.34

     Max.Eff.Inten.(mm/hr)=     137.32        82.28
               over (min)       5.00        15.00
     Storage Coeff.  (min)=       2.55 (ii)   10.18 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.29         0.10
                                                           *TOTALS*
```

```
     PEAK FLOW       (cms)=       0.51         0.13          0.588 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.50           1.33
     RUNOFF VOLUME    (mm)=      74.11        46.18          62.94
     TOTAL RAINFALL   (mm)=      75.61        75.61          75.61
     RUNOFF COEFFICIENT   =       0.98         0.61           0.83

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

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  85.0    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  (  0009)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0013):     0.53   0.048     1.50    33.56
      + ID2= 2 (  0005):     2.27   0.588     1.33    62.94
        ====================================================
        ID = 3 (  0009):     2.80   0.621     1.33    57.38

     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    |   0.0149      0.2017
                         0.0084     0.0559    |   0.0173      0.2933
                         0.0121     0.1228    |   0.0191      0.3876

                                  AREA     QPEAK     TPEAK       R.V.
                                  (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0009)       2.800      0.621      1.33       57.38
   OUTFLOW: ID= 1 (  0004)       2.800      0.013      4.17       56.77

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=  2.09
                   TIME SHIFT OF PEAK FLOW         (min)=170.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.1472

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0018)|   Area    (ha)=   0.08
|ID= 1 DT= 5.0 min |   Total Imp(%)=  60.00   Dir. Conn.(%)=  60.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.05         0.03
     Dep. Storage     (mm)=       1.50         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      23.09        40.00
     Mannings n           =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    6.10 | 1.083   39.99 | 2.083   13.50 |  3.08    7.16
                0.167    6.10 | 1.167   39.99 | 2.167   13.50 |  3.17    7.16
                0.250    6.92 | 1.250  137.32 | 2.250   11.63 |  3.25    6.69
                0.333    6.92 | 1.333  137.32 | 2.333   11.63 |  3.33    6.69
                0.417    8.05 | 1.417   51.10 | 2.417   10.27 |  3.42    6.28
                0.500    8.05 | 1.500   51.10 | 2.500   10.27 |  3.50    6.28
                0.583    9.73 | 1.583   28.93 | 2.583    9.22 |  3.58    5.93
                0.667    9.73 | 1.667   28.93 | 2.667    9.22 |  3.67    5.93
                0.750   12.55 | 1.750   20.61 | 2.750    8.39 |  3.75    5.62
                0.833   12.55 | 1.833   20.61 | 2.833    8.39 |  3.83    5.62
                0.917   18.40 | 1.917   16.22 | 2.917    7.72 |  3.92    5.34
                1.000   18.40 | 2.000   16.22 | 3.000    7.72 |  4.00    5.34

     Max.Eff.Inten.(mm/hr)=     137.32        55.45
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       0.93 (ii)    9.87 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.34         0.11
                                                        *TOTALS*
     PEAK FLOW       (cms)=       0.02         0.00          0.021 (iii)
```

```
     TIME TO PEAK    (hrs)=       1.33          1.42            1.33
     RUNOFF VOLUME    (mm)=      74.11         33.62           57.86
     TOTAL RAINFALL   (mm)=      75.61         75.61           75.61
     RUNOFF COEFFICIENT   =       0.98          0.44            0.77

***** 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  (  0016)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0010):     0.85   0.170     1.33    51.84
      + ID2= 2 (  0018):     0.08   0.021     1.33    57.86
        ===============================================
        ID = 3 (  0016):     0.93   0.191     1.33    52.35

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

--------------------
| ADD HYD  (  0016)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0016):     0.93   0.191     1.33    52.35
      + ID2= 2 (  0004):     2.80   0.013     4.17    56.77
        ===============================================
        ID = 1 (  0016):     3.73   0.198     1.33    55.67

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
********************************
** SIMULATION:Fort Erie-5yr   **
********************************
--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 747.930
| Ptotal= 43.50 mm |                          B=   6.800
--------------------                          C=   0.768
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  =  4.00 hrs
                        Storm time step    = 10.00 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    3.14 |  1.00   23.44 |  2.00     7.32 |  3.00    3.73
                 0.17    3.59 |  1.17   85.67 |  2.17     6.24 |  3.17    3.46
                 0.33    4.22 |  1.33   30.36 |  2.33     5.47 |  3.33    3.24
                 0.50    5.16 |  1.50   16.55 |  2.50     4.88 |  3.50    3.05
                 0.67    6.77 |  1.67   11.51 |  2.67     4.41 |  3.67    2.88
                 0.83   10.20 |  1.83    8.91 |  2.83     4.04 |  3.83    2.73


--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0010)|   Area    (ha)=   0.85
|ID= 1 DT= 5.0 min |   Total Imp(%)=  45.00   Dir. Conn.(%)=  45.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.38          0.47
     Dep. Storage     (mm)=       1.50          1.50
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      75.28         40.00
     Mannings n           =      0.013         0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    3.14 | 1.083   23.44 | 2.083     7.32 |  3.08    3.73
                0.167    3.14 | 1.167   23.44 | 2.167     7.32 |  3.17    3.73
                0.250    3.59 | 1.250   85.67 | 2.250     6.24 |  3.25    3.46
                0.333    3.59 | 1.333   85.67 | 2.333     6.24 |  3.33    3.46
```

```
              0.417    4.22 | 1.417   30.36 | 2.417    5.47 |  3.42    3.24
              0.500    4.22 | 1.500   30.36 | 2.500    5.47 |  3.50    3.24
              0.583    5.16 | 1.583   16.55 | 2.583    4.88 |  3.58    3.05
              0.667    5.16 | 1.667   16.55 | 2.667    4.88 |  3.67    3.05
              0.750    6.77 | 1.750   11.51 | 2.750    4.41 |  3.75    2.88
              0.833    6.77 | 1.833   11.51 | 2.833    4.41 |  3.83    2.88
              0.917   10.20 | 1.917    8.91 | 2.917    4.04 |  3.92    2.73
              1.000   10.20 | 2.000    8.91 | 3.000    4.04 |  4.00    2.73

     Max.Eff.Inten.(mm/hr)=      85.67        18.88
              over (min)          5.00        20.00
     Storage Coeff.  (min)=       2.29 (ii)   16.04 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=       0.30         0.06
                                                      *TOTALS*
     PEAK FLOW       (cms)=       0.09         0.01          0.096 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.58           1.33
     RUNOFF VOLUME    (mm)=      42.00        13.44          26.28
     TOTAL RAINFALL   (mm)=      43.50        43.50          43.50
     RUNOFF COEFFICIENT   =       0.97         0.31           0.60

***** 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.

-------------------------------------------------------------------------------
--------------------
| CALIB              |
| NASHYD   (  0013)|   Area    (ha)=   0.53   Curve Number   (CN)= 74.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   1.50   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.20

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                  ---- TRANSFORMED HYETOGRAPH ----
               TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
              0.083    3.14 | 1.083   23.44 | 2.083    7.32 |  3.08    3.73
              0.167    3.14 | 1.167   23.44 | 2.167    7.32 |  3.17    3.73
              0.250    3.59 | 1.250   85.67 | 2.250    6.24 |  3.25    3.46
              0.333    3.59 | 1.333   85.67 | 2.333    6.24 |  3.33    3.46
              0.417    4.22 | 1.417   30.36 | 2.417    5.47 |  3.42    3.24
              0.500    4.22 | 1.500   30.36 | 2.500    5.47 |  3.50    3.24
              0.583    5.16 | 1.583   16.55 | 2.583    4.88 |  3.58    3.05
              0.667    5.16 | 1.667   16.55 | 2.667    4.88 |  3.67    3.05
              0.750    6.77 | 1.750   11.51 | 2.750    4.41 |  3.75    2.88
              0.833    6.77 | 1.833   11.51 | 2.833    4.41 |  3.83    2.88
              0.917   10.20 | 1.917    8.91 | 2.917    4.04 |  3.92    2.73
              1.000   10.20 | 2.000    8.91 | 3.000    4.04 |  4.00    2.73

     Unit Hyd Qpeak  (cms)=   0.101

     PEAK FLOW       (cms)=   0.020 (i)
     TIME TO PEAK    (hrs)=   1.500
     RUNOFF VOLUME    (mm)=  13.412
     TOTAL RAINFALL   (mm)=  43.495
     RUNOFF COEFFICIENT   =   0.308

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

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--------------------
| CALIB              |
| STANDHYD (  0005)|   Area    (ha)=   2.27
|ID= 1 DT= 5.0 min |   Total Imp(%)=  60.00   Dir. Conn.(%)=  60.00
--------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       1.36          0.91
     Dep. Storage     (mm)=       1.50          1.50
     Average Slope     (%)=       1.00          2.00
     Length            (m)=     123.02         40.00
     Mannings n           =      0.013         0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                  ---- TRANSFORMED HYETOGRAPH ----
               TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
```

```
               0.083    3.14 | 1.083   23.44 | 2.083    7.32 |  3.08    3.73
               0.167    3.14 | 1.167   23.44 | 2.167    7.32 |  3.17    3.73
               0.250    3.59 | 1.250   85.67 | 2.250    6.24 |  3.25    3.46
               0.333    3.59 | 1.333   85.67 | 2.333    6.24 |  3.33    3.46
               0.417    4.22 | 1.417   30.36 | 2.417    5.47 |  3.42    3.24
               0.500    4.22 | 1.500   30.36 | 2.500    5.47 |  3.50    3.24
               0.583    5.16 | 1.583   16.55 | 2.583    4.88 |  3.58    3.05
               0.667    5.16 | 1.667   16.55 | 2.667    4.88 |  3.67    3.05
               0.750    6.77 | 1.750   11.51 | 2.750    4.41 |  3.75    2.88
               0.833    6.77 | 1.833   11.51 | 2.833    4.41 |  3.83    2.88
               0.917   10.20 | 1.917    8.91 | 2.917    4.04 |  3.92    2.73
               1.000   10.20 | 2.000    8.91 | 3.000    4.04 |  4.00    2.73

     Max.Eff.Inten.(mm/hr)=      85.67        30.41
              over (min)          5.00        15.00
     Storage Coeff.  (min)=       3.08 (ii)   14.44 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.27         0.08
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.31         0.05          0.341 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.50           1.33
     RUNOFF VOLUME    (mm)=      42.00        20.31          33.32
     TOTAL RAINFALL   (mm)=      43.50        43.50          43.50
     RUNOFF COEFFICIENT   =       0.97         0.47           0.77

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

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  85.0    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.

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--------------------
| ADD HYD  (  0009)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0013):     0.53   0.020     1.50    13.41
      + ID2= 2 (  0005):     2.27   0.341     1.33    33.32
        ====================================================
        ID = 3 (  0009):     2.80   0.354     1.33    29.55

     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   |   0.0149      0.2017
                          0.0084     0.0559   |   0.0173      0.2933
                          0.0121     0.1228   |   0.0191      0.3876

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0009)      2.800      0.354      1.33      29.55
   OUTFLOW: ID= 1 (  0004)      2.800      0.009      4.08      28.95

                 PEAK   FLOW   REDUCTION [Qout/Qin](%)=  2.65
                 TIME SHIFT OF PEAK FLOW         (min)=165.00
                 MAXIMUM  STORAGE   USED       (ha.m.)=  0.0734

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0018)|   Area    (ha)=   0.08
|ID= 1 DT= 5.0 min |   Total Imp(%)=  60.00   Dir. Conn.(%)=  60.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.05         0.03
     Dep. Storage     (mm)=       1.50         1.50
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      23.09        40.00
     Mannings n           =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                 ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
               0.083    3.14 | 1.083   23.44 | 2.083    7.32 |  3.08    3.73
```

```
               0.167    3.14 | 1.167   23.44 | 2.167    7.32 |  3.17    3.73
               0.250    3.59 | 1.250   85.67 | 2.250    6.24 |  3.25    3.46
               0.333    3.59 | 1.333   85.67 | 2.333    6.24 |  3.33    3.46
               0.417    4.22 | 1.417   30.36 | 2.417    5.47 |  3.42    3.24
               0.500    4.22 | 1.500   30.36 | 2.500    5.47 |  3.50    3.24
               0.583    5.16 | 1.583   16.55 | 2.583    4.88 |  3.58    3.05
               0.667    5.16 | 1.667   16.55 | 2.667    4.88 |  3.67    3.05
               0.750    6.77 | 1.750   11.51 | 2.750    4.41 |  3.75    2.88
               0.833    6.77 | 1.833   11.51 | 2.833    4.41 |  3.83    2.88
               0.917   10.20 | 1.917    8.91 | 2.917    4.04 |  3.92    2.73
               1.000   10.20 | 2.000    8.91 | 3.000    4.04 |  4.00    2.73

     Max.Eff.Inten.(mm/hr)=      85.67         18.88
               over (min)         5.00         15.00
     Storage Coeff.  (min)=       1.13 (ii)    14.88 (ii)
     Unit Hyd. Tpeak (min)=       5.00         15.00
     Unit Hyd. peak  (cms)=       0.34          0.08
                                                        *TOTALS*
     PEAK FLOW       (cms)=       0.01          0.00          0.012 (iii)
     TIME TO PEAK    (hrs)=       1.33          1.50           1.33
     RUNOFF VOLUME    (mm)=      42.00         13.44          30.47
     TOTAL RAINFALL   (mm)=      43.50         43.50          43.50
     RUNOFF COEFFICIENT   =       0.97          0.31           0.70

***** 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.

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--------------------
| ADD HYD  (  0016)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0010):     0.85   0.096     1.33    26.28
      + ID2= 2 (  0018):     0.08   0.012     1.33    30.47
        ===================================================
        ID = 3 (  0016):     0.93   0.108     1.33    26.64

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
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--------------------
| ADD HYD  (  0016)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0016):     0.93   0.108     1.33    26.64
      + ID2= 2 (  0004):     2.80   0.009     4.08    28.95
        ===================================================
        ID = 1 (  0016):     3.73   0.111     1.33    28.37

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
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********************************
** SIMULATION:2yr-control     **
********************************
--------------------
| CALIB            |
| STANDHYD (  0019)|   Area    (ha)=   0.24
|ID= 1 DT= 5.0 min |   Total Imp(%)=  60.00   Dir. Conn.(%)=  60.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.14         0.10
     Dep. Storage     (mm)=       1.50         1.50
     Average Slope     (%)=       1.00         1.00
     Length            (m)=      40.00        40.00
     Mannings n          =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    2.03 | 1.083   16.99 | 2.083    4.94 |  3.08    2.42
                0.167    2.03 | 1.167   16.99 | 2.167    4.94 |  3.17    2.42
                0.250    2.33 | 1.250   66.94 | 2.250    4.17 |  3.25    2.25
                0.333    2.33 | 1.333   66.94 | 2.333    4.17 |  3.33    2.25
                0.417    2.76 | 1.417   22.29 | 2.417    3.63 |  3.42    2.10
                0.500    2.76 | 1.500   22.29 | 2.500    3.63 |  3.50    2.10
                0.583    3.42 | 1.583   11.71 | 2.583    3.22 |  3.58    1.96
                0.667    3.42 | 1.667   11.71 | 2.667    3.22 |  3.67    1.96
                0.750    4.55 | 1.750    7.97 | 2.750    2.90 |  3.75    1.85
                0.833    4.55 | 1.833    7.97 | 2.833    2.90 |  3.83    1.85
                0.917    7.02 | 1.917    6.08 | 2.917    2.64 |  3.92    1.75
                1.000    7.02 | 2.000    6.08 | 3.000    2.64 |  4.00    1.75

     Max.Eff.Inten.(mm/hr)=      66.94         8.85
                over (min)        5.00        25.00
     Storage Coeff.  (min)=       1.73 (ii)   24.65 (ii)
     Unit Hyd. Tpeak (min)=       5.00        25.00
     Unit Hyd. peak  (cms)=       0.32         0.05
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.03         0.00           0.027 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.75            1.33
     RUNOFF VOLUME    (mm)=      29.82         7.47           20.82
     TOTAL RAINFALL   (mm)=      31.32        31.32           31.32
     RUNOFF COEFFICIENT   =       0.95         0.24            0.66

***** 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.

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--------------------
| RESERVOIR(  0020)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE    |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)    |   (cms)     (ha.m.)
                          0.0000     0.0000    |   0.0100      0.0020
                          0.0038     0.0002    |   0.0119      0.0026
                          0.0053     0.0005    |   0.0125      0.0028
                          0.0065     0.0005    |   0.0131      0.0028
                          0.0084     0.0012    |   0.0150      0.0031

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0019)      0.240      0.027      1.33      20.82
   OUTFLOW: ID= 1 (  0020)      0.240      0.009      1.50      20.79
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                  TOTAL NUMBER OF SIMULATION OVERFLOW  =      0
                  CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                  PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)= 33.30
                  TIME SHIFT OF PEAK FLOW         (min)= 10.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=  0.0015

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--------------------
| CALIB            |
| STANDHYD (  0022)|   Area    (ha)=   0.35
```

```
|ID= 1 DT= 5.0 min |   Total Imp(%)=  60.00   Dir. Conn.(%)=  60.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.21         0.14
     Dep. Storage     (mm)=       1.50         1.50
     Average Slope     (%)=       1.00         1.00
     Length            (m)=      48.30        40.00
     Mannings n           =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                  TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                   hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.083    2.03 | 1.083   16.99 | 2.083    4.94 |  3.08    2.42
                 0.167    2.03 | 1.167   16.99 | 2.167    4.94 |  3.17    2.42
                 0.250    2.33 | 1.250   66.94 | 2.250    4.17 |  3.25    2.25
                 0.333    2.33 | 1.333   66.94 | 2.333    4.17 |  3.33    2.25
                 0.417    2.76 | 1.417   22.29 | 2.417    3.63 |  3.42    2.10
                 0.500    2.76 | 1.500   22.29 | 2.500    3.63 |  3.50    2.10
                 0.583    3.42 | 1.583   11.71 | 2.583    3.22 |  3.58    1.96
                 0.667    3.42 | 1.667   11.71 | 2.667    3.22 |  3.67    1.96
                 0.750    4.55 | 1.750    7.97 | 2.750    2.90 |  3.75    1.85
                 0.833    4.55 | 1.833    7.97 | 2.833    2.90 |  3.83    1.85
                 0.917    7.02 | 1.917    6.08 | 2.917    2.64 |  3.92    1.75
                 1.000    7.02 | 2.000    6.08 | 3.000    2.64 |  4.00    1.75

     Max.Eff.Inten.(mm/hr)=      66.94         8.85
               over (min)         5.00        25.00
     Storage Coeff.  (min)=       1.94 (ii)   24.86 (ii)
     Unit Hyd. Tpeak (min)=       5.00        25.00
     Unit Hyd. peak  (cms)=       0.31         0.05
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.04         0.00           0.039 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.75            1.33
     RUNOFF VOLUME    (mm)=      29.82         7.47           20.84
     TOTAL RAINFALL   (mm)=      31.32        31.32           31.32
     RUNOFF COEFFICIENT   =       0.95         0.24            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.

-------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0021)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0122     0.0015
                          0.0054     0.0005   |   0.0163     0.0038
                          0.0094     0.0006   |   0.0232     0.0060
                          0.0109     0.0010   |   0.0240     0.0064

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0022)      0.350     0.039      1.33      20.84
   OUTFLOW: ID= 1 (  0021)      0.350     0.013      1.50      20.79
   OVERFLOW:ID= 3 (  0003)      0.000     0.000      0.00       0.00

                   TOTAL NUMBER OF SIMULATION OVERFLOW  =      0
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 34.06
                   TIME SHIFT OF PEAK FLOW         (min)= 10.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0023

-------------------------------------------------------------------------------
********************************
** SIMULATION:Fort Erie-100yr **
********************************
--------------------
| CALIB            |
| STANDHYD (  0019)|   Area    (ha)=   0.24
|ID= 1 DT= 5.0 min |   Total Imp(%)=  60.00   Dir. Conn.(%)=  60.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.14         0.10
```

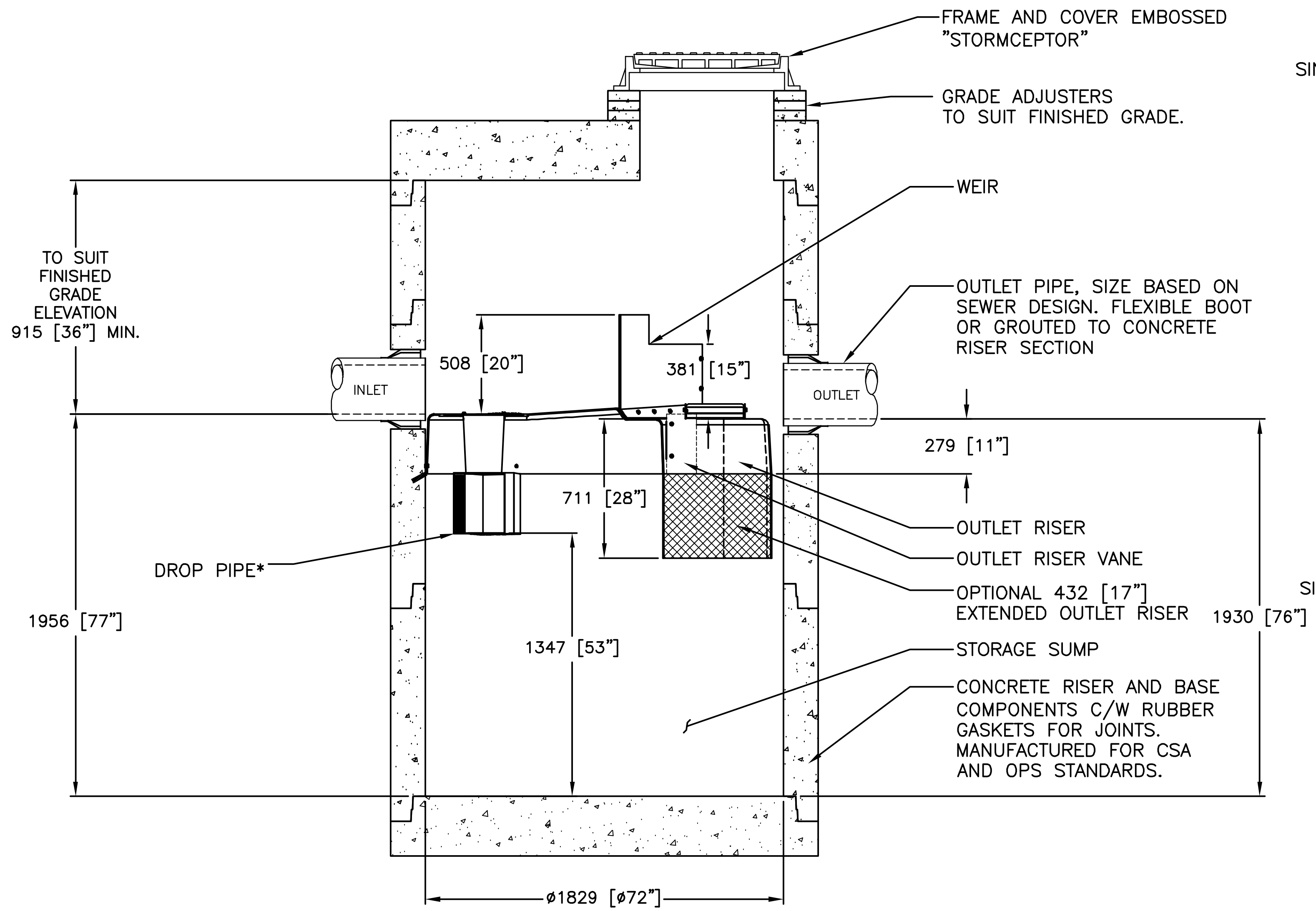
```
     Dep. Storage     (mm)=       1.50         1.50
     Average Slope     (%)=       1.00         1.00
     Length            (m)=      40.00        40.00
     Mannings n           =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                  ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    6.10 | 1.083   39.99 | 2.083   13.50 |  3.08    7.16
                0.167    6.10 | 1.167   39.99 | 2.167   13.50 |  3.17    7.16
                0.250    6.92 | 1.250  137.32 | 2.250   11.63 |  3.25    6.69
                0.333    6.92 | 1.333  137.32 | 2.333   11.63 |  3.33    6.69
                0.417    8.05 | 1.417   51.10 | 2.417   10.27 |  3.42    6.28
                0.500    8.05 | 1.500   51.10 | 2.500   10.27 |  3.50    6.28
                0.583    9.73 | 1.583   28.93 | 2.583    9.22 |  3.58    5.93
                0.667    9.73 | 1.667   28.93 | 2.667    9.22 |  3.67    5.93
                0.750   12.55 | 1.750   20.61 | 2.750    8.39 |  3.75    5.62
                0.833   12.55 | 1.833   20.61 | 2.833    8.39 |  3.83    5.62
                0.917   18.40 | 1.917   16.22 | 2.917    7.72 |  3.92    5.34
                1.000   18.40 | 2.000   16.22 | 3.000    7.72 |  4.00    5.34

     Max.Eff.Inten.(mm/hr)=     137.32        45.93
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       1.30 (ii)   13.16 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.33         0.08
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.05         0.01          0.059 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.50           1.33
     RUNOFF VOLUME    (mm)=      74.11        33.62          57.89
     TOTAL RAINFALL   (mm)=      75.61        75.61          75.61
     RUNOFF COEFFICIENT   =       0.98         0.44           0.77

***** 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.

--------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0020)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0100      0.0020
                          0.0038     0.0002   |   0.0119      0.0026
                          0.0053     0.0005   |   0.0125      0.0028
                          0.0065     0.0005   |   0.0131      0.0028
                          0.0084     0.0012   |   0.0150      0.0031

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0019)      0.240      0.059      1.33      57.89
   OUTFLOW: ID= 1 (  0020)      0.210      0.015      1.42      57.19
   OVERFLOW:ID= 3 (  0003)      0.030      0.021      1.33      57.19

                   TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 25.24
                   TIME SHIFT OF PEAK FLOW         (min)=  5.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0031

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0022)|   Area    (ha)=   0.35
|ID= 1 DT= 5.0 min |   Total Imp(%)=  60.00   Dir. Conn.(%)=  60.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.21         0.14
     Dep. Storage     (mm)=       1.50         1.50
     Average Slope     (%)=       1.00         1.00
     Length            (m)=      48.30        40.00
     Mannings n           =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

```
                              ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    6.10 | 1.083   39.99 | 2.083   13.50 |  3.08    7.16
                0.167    6.10 | 1.167   39.99 | 2.167   13.50 |  3.17    7.16
                0.250    6.92 | 1.250  137.32 | 2.250   11.63 |  3.25    6.69
                0.333    6.92 | 1.333  137.32 | 2.333   11.63 |  3.33    6.69
                0.417    8.05 | 1.417   51.10 | 2.417   10.27 |  3.42    6.28
                0.500    8.05 | 1.500   51.10 | 2.500   10.27 |  3.50    6.28
                0.583    9.73 | 1.583   28.93 | 2.583    9.22 |  3.58    5.93
                0.667    9.73 | 1.667   28.93 | 2.667    9.22 |  3.67    5.93
                0.750   12.55 | 1.750   20.61 | 2.750    8.39 |  3.75    5.62
                0.833   12.55 | 1.833   20.61 | 2.833    8.39 |  3.83    5.62
                0.917   18.40 | 1.917   16.22 | 2.917    7.72 |  3.92    5.34
                1.000   18.40 | 2.000   16.22 | 3.000    7.72 |  4.00    5.34

     Max.Eff.Inten.(mm/hr)=     137.32        45.93
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       1.45 (ii)   13.32 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.33         0.08
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.08         0.01          0.087 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.50           1.33
     RUNOFF VOLUME    (mm)=      74.11        33.62          57.90
     TOTAL RAINFALL   (mm)=      75.61        75.61          75.61
     RUNOFF COEFFICIENT   =       0.98         0.44           0.77

***** 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.

--------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0021)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0122     0.0015
                          0.0054     0.0005   |   0.0163     0.0038
                          0.0094     0.0006   |   0.0232     0.0060
                          0.0109     0.0010   |   0.0240     0.0064

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0022)      0.350     0.087      1.33      57.90
   OUTFLOW: ID= 1 (  0021)      0.341     0.024      1.58      56.85
   OVERFLOW:ID= 3 (  0003)      0.009     0.008      1.50      56.85

                   TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 27.71
                   TIME SHIFT OF PEAK FLOW         (min)= 15.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0064

--------------------------------------------------------------------------------
********************************
** SIMULATION:Fort Erie-5yr   **
********************************
--------------------
| CALIB            |
| STANDHYD (  0019)|   Area    (ha)=   0.24
|ID= 1 DT= 5.0 min |   Total Imp(%)=  60.00   Dir. Conn.(%)=  60.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.14         0.10
     Dep. Storage     (mm)=       1.50         1.50
     Average Slope     (%)=       1.00         1.00
     Length            (m)=      40.00        40.00
     Mannings n           =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
```

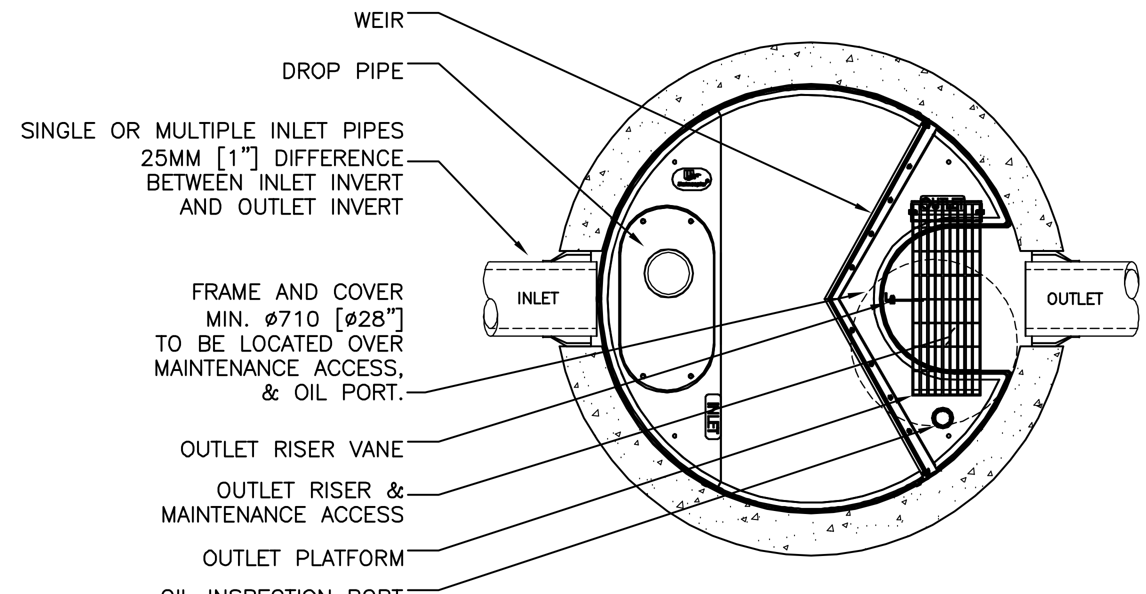
```
               hrs    mm/hr |    hrs    mm/hr |'    hrs    mm/hr |    hrs     mm/hr
             0.083     3.14 | 1.083    23.44 | 2.083     7.32 |  3.08     3.73
             0.167     3.14 | 1.167    23.44 | 2.167     7.32 |  3.17     3.73
             0.250     3.59 | 1.250    85.67 | 2.250     6.24 |  3.25     3.46
             0.333     3.59 | 1.333    85.67 | 2.333     6.24 |  3.33     3.46
             0.417     4.22 | 1.417    30.36 | 2.417     5.47 |  3.42     3.24
             0.500     4.22 | 1.500    30.36 | 2.500     5.47 |  3.50     3.24
             0.583     5.16 | 1.583    16.55 | 2.583     4.88 |  3.58     3.05
             0.667     5.16 | 1.667    16.55 | 2.667     4.88 |  3.67     3.05
             0.750     6.77 | 1.750    11.51 | 2.750     4.41 |  3.75     2.88
             0.833     6.77 | 1.833    11.51 | 2.833     4.41 |  3.83     2.88
             0.917    10.20 | 1.917     8.91 | 2.917     4.04 |  3.92     2.73
             1.000    10.20 | 2.000     8.91 | 3.000     4.04 |  4.00     2.73

     Max.Eff.Inten.(mm/hr)=      85.67        17.20
                over (min)        5.00        20.00
     Storage Coeff.  (min)=       1.57 (ii)   19.14 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=       0.33         0.06
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.03         0.00         0.035 (iii)
     TIME TO PEAK    (hrs)=       1.33         1.58          1.33
     RUNOFF VOLUME    (mm)=      42.00        13.44         30.53
     TOTAL RAINFALL   (mm)=      43.50        43.50         43.50
     RUNOFF COEFFICIENT   =       0.97         0.31          0.70

***** 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.

--------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0020)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0100     0.0020
                          0.0038     0.0002   |   0.0119     0.0026
                          0.0053     0.0005   |   0.0125     0.0028
                          0.0065     0.0005   |   0.0131     0.0028
                          0.0084     0.0012   |   0.0150     0.0031

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0019)      0.240      0.035      1.33      30.53
   OUTFLOW: ID= 1 (  0020)      0.240      0.011      1.58      30.49
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                     TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                     CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                     PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                     PEAK   FLOW   REDUCTION [Qout/Qin](%)= 30.70
                     TIME SHIFT OF PEAK FLOW         (min)= 15.00
                     MAXIMUM  STORAGE   USED       (ha.m.)=  0.0023

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0022)|   Area    (ha)=   0.35
|ID= 1 DT= 5.0 min |   Total Imp(%)=  60.00   Dir. Conn.(%)=  60.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.21         0.14
     Dep. Storage     (mm)=       1.50         1.50
     Average Slope     (%)=       1.00         1.00
     Length            (m)=      48.30        40.00
     Mannings n           =      0.013        0.250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                ---- TRANSFORMED HYETOGRAPH ----
              TIME     RAIN |  TIME     RAIN |'  TIME     RAIN |  TIME     RAIN
               hrs    mm/hr |   hrs    mm/hr |'   hrs    mm/hr |   hrs    mm/hr
             0.083     3.14 | 1.083    23.44 | 2.083     7.32 |  3.08     3.73
             0.167     3.14 | 1.167    23.44 | 2.167     7.32 |  3.17     3.73
             0.250     3.59 | 1.250    85.67 | 2.250     6.24 |  3.25     3.46
             0.333     3.59 | 1.333    85.67 | 2.333     6.24 |  3.33     3.46
             0.417     4.22 | 1.417    30.36 | 2.417     5.47 |  3.42     3.24
```

```
               0.500    4.22 | 1.500   30.36 | 2.500    5.47 |  3.50    3.24
               0.583    5.16 | 1.583   16.55 | 2.583    4.88 |  3.58    3.05
               0.667    5.16 | 1.667   16.55 | 2.667    4.88 |  3.67    3.05
               0.750    6.77 | 1.750   11.51 | 2.750    4.41 |  3.75    2.88
               0.833    6.77 | 1.833   11.51 | 2.833    4.41 |  3.83    2.88
               0.917   10.20 | 1.917    8.91 | 2.917    4.04 |  3.92    2.73
               1.000   10.20 | 2.000    8.91 | 3.000    4.04 |  4.00    2.73

    Max.Eff.Inten.(mm/hr)=      85.67        17.20
              over (min)         5.00        20.00
    Storage Coeff.  (min)=       1.76 (ii)   19.33 (ii)
    Unit Hyd. Tpeak (min)=       5.00        20.00
    Unit Hyd. peak  (cms)=       0.32         0.06
                                                          *TOTALS*
    PEAK FLOW       (cms)=       0.05         0.00          0.051 (iii)
    TIME TO PEAK    (hrs)=       1.33         1.58           1.33
    RUNOFF VOLUME    (mm)=      42.00        13.44          30.54
    TOTAL RAINFALL   (mm)=      43.50        43.50          43.50
    RUNOFF COEFFICIENT   =       0.97         0.31           0.70

***** 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.

-------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0021)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0122      0.0015
                          0.0054     0.0005   |   0.0163      0.0038
                          0.0094     0.0006   |   0.0232      0.0060
                          0.0109     0.0010   |   0.0240      0.0064

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
  INFLOW : ID= 2 (  0022)      0.350      0.051      1.33      30.54
  OUTFLOW: ID= 1 (  0021)      0.350      0.015      1.58      30.49
  OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                  TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                  CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                  PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                  PEAK   FLOW   REDUCTION [Qout/Qin](%)= 30.04
                  TIME SHIFT OF PEAK FLOW         (min)= 15.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=  0.0034

-------------------------------------------------------------------------------
```

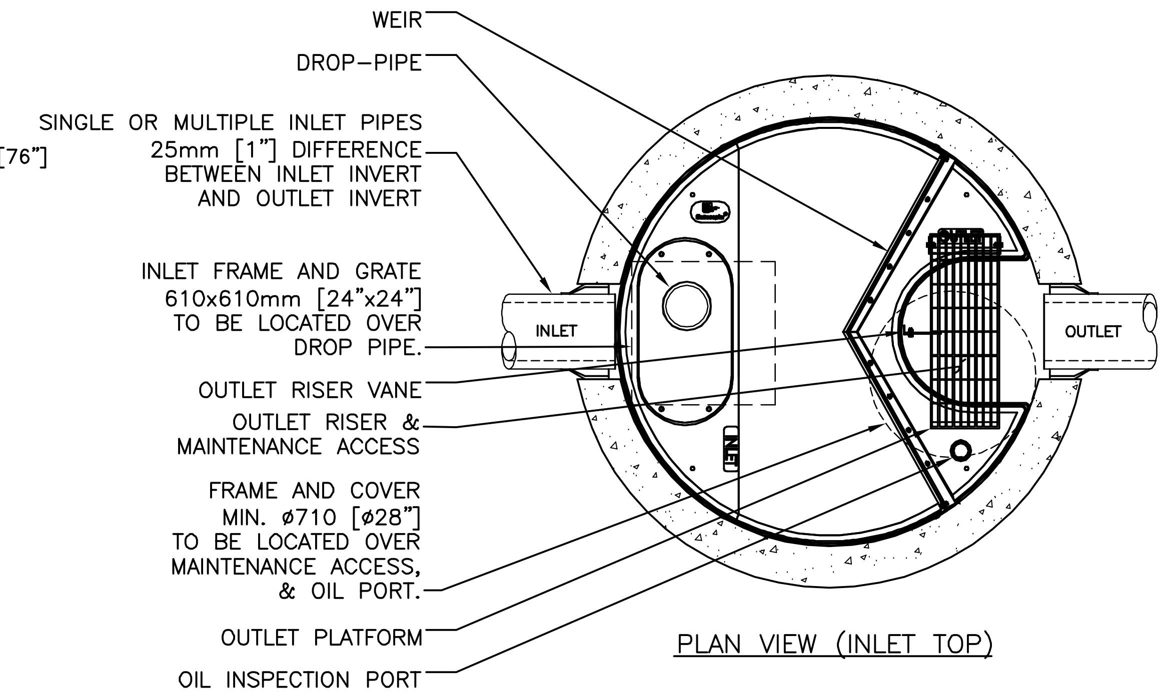
DRAWING NOT TO BE USED FOR CONSTRUCTION



SECTION VIEW



PLAN VIEW (STANDARD)



PLAN VIEW (INLET TOP)

GENERAL NOTES:

* MAXIMUM SURFACE LOADING RATE (SLR) INTO LOWER CHAMBER THROUGH DROP PIPE IS 1135 L/min/m^2 (27.9 gpm/ft^2) FOR STORMCEPTOR EF6 AND 535 L/min/m^2 (13.1 gpm/ft^2) FOR STORMCEPTOR EFO6 (OIL CAPTURE CONFIGURATION).

1. ALL DIMENSIONS INDICATED ARE IN MILLIMETERS (INCHES) UNLESS OTHERWISE SPECIFIED.
2. STORMCEPTOR STRUCTURE INLET AND OUTLET PIPE SIZE AND ORIENTATION SHOWN FOR INFORMATIONAL PURPOSES ONLY.
3. UNLESS OTHERWISE NOTED, BYPASS INFRASTRUCTURE, SUCH AS ALL UPSTREAM DIVERSION STRUCTURES, CONNECTING STRUCTURES, OR PIPE CONDUITS CONNECTING TO COMPLETE THE STORMCEPTOR SYSTEM SHALL BE PROVIDED AND ADDRESSED SEPARATELY.
4. DRAWING FOR INFORMATION PURPOSES ONLY. REFER TO ENGINEER'S SITE/UTILITY PLAN FOR STRUCTURE ORIENTATION.
5. NO PRODUCT SUBSTITUTIONS SHALL BE ACCEPTED UNLESS SUBMITTED 10 DAYS PRIOR TO PROJECT BID DATE, OR AS DIRECTED BY THE ENGINEER OF RECORD.

FOR SITE SPECIFIC DRAWINGS PLEASE CONTACT YOUR LOCAL STORMCEPTOR REPRESENTATIVE. SITE SPECIFIC DRAWINGS ARE BASED ON THE BEST AVAILABLE INFORMATION AT THE TIME. SOME FIELD REVISIONS TO THE SYSTEM LOCATION OR CONNECTION PIPING MAY BE NECESSARY BASED ON AVAILABLE SPACE OR SITE CONFIGURATION REVISIONS. ELEVATIONS SHOULD BE MAINTAINED EXCEPT WHERE NOTED ON BYPASS STRUCTURE (IF REQUIRED).

INSTALLATION NOTES

A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STRUCTURE (LIFTING CLUTCHES PROVIDED)
C. CONTRACTOR WILL INSTALL AND LEVEL THE STRUCTURE, SEALING THE JOINTS, LINE ENTRY AND EXIT POINTS (NON-SHRINK GROUT WITH APPROVED WATERSTOP OR FLEXIBLE BOOT)
D. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT THE DEVICE FROM CONSTRUCTION-RELATED EROSION RUNOFF.
E. DEVICE ACTIVATION, BY CONTRACTOR, SHALL OCCUR ONLY AFTER SITE HAS BEEN STABILIZED AND THE STORMCEPTOR UNIT IS CLEAN AND FREE OF DEBRIS.

STANDARD DETAIL
NOT FOR CONSTRUCTION

SITE SPECIFIC DATA REQUIREMENTS

STORMCEPTOR MODEL	EFO6				
STRUCTURE ID					*
HYDROCARBON STORAGE REQ'D (L)					*
WATER QUALITY FLOW RATE (L/s)					*
PEAK FLOW RATE (L/s)					*
RETURN PERIOD OF PEAK FLOW (yrs)					*
DRAINAGE AREA (HA)					*
DRAINAGE AREA IMPERVIOUSNESS (%)					*
PIPE DATA:	I.E.	MAT'L	DIA	SLOPE %	HGL
INLET #1	*	*	*	*	*
INLET #2	*	*	*	*	*
OUTLET	*	*	*	*	*

* PER ENGINEER OF RECORD

MARK	DATE	REVISION DESCRIPTION	BY
####	####	####	####
####	####	####	####
####	####	####	####
1	6/8/18	OUTLET PLATFORM	JSK
0	05/26/17	INITIAL RELEASE	JSK

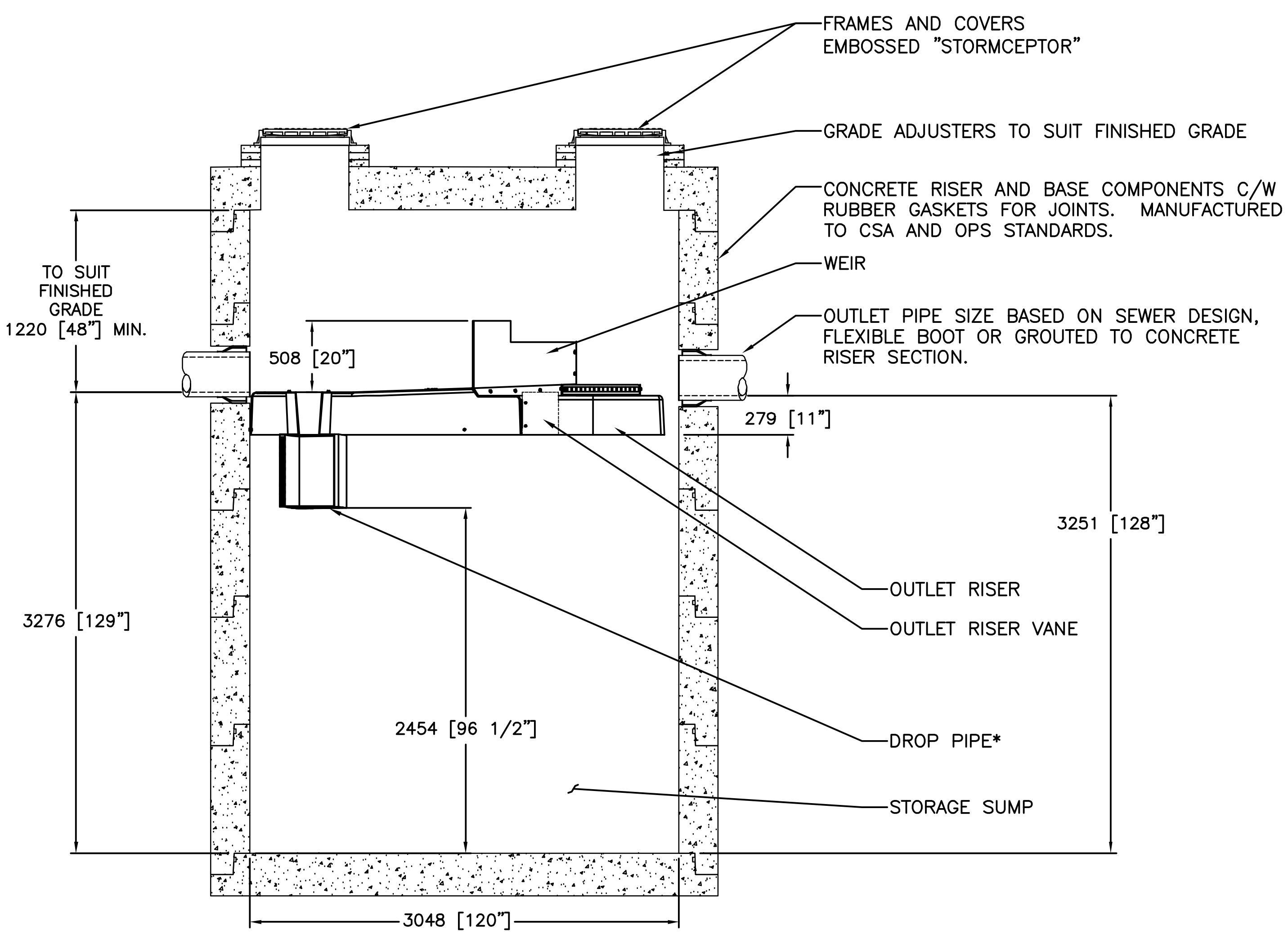
Stormceptor® EF

imbrium®

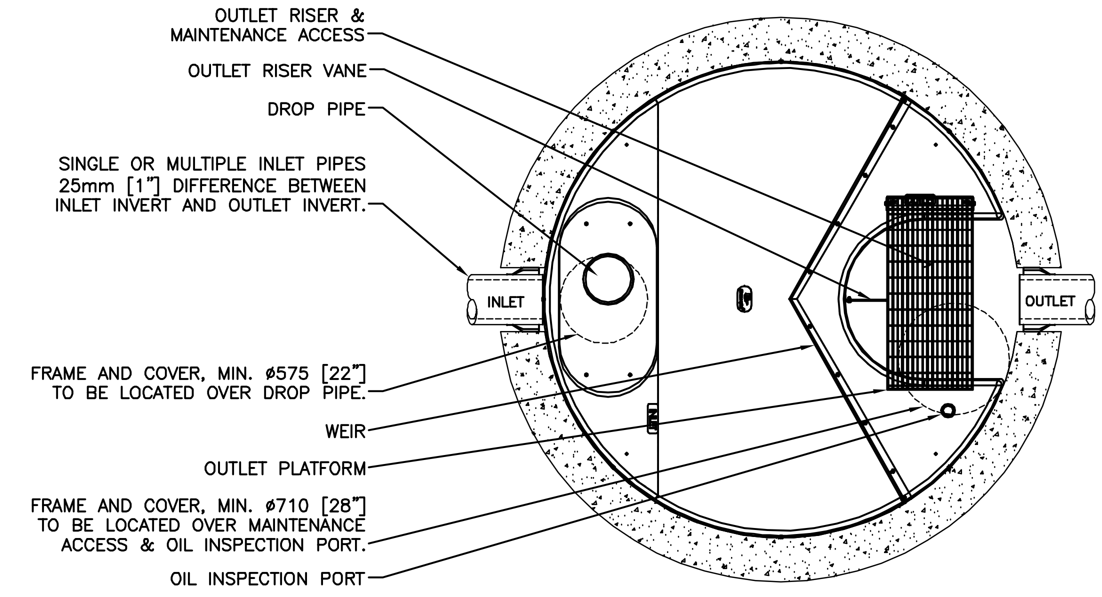
SCALE = NTS

DATE: 10/13/2017	
DESIGNED: JSK	DRAWN: JSK
CHECKED: BSF	APPROVED: SP
PROJECT No.: EFO6	SEQUENCE No.: *
SHEET: 1 OF 1	

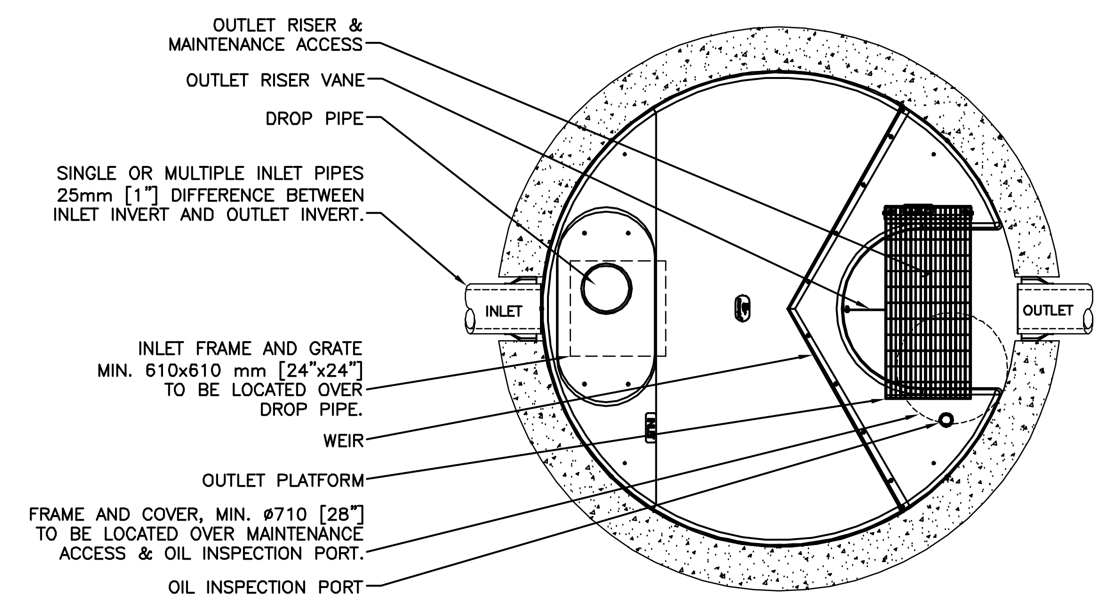
DRAWING NOT TO BE USED FOR CONSTRUCTION



SECTION VIEW



PLAN VIEW (STANDARD)



PLAN VIEW (INLET TOP)

GENERAL NOTES:

* MAXIMUM SURFACE LOADING RATE (SLR) INTO LOWER CHAMBER THROUGH DROP PIPE IS 1135 L/min/m^2 (27.9 gpm/ft^2) FOR STORMCEPTOR EF10 AND 535 L/min/m^2 (13.1 gpm/ft^2) FOR STORMCEPTOR EFO10 (OIL CAPTURE CONFIGURATION).

1. ALL DIMENSIONS INDICATED ARE IN MILLIMETERS (INCHES) UNLESS OTHERWISE SPECIFIED.
2. STORMCEPTOR STRUCTURE INLET AND OUTLET PIPE SIZE AND ORIENTATION SHOWN FOR INFORMATIONAL PURPOSES ONLY.
3. UNLESS OTHERWISE NOTED, BYPASS INFRASTRUCTURE, SUCH AS ALL UPSTREAM DIVERSION STRUCTURES, CONNECTING STRUCTURES, OR PIPE CONDUITS CONNECTING TO COMPLETE THE STORMCEPTOR SYSTEM SHALL BE PROVIDED AND ADDRESSED SEPARATELY.
4. DRAWING FOR INFORMATION PURPOSES ONLY. REFER TO ENGINEER'S SITE/UTILITY PLAN FOR STRUCTURE ORIENTATION.
5. NO PRODUCT SUBSTITUTIONS SHALL BE ACCEPTED UNLESS SUBMITTED 10 DAYS PRIOR TO PROJECT BID DATE, OR AS DIRECTED BY THE ENGINEER OF RECORD.

FOR SITE SPECIFIC DRAWINGS PLEASE CONTACT YOUR LOCAL STORMCEPTOR REPRESENTATIVE. SITE SPECIFIC DRAWINGS ARE BASED ON THE BEST AVAILABLE INFORMATION AT THE TIME. SOME FIELD REVISIONS TO THE SYSTEM LOCATION OR CONNECTION PIPING MAY BE NECESSARY BASED ON AVAILABLE SPACE OR SITE CONFIGURATION REVISIONS. ELEVATIONS SHOULD BE MAINTAINED EXCEPT WHERE NOTED ON BYPASS STRUCTURE (IF REQUIRED).

INSTALLATION NOTES

A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STRUCTURE (LIFTING CLUTCHES PROVIDED)
C. CONTRACTOR WILL INSTALL AND LEVEL THE STRUCTURE, SEALING THE JOINTS, LINE ENTRY AND EXIT POINTS (NON-SHRINK GROUT WITH APPROVED WATERSTOP OR FLEXIBLE BOOT)
D. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT THE DEVICE FROM CONSTRUCTION-RELATED EROSION RUNOFF.
E. DEVICE ACTIVATION, BY CONTRACTOR, SHALL OCCUR ONLY AFTER SITE HAS BEEN STABILIZED AND THE STORMCEPTOR UNIT IS CLEAN AND FREE OF DEBRIS.

STANDARD DETAIL
NOT FOR CONSTRUCTION

SITE SPECIFIC DATA REQUIREMENTS

STORMCEPTOR MODEL		EFO10			
STRUCTURE ID					*
HYDROCARBON STORAGE REQ'D (L)					*
WATER QUALITY FLOW RATE (L/s)					
PEAK FLOW RATE (L/s)					*
RETURN PERIOD OF PEAK FLOW (yrs)					*
DRAINAGE AREA (HA)					*
DRAINAGE AREA IMPERVIOUSNESS (%)					*
PIPE DATA:	I.E.	MAT'L	DIA	SLOPE %	HGL
INLET #1	*	*	*	*	*
INLET #2	*	*	*	*	*
OUTLET	*	*	*	*	*

* PER ENGINEER OF RECORD

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MARK	DATE	REVISION DESCRIPTION	BY
####	####	####	####
####	####	####	####
####	####	####	####
1	6/8/18	OUTLET PLATFORM	JSK
0	5/26/17	INITIAL RELEASE	JSK

Stormceptor® EF

SCALE = NTS

imbrium

407 FAIRVIEW DRIVE, WHITBY, ON L1N 3A9
TF 800-565-4801 CA 416-960-9900 INTL +1-416-960-9900

DATE: 10/24/2017	
DESIGNED: JSK	DRAWN: JSK
CHECKED: BSF	APPROVED: SP
PROJECT No.: EFO10	SEQUENCE No.: *
SHEET: 1 OF 1	

I:\IMBRIUM\PRODUCTS\STORMCEPTOR\STORMCEPTOR EF\40 DRAWINGS & DETAILS\STANDARD DETAILS\EFO STANDARD DETAILS\EFO10-DETAIL.DWG 4/12/2019 11:09 AM

◆ Verification Statement ◆ Verification Statement ◆ Verification Statement ◆

VERIFICATION STATEMENT

GLOBE Performance Solutions

Verifies the performance of

Stormceptor® EF4 and EFO4 Oil-Grit Separators

Developed by Imbrium Systems, Inc.,
Whitby, Ontario, Canada

In accordance with

ISO 14034:2016

Environmental management —
Environmental technology verification (ETV)

John D. Wiebe, PhD
Executive Chairman
GLOBE Performance Solutions

GLOBE PERFORMANCE SOLUTIONS

November 10, 2017
Vancouver, BC, Canada

Verification Body
GLOBE Performance Solutions
404 – 999 Canada Place | Vancouver, B.C | Canada |V6C 3E2

Technology description and application

The Stormceptor® EF4 and EFO4 are treatment devices designed to remove oil, sediment, trash, debris, and pollutants attached to particulates from Stormwater and snowmelt runoff. The device takes the place of a conventional manhole within a storm drain system and offers design flexibility that works with various site constraints. The EFO4 is designed with a shorter bypass weir height, which accepts lower surface loading rate into the sump, thereby reducing re-entrainment of captured free floating light liquids.

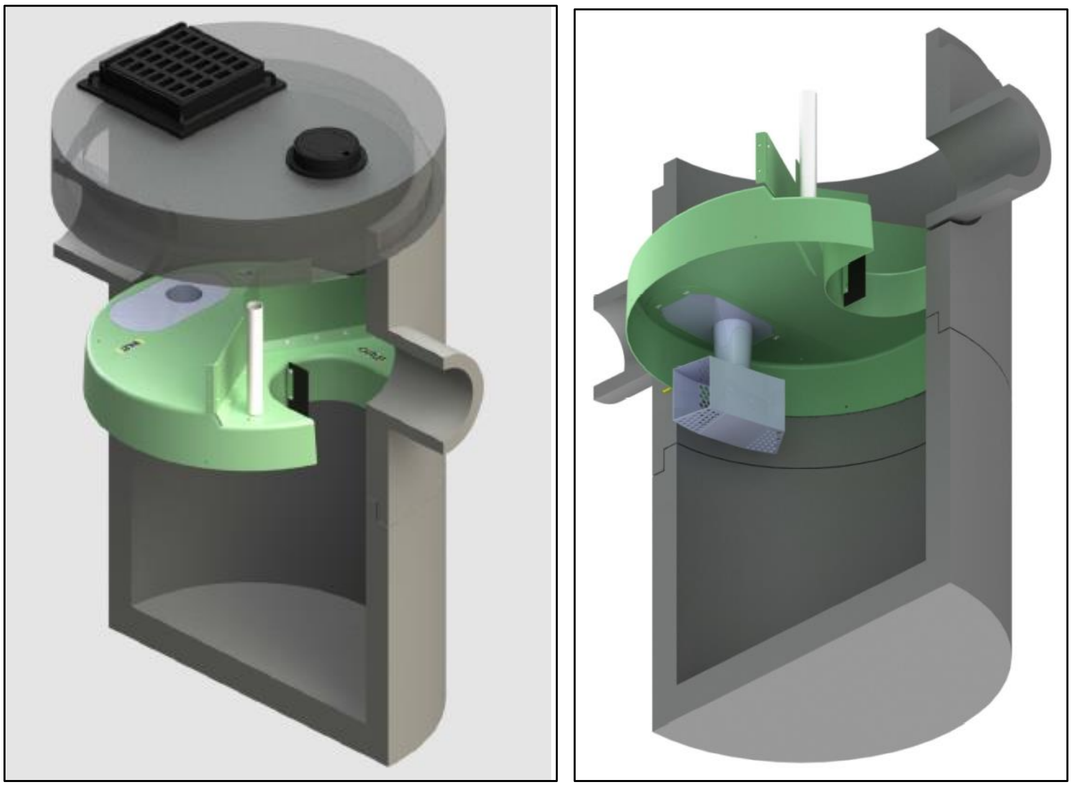

Figure 1. Graphic of typical inline Stormceptor® unit and core components.

Stormwater and snowmelt runoff enters the Stormceptor® EF/EFO's upper chamber through the inlet pipe(s) or a surface inlet grate. An insert divides the unit into lower and upper chambers and incorporates a weir to reduce influent velocity and separate influent (untreated) from effluent (treated) flows. Influent water ponds upstream of the insert's weir providing driving head for the water flowing downwards into the drop pipe where a vortex pulls the water into the lower chamber. The water diffuses at lower velocities in multiple directions through the drop pipe outlet openings. Oil and other floatables rise up and are trapped beneath the insert, while sediments undergo gravitational settling to the sump's bottom. Water from the sump can exit by flowing upward to the outlet riser onto the top side of the insert and downstream of the weir, where it discharges through the outlet pipe.

Maximum flow rate into the lower chamber is a function of weir height and drop pipe orifice diameter. The Stormceptor® EF and EFO are designed to allow a surface loading rate of 1135 L/min/m^2 (27.9 gal/min/ft^2) and 535 L/min/m^2 (13.1 gal/min/ft^2) into the lower chamber, respectively. When prescribed surface loading rates are exceeded, ponding water can overtop the weir height and bypass the lower treatment chamber, exiting directly through the outlet pipe. Hydraulic testing and scour testing demonstrate that the internal bypass effectively prevents scour at all bypass flow rates. Increasing the bypass flow rate does not increase the orifice-controlled flow rate into the lower treatment chamber where sediment is stored. This internal bypass feature allows for in-line installation, avoiding the cost of additional bypass structures. During bypass, treatment continues in the lower chamber at the maximum flow rate. The Stormceptor® EFO's lower design surface loading rate is favorable for minimizing re-entrainment and washout of captured light liquids. Inspection of Stormceptor® EF and EFO devices is performed from grade by inserting a sediment probe through the outlet riser and an oil dipstick through the oil inspection pipe. The unit can be maintained by using a vacuum hose through the outlet riser.

Performance conditions

The data and results published in this Technology Fact Sheet were obtained from the testing program conducted on the Imbrium Systems Inc.'s Stormceptor® OGS device, in accordance with the Procedure for Laboratory Testing of Oil-Grit Separators (Version 3.0, June 2014). The Procedure was prepared by the Toronto and Region Conservation Authority (TRCA) for Environment Canada's Environmental Technology Verification (ETV) Program. A copy of the Procedure may be accessed on the Canadian ETV website at www.etvcanada.ca.

Performance claim(s)

Capture test [a]:

During the capture test, the Stormceptor® EF OGS device, with a false floor set to 50% of the manufacturer's recommended maximum sediment storage depth and a constant influent test sediment concentration of 200 mg/L, removes 70, 64, 54, 48, 46, 44, and 49 percent of influent sediment by mass at surface loading rates of 40, 80, 200, 400, 600, 1000, and 1400 L/min/m^2, respectively.

Stormceptor® EFO, with a false floor set to 50% of the manufacturer's recommended maximum sediment storage depth and a constant influent test sediment concentration of 200 mg/L, removes 70, 64, 54, 48, 42, 40, and 34 percent of influent sediment by mass at surface loading rates of 40, 80, 200, 400, 600, 1000, and 1400 L/min/m^2, respectively.

Scour test [a]:

During the scour test, the Stormceptor® EF and Stormceptor® EFO OGS devices, with 10.2 cm (4 inches) of test sediment pre-loaded onto a false floor reaching 50% of the manufacturer's recommended maximum sediment storage depth, generate corrected effluent concentrations of 4.6, 0.7, 0, 0.2, and 0.4 mg/L at 5-minute duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/m^2, respectively.

Light liquid re-entrainment test[a]:

During the light liquid re-entrainment test, the Stormceptor® EFO OGS device with surrogate low-density polyethylene beads preloaded within the lower chamber oil collection zone, representing a floating light liquid volume equal to a depth of 50.8 mm over the sedimentation area, retained 100, 99.5, 99.8, 99.8, and 99.9 percent of loaded beads by mass during the 5-minute duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/m^2.

[a] The claim can be applied to other units smaller or larger than the tested unit as long as the untested units meet the scaling rule specified in the Procedure for Laboratory of Testing of Oil Grit Separators (Version 3.0, June 2014)

Performance results

The test sediment consisted of ground silica (1 – 1000 micron) with a specific gravity of 2.65, uniformly mixed to meet the particle size distribution specified in the testing procedure. The *Procedure for Laboratory Testing of Oil Grit Separators* requires that the three sample average of the test sediment particle size distribution (PSD) meet the specified PSD percent less than values within a boundary threshold of 6%. The comparison of the average test sediment PSD to the CETV specified PSD in Figure 2 indicates that the test sediment used for the capture and scour tests met this condition.

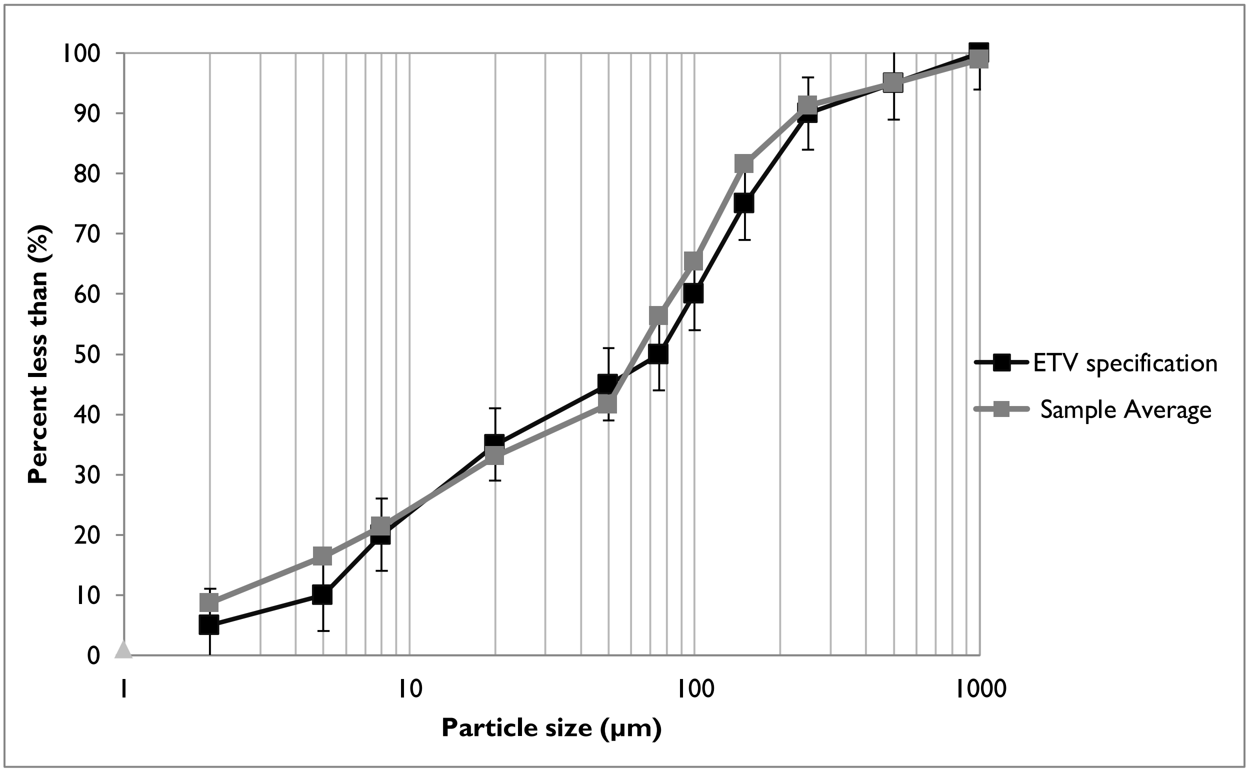

Figure 2. The three sample average particle size distribution (PSD) of the test sediment used for the capture and scour test compared to the specified PSD.

The capacity of the device to retain sediment was determined at seven surface loading rates using the modified mass balance method. This method involved measuring the mass and particle size distribution of the injected and retained sediment for each test run. Performance was evaluated with a false floor simulating the technology filled to 50% of the manufacturer's recommended maximum sediment storage depth. The test was carried out with clean water that maintained a sediment concentration below 20 mg/L. Based on these conditions, removal efficiencies for individual particle size classes and for the test sediment as a whole were determined for each of the tested surface loading rates (Table 1). Since the EF and EFO models are identical except for the weir height, which bypasses flows from the EFO model at a surface loading rate of 535 L/min/m² (13.1 gpm/ft²), sediment capture tests at surface loading rates from 40 to 400 L/min/m² were only performed on the EF unit. Surface loading rates of 600, 1000, and 1400 L/min/m² were tested on both units separately. Results for the EFO model at these higher flow rates are presented in Table 2.

In some instances, the removal efficiencies were above 100% for certain particle size fractions. These discrepancies are not unique to any one test laboratory and may be attributed to errors relating to the blending of sediment, collection of representative samples for laboratory submission, and laboratory analysis of PSD. Due to these errors, caution should be exercised in applying the removal efficiencies by particle size fraction for the purposes of sizing the tested device (see Bulletin # CETV 2016-11-0001). The results for "all particle sizes by mass balance" (see Table 1 and 2) are based on measurements of the total injected and retained sediment mass, and are therefore not subject to blending, sampling or PSD analysis errors.

Table 1. Removal efficiencies (%) of the EF4 at specified surface loading rates

Particle size fraction (µm)	Surface loading rate (L/min/m²)						
	40	80	200	400	600	1000	1400
>500	90	58	58	100*	86	72	100*
250 - 500	100*	100*	100	100*	100*	100*	100*
150 - 250	90	82	26	100*	100*	67	90
105 - 150	100*	100*	100*	100*	100*	100*	100
75 - 105	100*	92	74	82	77	68	76
53 - 75	Undefined [a]	56	100*	72	69	50	80
20 - 53	54	100*	54	33	36	40	31
8 - 20	67	52	25	21	17	20	20
5 – 8	33	29	11	12	9	7	19
<5	13	0	0	0	0	0	4
All particle sizes by mass balance	**70.4**	**63.8**	**53.9**	**47.5**	**46.0**	**43.7**	**49.0**

[a] An outlier in the feed sample sieve data resulted in a negative removal efficiency for this size fraction.
* Removal efficiencies were calculated to be above 100%. Calculated values ranged between 101 and 171% (average 128%). See text and Bulletin # CETV 2016-11-0001 for more information.

Table 2. Removal efficiencies (%) of the EFO4 at surface loading rates above the bypass rate of 535 L/min/m²

Particle size fraction (µm)	Surface loading rate (L/min/m²)		
	600	1000	1400
>500	89	83	100*
250 - 500	90	100*	92
150 - 250	90	67	100*
105 - 150	85	92	77
75 - 105	80	71	65
53 - 75	60	31	36
20 - 53	33	43	23
8 - 20	17	23	15
5 – 8	10	3	3
<5	0	0	0
All particle sizes by mass balance	**41.7**	**39.7**	**34.2**

* Removal efficiencies were calculated to be above 100%. Calculated values ranged between 103 and 111% (average 107%). See text and Bulletin # CETV 2016-11-0001 for more information.

Figure 3 compares the particle size distribution (PSD) of the three sample average of the test sediment to the PSD of the sediment retained by the EF4 at each of the tested surface loading rates. Figure 4 shows the same graph for the EFO4 unit at surface loading rates above the bypass rate of 535 L/min/m².

As expected, the capture efficiency for fine particles in both units was generally found to decrease as surface loading rates increased.

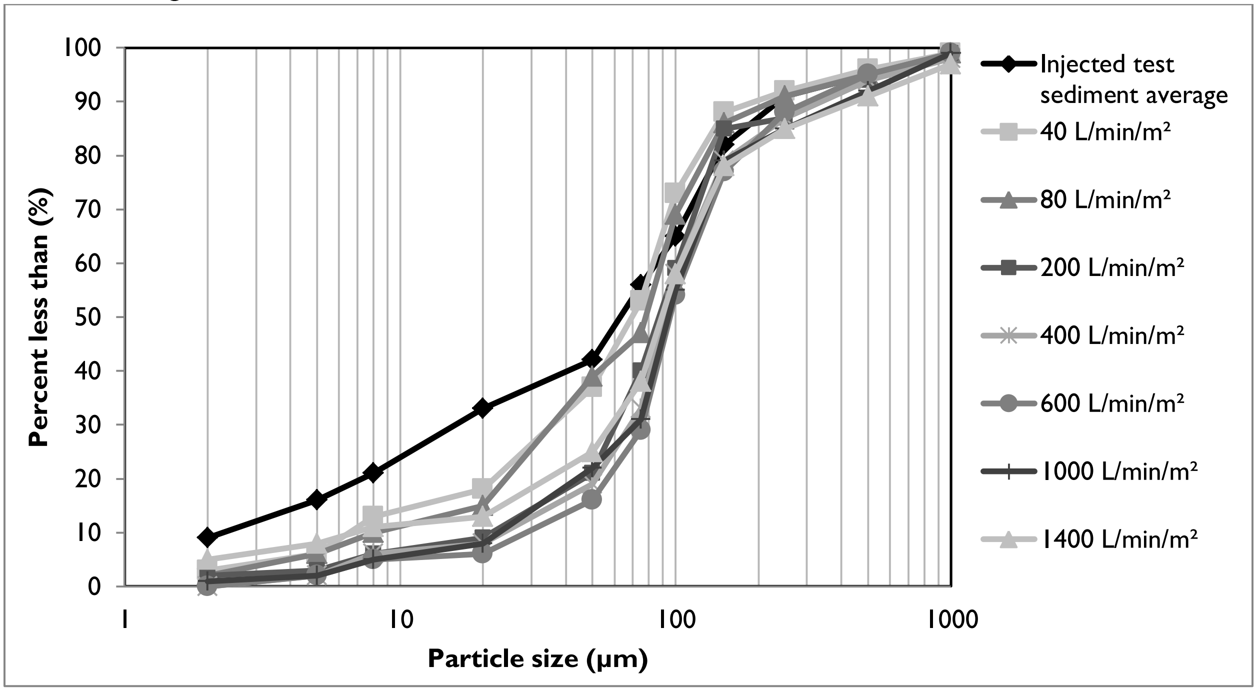

Figure 3. Particle size distribution of sediment retained in the EF4 in relation to the injected test sediment average.

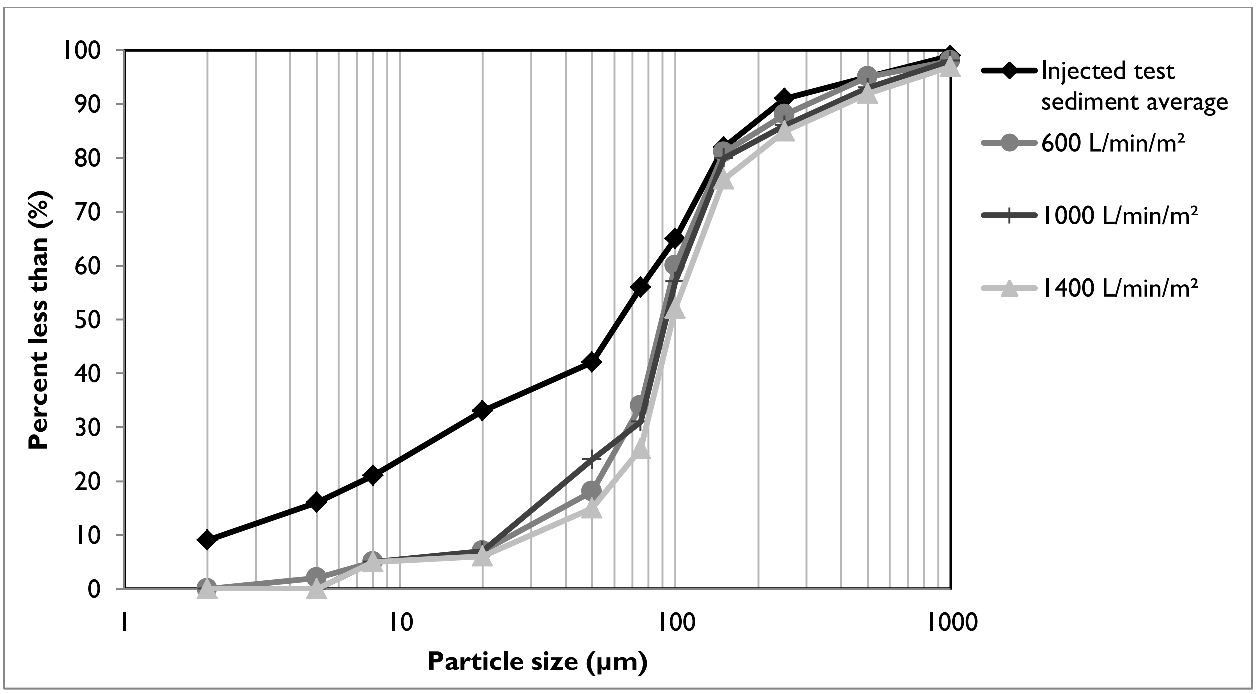

Figure 4. Particle size distribution of sediment retained in the EFO4 in relation to the injected test sediment average at surface loading rates above the bypass rate of 535 L/min/m^2

Table 4 shows the results of the sediment scour and re-suspension test for the EF4 unit. The EFO4 was not tested as it was reasonably assumed that scour rates would be lower given that flow bypass occurs at a lower surface loading rate. The scour test involved preloading 10.2 cm of fresh test sediment into the sedimentation sump of the device. The sediment was placed on a false floor to mimic a device filled to 50% of the maximum recommended sediment storage depth. Clean water was run through the device at five surface loading rates over a 30 minute period. Each flow rate was maintained for 5 minutes with a one minute transition time between flow rates. Effluent samples were collected at one minute sampling intervals and analyzed for Suspended Sediment Concentration (SSC) and PSD by recognized methods. The effluent samples were subsequently adjusted based on the background concentration of the influent water. Typically, the smallest 5% of particles captured during the 40 L/min/m² sediment capture test is also used to adjust the concentration, as per the method described in Bulletin # CETV 2016-09-0001. However, since the composites of effluent concentrations were below the Reporting Detection Limit of the Laser Diffraction PSD methodology, this adjustment was not made. Results showed average adjusted effluent sediment concentrations below 5 mg/L at all tested surface loading rates.

It should be noted that the EF4 starts to internally bypass water at 1135 L/min/m², potentially resulting in the dilution of effluent concentrations, which would not normally occur under typical field conditions because the field influent concentration would contain a much higher sediment concentration than during the lab test. Recalculation of effluent concentrations to account for dilution at surface loading rates above the bypass rate showed sediment effluent concentrations to be below 1.6 mg/L.

Table 4. Scour test adjusted effluent sediment concentration.

Run	Surface loading rate (L/min/m²)	Run time (min)	Background sample concentration (mg/L)	Adjusted effluent suspended sediment concentration (mg/L) [a]	Average (mg/L)
1	200	1:00	<RDL	11.9	4.6
		2:00		7.0	
		3:00		4.4	
		4:00		2.2	
		5:00		1.0	
		6:00		1.2	
2	800	7:00	<RDL	1.1	0.7
		8:00		0.9	
		9:00		0.6	
		10:00		1.4	
		11:00		0.1	
		12:00		0	
3	1400	13:00	<RDL	0	0
		14:00		0.1	
		15:00		0	
		16:00		0	
		17:00		0	
		18:00		0	
4	2000	19:00	1.2	0.2	0.2
		20:00		0	
		21:00		0	
		22:00		0.7	
		23:00		0	

		24:00		0.4	
5	2600	25:00	1.6	0.3	0.4
		26:00		0.4	
		27:00		0.7	
		28:00		0.4	
		29:00		0.2	
		30:00		0.4	

[a] The adjusted effluent suspended sediment concentration represents the actual measured effluent concentration minus the background concentration. For more information see Bulletin # CETV 2016-09-0001.

The results of the light liquid re-entrainment test used to evaluate the unit's capacity to prevent re-entrainment of light liquids are reported in Table 5. The test involved preloading 58.3 L (corresponding to a 5 cm depth over the collection sump area of 1.17m^2) of surrogate low-density polyethylene beads within the oil collection skirt and running clean water through the device continuously at five surface loading rates (200, 800, 1400, 2000, and 2600 L/min/m^2). Each flow rate was maintained for 5 minutes with approximately 1 minute transition time between flow rates. The effluent flow was screened to capture all re-entrained pellets throughout the test.

Table 5. Light liquid re-entrainment test results for the EFO4.

Surface Loading Rate (L/min/m2)	Time Stamp	Amount of Beads Re-entrained			
		Mass (g)	Volume (L)[a]	% of Pre-loaded Mass Re-entrained	% of Pre-loaded Mass Retained
200	62	0	0	0.00	100
800	247	168.45	0.3	0.52	99.48
1400	432	51.88	0.09	0.16	99.83
2000	617	55.54	0.1	0.17	99.84
2600	802	19.73	0.035	0.06	99.94
Total Re-entrained		295.60	0.525	0.91	--
Total Retained		32403	57.78	--	99.09
Total Loaded		32699	58.3	--	--

[a] Determined from bead bulk density of 0.56074 g/cm^3

Variances from testing Procedure

The following minor deviations from the *Procedure for Laboratory Testing of Oil-Grit Separators* (Version 3.0, June 2014) have been noted:

1. During the capture test, the 40 L/min/m^2 and 80 L/min/m^2 surface loading rates were evaluated over 3 and 2 days respectively due to the long duration needed to feed the required minimum of 11.3 kg of test sediment into the unit at these lower flow rates. Pumps were shut down at the end of each intermediate day, and turned on again the following morning. The target flow rate was re-established within 30 seconds of switching on the pump. This procedure may have allowed sediments to be captured that otherwise may have exited the unit if the test was

continuous. On the basis of practical considerations, this variance was approved by the verifier prior to testing.

2. During the scour test, the coefficient of variation (COV) for the lowest flow rate tested (200 L/min/m^2) was 0.07, which exceeded the specified limit of 0.04 target specified in the OGS Procedure. A pump capable of attaining the highest flow rate of 3036 L/min had difficulty maintaining the lowest flow of 234 L/min but still remained within +/- 10% of the target flow and is viewed as having very little impact on the observed results. Similarly, for the light liquid re-entrainment test the COV for the flow rate of the 200 L/min/m^2 run was 0.049, exceeding the limit of 0.04, but is believed to introduce negligible bias.

3. Due to pressure build up in the filters, the runs at 1000 L/min/m^2 for the Stormceptor® EF4 and 1000 and 1400 L/min/m^2 for the Stormceptor® EFO4 were slightly shorter than the target. The run times were 54, 59 and 43 minutes respectively, versus targets of 60 and 50 minutes. The final feed samples were timed to coincide with the end of the run. Since >25 lbs of sediment was fed, the shortened time did not invalidate the runs.

Verification

The verification was completed by the Verification Expert, Toronto and Region Conservation Authority, contracted by GLOBE Performance Solutions, using the International Standard ***ISO 14034:2016 Environmental management -- Environmental technology verification (ETV)***. Data and information provided by Imbrium Systems Inc. to support the performance claim included the following: Performance test report prepared by Good Harbour Laboratories, and dated September 8, 2017; the report is based on testing completed in accordance with the Procedure for Laboratory Testing of Oil-Grit Separators (Version 3.0, June 2014).

What is ISO14034:2016 Environmental management – Environmental technology verification (ETV)?

ISO 14034:2016 specifies principles, procedures and requirements for environmental technology verification (ETV), and was developed and published by the *International Organization for Standardization (ISO)*. The objective of ETV is to provide credible, reliable and independent verification of the performance of environmental technologies. An environmental technology is a technology that either results in an environmental added value or measures parameters that indicate an environmental impact. Such technologies have an increasingly important role in addressing environmental challenges and achieving sustainable development.

For more information on the Stormceptor® EF4 and EFO4 please contact:

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407 Fairview Drive
Whitby, ON
L1N 3A9, Canada
Tel: 416-960-9900
info@imbriumsystems.com

For more information on ISO 14034:2016 / ETV please contact:

GLOBE Performance Solutions
World Trade Centre
404 – 999 Canada Place
Vancouver, BC
V6C 3E2 Canada
Tel: 604-695-5018 / Toll Free: 1-855-695-5018
etv@globeperformance.com

Limitation of verification

GLOBE Performance Solutions and the Verification Expert provide the verification services solely on the basis of the information supplied by the applicant or vendor and assume no liability thereafter. The responsibility for the information supplied remains solely with the applicant or vendor and the liability for the purchase, installation, and operation (whether consequential or otherwise) is not transferred to any other party as a result of the verification.

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

02/18/2022

Province:	Ontario
City:	Fort Erie
Nearest Rainfall Station:	ST CATHARINES AP
Climate Station Id:	6137287
Years of Rainfall Data:	33
Site Name:	613 Helena-OGS #2-to Roadside Ditch
Drainage Area (ha):	0.24
Runoff Coefficient 'c':	0.60
Particle Size Distribution:	CA ETV
Target TSS Removal (%):	68.0
Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	4.82
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:	613 Helena
Project Number:	131951
Designer Name:	Chris Zhang
Designer Company:	IBI
Designer Email:	chris.zhang@ibigroup.com
Designer Phone:	905-966-2053
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	64
EFO6	68
EFO8	70
EFO10	70
EFO12	70

Recommended Stormceptor EFO Model: EFO6

Estimated Net Annual Sediment (TSS) Load Reduction (%): 68

Water Quality Runoff Volume Capture (%): > 90

THIRD-PARTY TESTING AND VERIFICATION

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

PERFORMANCE

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

PARTICLE SIZE DISTRIBUTION (PSD)

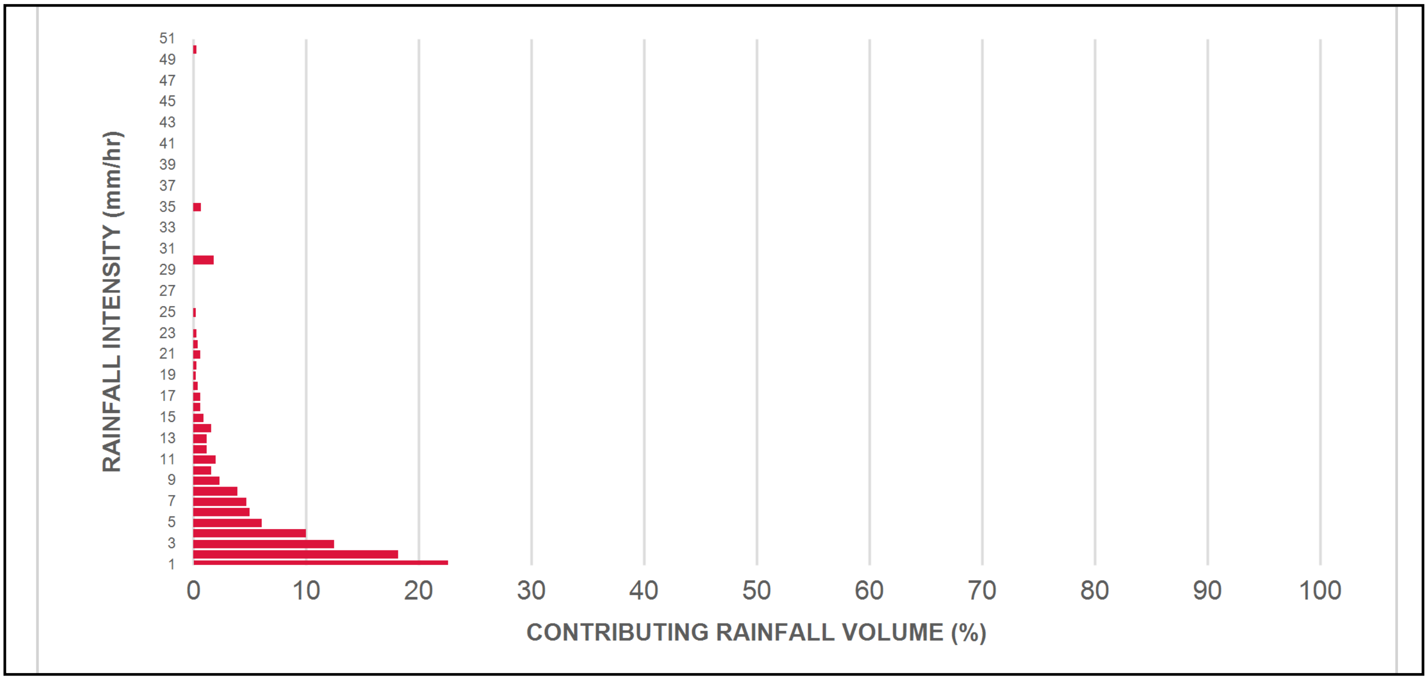
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a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

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

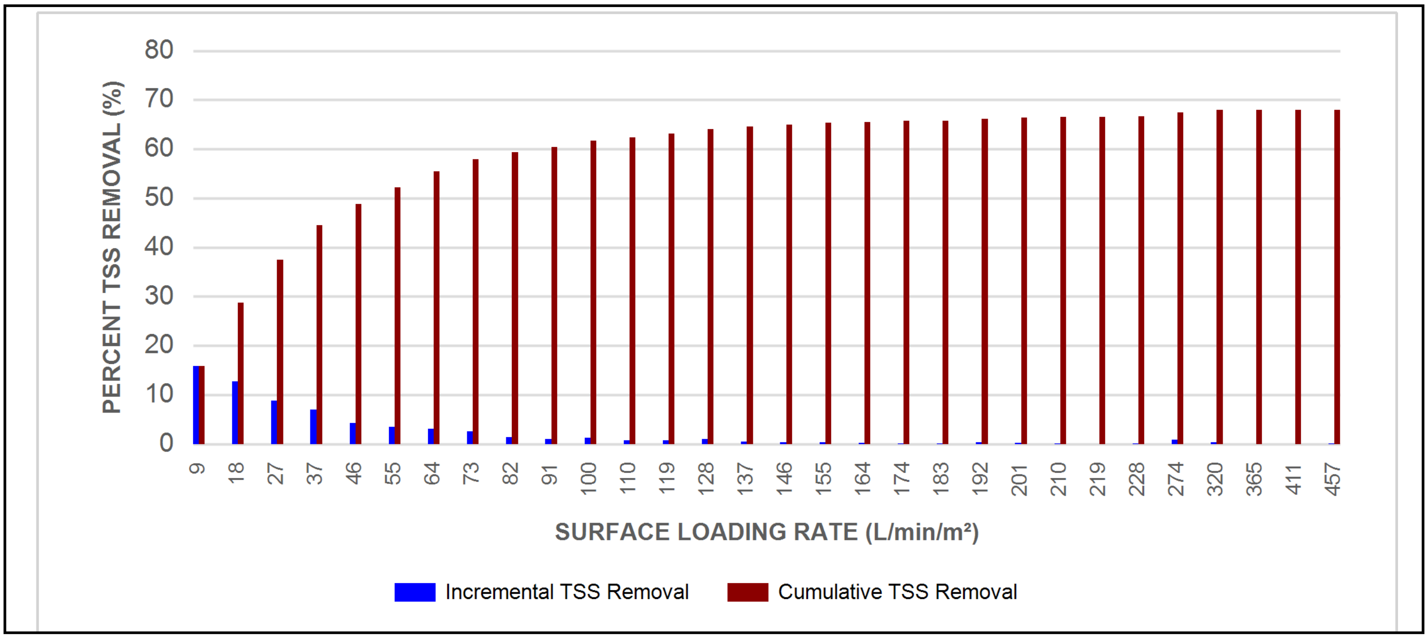
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	22.6	22.6	0.40	24.0	9.0	70	15.9	15.9
2	18.2	40.7	0.80	48.0	18.0	70	12.8	28.7
3	12.5	53.2	1.20	72.0	27.0	70	8.8	37.5
4	10.0	63.3	1.60	96.0	37.0	70	7.1	44.5
5	6.1	69.3	2.00	120.0	46.0	70	4.3	48.8
6	5.0	74.3	2.40	144.0	55.0	69	3.4	52.2
7	4.7	79.0	2.80	168.0	64.0	67	3.1	55.4
8	3.9	82.9	3.20	192.0	73.0	66	2.5	57.9
9	2.3	85.1	3.60	216.0	82.0	64	1.4	59.4
10	1.6	86.7	4.00	240.0	91.0	63	1.0	60.4
11	2.0	88.8	4.40	264.0	100.0	62	1.3	61.7
12	1.2	90.0	4.80	288.0	110.0	62	0.7	62.4
13	1.2	91.2	5.20	312.0	119.0	62	0.7	63.1
14	1.6	92.7	5.60	336.0	128.0	61	1.0	64.1
15	0.9	93.6	6.00	360.0	137.0	60	0.5	64.6
16	0.6	94.3	6.41	384.0	146.0	59	0.4	65.0
17	0.6	94.8	6.81	408.0	155.0	58	0.3	65.3
18	0.4	95.2	7.21	432.0	164.0	57	0.2	65.5
19	0.2	95.4	7.61	456.0	174.0	57	0.1	65.7
20	0.3	95.7	8.01	480.0	183.0	56	0.1	65.8
21	0.6	96.3	8.41	504.0	192.0	55	0.3	66.1
22	0.4	96.7	8.81	528.0	201.0	54	0.2	66.4
23	0.3	97.0	9.21	552.0	210.0	54	0.2	66.5
24	0.0	97.0	9.61	576.0	219.0	53	0.0	66.5
25	0.2	97.2	10.01	600.0	228.0	53	0.1	66.6
30	1.8	99.0	12.01	721.0	274.0	52	0.9	67.5
35	0.7	99.7	14.01	841.0	320.0	50	0.4	67.9
40	0.0	99.7	16.01	961.0	365.0	49	0.0	67.9
45	0.0	99.7	18.01	1081.0	411.0	48	0.0	67.9
50	0.3	100.0	20.02	1201.0	457.0	47	0.2	68.0
Estimated Net Annual Sediment (TSS) Load Reduction =								**68 %**

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

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

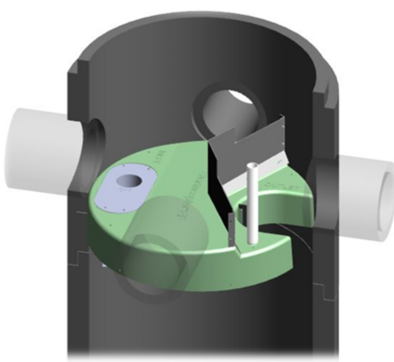
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test 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.

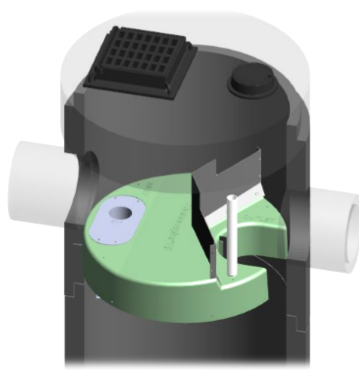
DESIGN FLEXIBILITY

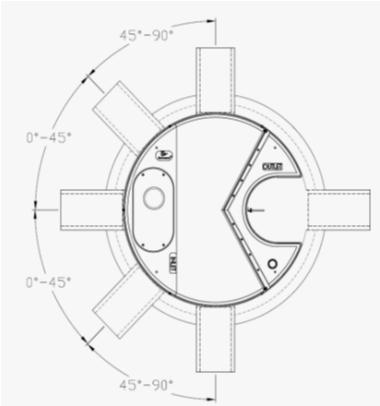
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend 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)	(ft³)	(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/ft³)

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

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Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results
Stormceptor® EFO

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34
60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

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, and only rainfall intensities greater than 0.5 mm/hr shall be included in sizing calculations. 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.

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

02/18/2022

Province:	Ontario
City:	Fort Erie
Nearest Rainfall Station:	ST CATHARINES AP
Climate Station Id:	6137287
Years of Rainfall Data:	33
Site Name:	613 Helena-OGS #3-to Roadside Ditch
Drainage Area (ha):	0.35
Runoff Coefficient 'c':	0.60
Particle Size Distribution:	CA ETV
Target TSS Removal (%):	66.0
Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	7.03
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:	613 Helena
Project Number:	131951
Designer Name:	Chris Zhang
Designer Company:	IBI
Designer Email:	chris.zhang@ibigroup.com
Designer Phone:	905-966-2053
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	62
EFO6	66
EFO8	69
EFO10	70
EFO12	70

Recommended Stormceptor EFO Model: EFO6

Estimated Net Annual Sediment (TSS) Load Reduction (%): 66

Water Quality Runoff Volume Capture (%): > 90

THIRD-PARTY TESTING AND VERIFICATION

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

PERFORMANCE

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

PARTICLE SIZE DISTRIBUTION (PSD)

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

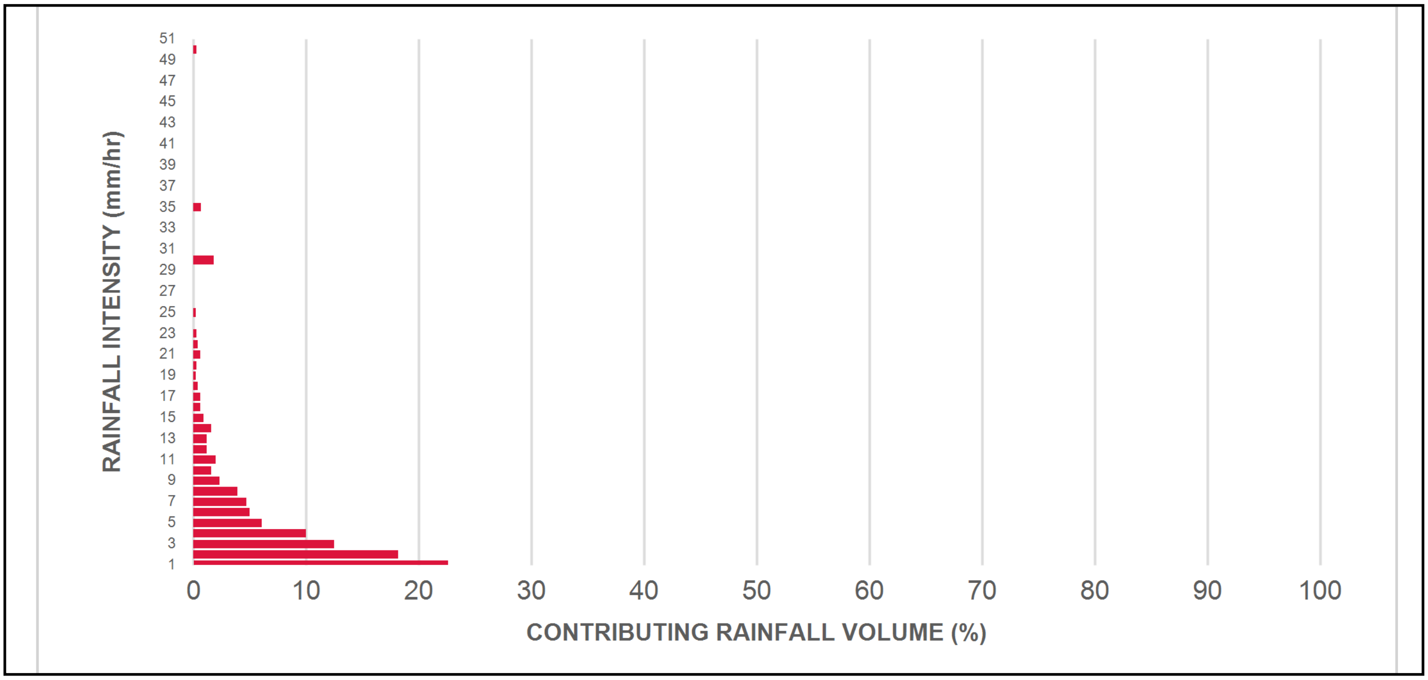
Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

Stormceptor® EF Sizing Report

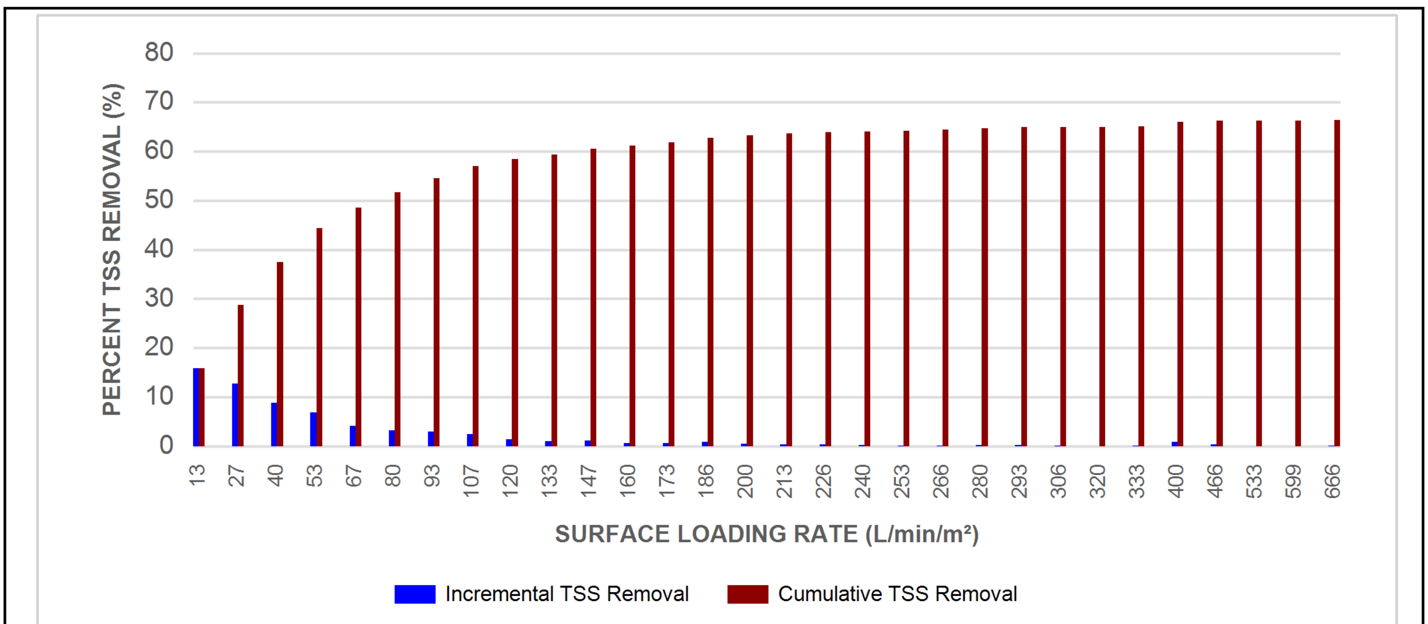
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	22.6	22.6	0.58	35.0	13.0	70	15.9	15.9
2	18.2	40.7	1.17	70.0	27.0	70	12.8	28.7
3	12.5	53.2	1.75	105.0	40.0	70	8.8	37.5
4	10.0	63.3	2.34	140.0	53.0	69	6.9	44.4
5	6.1	69.3	2.92	175.0	67.0	67	4.1	48.5
6	5.0	74.3	3.50	210.0	80.0	64	3.2	51.7
7	4.7	79.0	4.09	245.0	93.0	63	3.0	54.6
8	3.9	82.9	4.67	280.0	107.0	62	2.4	57.0
9	2.3	85.1	5.25	315.0	120.0	61	1.4	58.4
10	1.6	86.7	5.84	350.0	133.0	60	1.0	59.3
11	2.0	88.8	6.42	385.0	147.0	59	1.2	60.5
12	1.2	90.0	7.01	420.0	160.0	57	0.7	61.2
13	1.2	91.2	7.59	455.0	173.0	57	0.7	61.9
14	1.6	92.7	8.17	490.0	186.0	56	0.9	62.8
15	0.9	93.6	8.76	525.0	200.0	54	0.5	63.3
16	0.6	94.3	9.34	560.0	213.0	54	0.3	63.6
17	0.6	94.8	9.92	595.0	226.0	53	0.3	63.9
18	0.4	95.2	10.51	631.0	240.0	53	0.2	64.1
19	0.2	95.4	11.09	666.0	253.0	53	0.1	64.2
20	0.3	95.7	11.68	701.0	266.0	52	0.1	64.4
21	0.6	96.3	12.26	736.0	280.0	52	0.3	64.7
22	0.4	96.7	12.84	771.0	293.0	51	0.2	64.9
23	0.3	97.0	13.43	806.0	306.0	51	0.2	65.0
24	0.0	97.0	14.01	841.0	320.0	50	0.0	65.0
25	0.2	97.2	14.60	876.0	333.0	50	0.1	65.1
30	1.8	99.0	17.51	1051.0	400.0	48	0.9	66.0
35	0.7	99.7	20.43	1226.0	466.0	46	0.3	66.3
40	0.0	99.7	23.35	1401.0	533.0	44	0.0	66.3
45	0.0	99.7	26.27	1576.0	599.0	42	0.0	66.3
50	0.3	100.0	29.19	1751.0	666.0	42	0.1	66.4
Estimated Net Annual Sediment (TSS) Load Reduction =								**66 %**

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

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

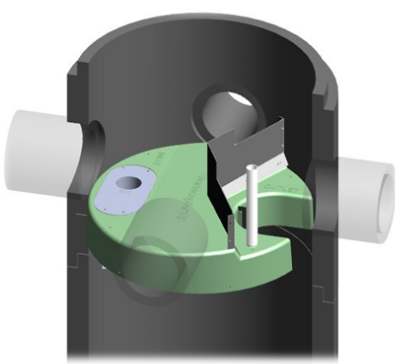
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test 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.

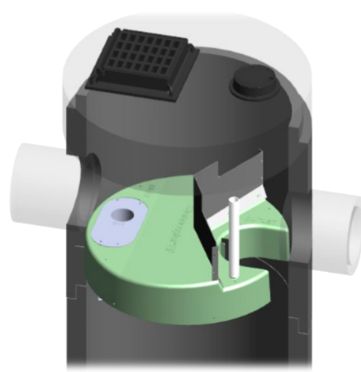
DESIGN FLEXIBILITY

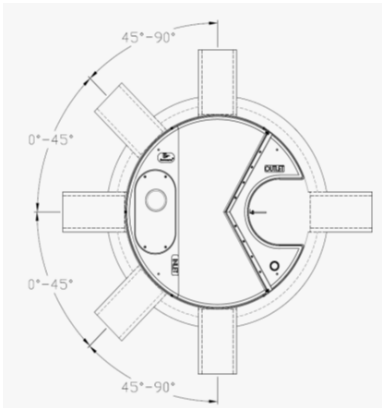
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend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

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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)	(ft³)	(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/ft³)

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

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results

Stormceptor® EFO

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34
60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

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, and only rainfall intensities greater than 0.5 mm/hr shall be included in sizing calculations. 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.

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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.

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

02/18/2022

Province:	Ontario
City:	Fort Erie
Nearest Rainfall Station:	ST CATHARINES AP
Climate Station Id:	6137287
Years of Rainfall Data:	33
Site Name:	613 Helena-OGS1 To Dry Pond
Drainage Area (ha):	2.27
Runoff Coefficient 'c':	0.60
Particle Size Distribution:	CA ETV
Target TSS Removal (%):	60.0
Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	45.57
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:	613 Helena
Project Number:	131951
Designer Name:	Chris Zhang
Designer Company:	IBI
Designer Email:	chris.zhang@ibigroup.com
Designer Phone:	905-966-2053
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	41
EFO6	51
EFO8	57
EFO10	61
EFO12	64

Recommended Stormceptor EFO Model:	**EFO10**
Estimated Net Annual Sediment (TSS) Load Reduction (%):	**61**
Water Quality Runoff Volume Capture (%):	**> 90**

imbrium

THIRD-PARTY TESTING AND VERIFICATION

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

PERFORMANCE

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

PARTICLE SIZE DISTRIBUTION (PSD)

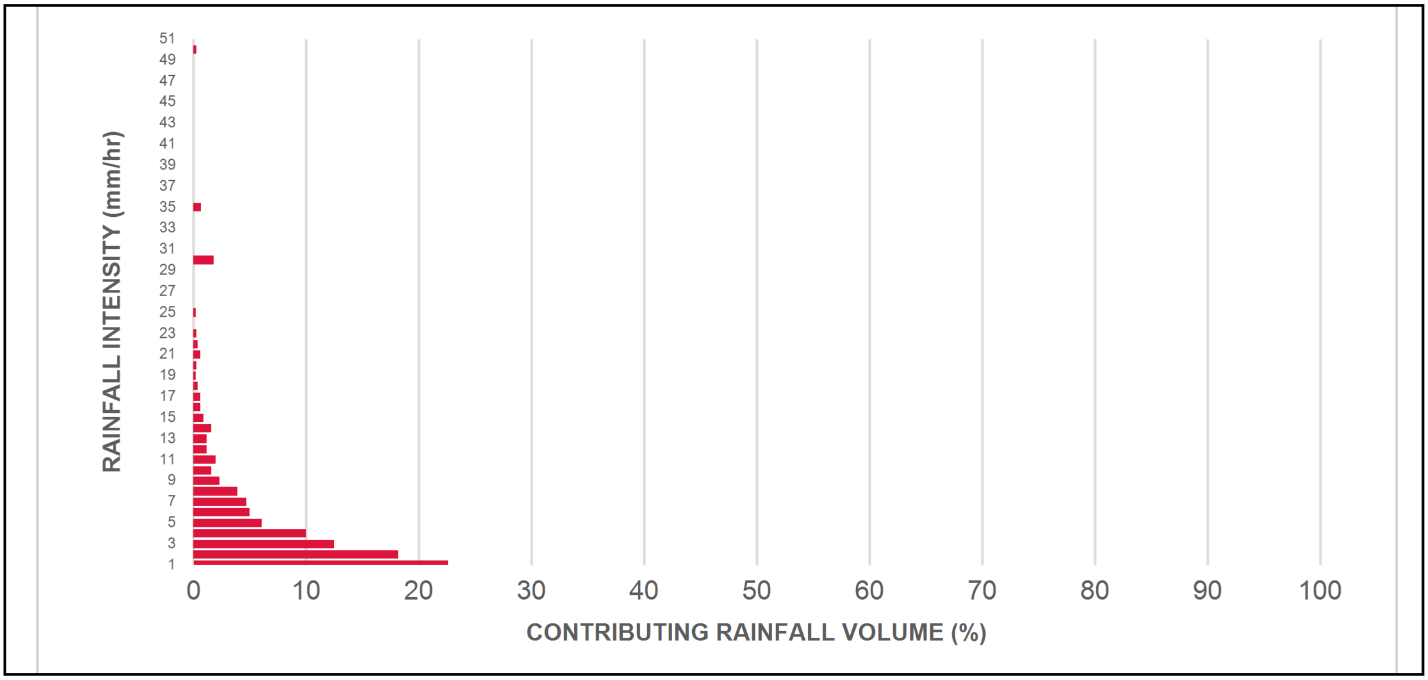
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a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

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

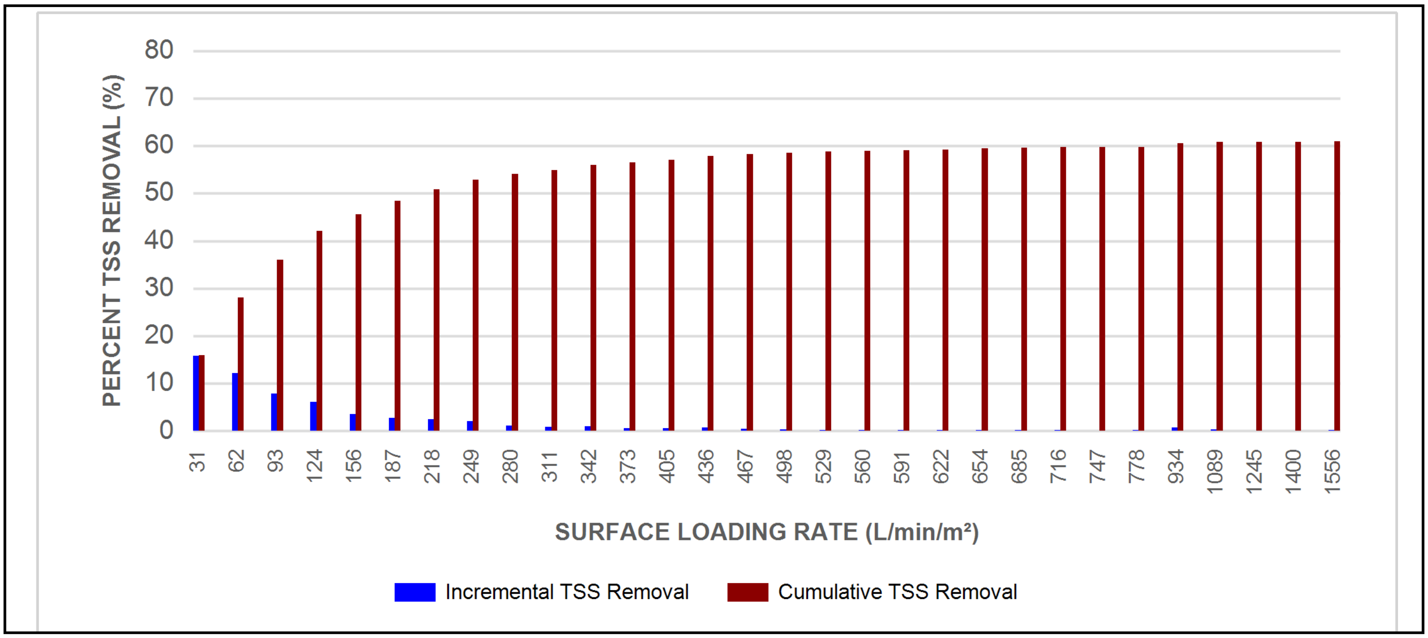
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	22.6	22.6	3.79	227.0	31.0	70	15.9	15.9
2	18.2	40.7	7.57	454.0	62.0	67	12.2	28.1
3	12.5	53.2	11.36	682.0	93.0	63	7.9	36.0
4	10.0	63.3	15.15	909.0	124.0	61	6.1	42.1
5	6.1	69.3	18.93	1136.0	156.0	58	3.5	45.6
6	5.0	74.3	22.72	1363.0	187.0	56	2.8	48.4
7	4.7	79.0	26.50	1590.0	218.0	54	2.5	50.9
8	3.9	82.9	30.29	1817.0	249.0	53	2.0	52.9
9	2.3	85.1	34.08	2045.0	280.0	52	1.2	54.1
10	1.6	86.7	37.86	2272.0	311.0	51	0.8	54.9
11	2.0	88.8	41.65	2499.0	342.0	50	1.0	55.9
12	1.2	90.0	45.44	2726.0	373.0	49	0.6	56.5
13	1.2	91.2	49.22	2953.0	405.0	48	0.6	57.1
14	1.6	92.7	53.01	3181.0	436.0	47	0.7	57.8
15	0.9	93.6	56.80	3408.0	467.0	46	0.4	58.2
16	0.6	94.3	60.58	3635.0	498.0	45	0.3	58.5
17	0.6	94.8	64.37	3862.0	529.0	44	0.3	58.8
18	0.4	95.2	68.15	4089.0	560.0	43	0.2	58.9
19	0.2	95.4	71.94	4316.0	591.0	42	0.1	59.0
20	0.3	95.7	75.73	4544.0	622.0	42	0.1	59.2
21	0.6	96.3	79.51	4771.0	654.0	42	0.2	59.4
22	0.4	96.7	83.30	4998.0	685.0	42	0.2	59.6
23	0.3	97.0	87.09	5225.0	716.0	41	0.1	59.7
24	0.0	97.0	90.87	5452.0	747.0	41	0.0	59.7
25	0.2	97.2	94.66	5680.0	778.0	41	0.1	59.8
30	1.8	99.0	113.59	6815.0	934.0	40	0.7	60.5
35	0.7	99.7	132.52	7951.0	1089.0	39	0.3	60.8
40	0.0	99.7	151.45	9087.0	1245.0	36	0.0	60.8
45	0.0	99.7	170.39	10223.0	1400.0	34	0.0	60.8
50	0.3	100.0	189.32	11359.0	1556.0	31	0.1	60.9
Estimated Net Annual Sediment (TSS) Load Reduction =								**61 %**

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

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

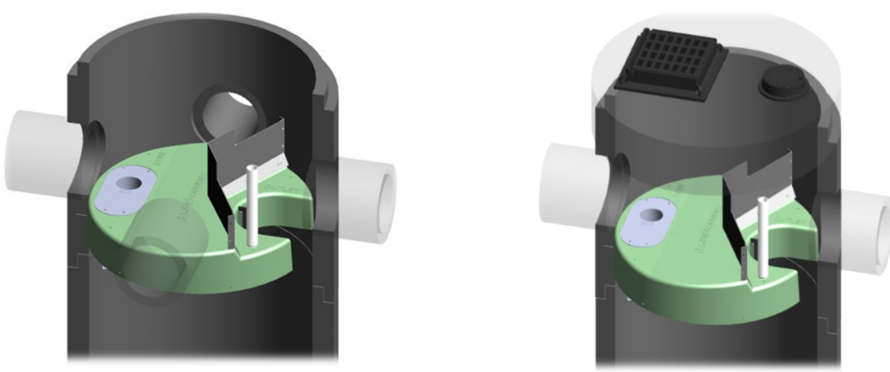
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test 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.

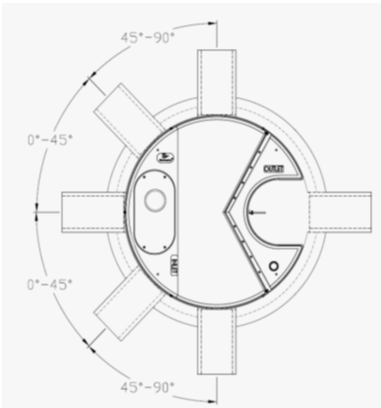
DESIGN FLEXIBILITY

►**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)	(ft³)	(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/ft³)

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

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Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results
Stormceptor® EFO

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34
60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

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).

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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, and only rainfall intensities greater than 0.5 mm/hr shall be included in sizing calculations. 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.

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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.

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