Gsd Developments & Management Inc.

Stormwater Management and Functional Servicing Report for 1166 - 1204 Gordon Street

GMBP File: 121139

March 9, 2022

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STORMWATER MANAGEMENT AND FUNCTIONAL SERVICING REPORT

1166-1204 GORDON STREET, GUELPH

March 9, 2022

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1.0 INTRODUCTION

In support of the Zoning By-law Amendment Application, GM BluePlan Engineering Limited (GMBP) provides this report that documents the proposed stormwater management design and servicing for the proposed multi-storey high density residential development at 1166-1204 Gordon Street in the City of Guelph (City).

The Owner is required to have a Professional Engineer design a stormwater management system and have the said Engineer supervise and certify that the stormwater management system is installed in accordance with the approvals given under Section 41 of the Planning Act.

This report and stormwater management design is based on the following information:

- Topographic survey, by Van Harten Surveying Inc., File No. 27080-19, dated February 18, 2021
- 1166-1204 Gordon Street Residential Development, Site Plan and Project Statistics, by Broadview Architect, undated, dated December 6, 2021
- Hydrogeological Study for Residential Development at 1166, 1170, 1182, 1190, 1200 and 1204 Gordon Street, Guelph, by GM BluePlan Engineering Limited, dated February 2022
- The existing and proposed site details are shown on the GM BluePlan Engineering Plans.

Aside from documents generated by GMBP, GM BluePlan Engineering Limited accepts no responsibility for the accuracy or completeness of the information supplied.

2.0 SITE INFORMATION

The 1.12-hectare subject property is located at 1166-1204 Gordon Street in the City of Guelph. The subject property is generally rectangular, with approximately 171 m of frontage along Gordon Street to the south and approximately 65 m deep, with the opposing side fronting onto Landsdown Drive to the north. The site is further bordered by 1210 Gordon Street to the east and 1160 Gordon Street to the west.

The 1166-1204 Gordon Street properties currently contain detached single-family dwellings, asphalt driveways and garages. The overall site topography slopes from the north to the south. Existing runoff sheet flows uncontrolled to Gordon Street storm system.

3.0 GEOLOGY

The site is located in the physiographic region known as the "Guelph Drumlin Field", which is centred in the City of Guelph[1]. The local soils in this area consist of stony tills and deep gravel terraces typical of drumlins and melt water spillways[2]. Refer to the Hydrogeological Study for more detailed subsurface information.

4.0 PROPOSED DEVELOPMENT

The proposed development includes two apartment buildings with six (6) residential floors and one below grade parking level. Additionally, four (4) 3-storey townhouse blocks are proposed along Landsdown Drive.

The City of Guelph provided the following drawings for information:

- Dwg No. 2D-102 – Gordon Street Reconstruction – Gordon Street Proposed Works – Station 4+380 to Station 4+525, As Recorded, by AECOM, dated December 2002.
- Dwg No. 2D-103 – Gordon Street Reconstruction – Gordon Street Proposed Works – Station 4+525 to Station 4+690, As Recorded, by AECOM, dated December 2002.
- Dwg No. 2D-104 – Gordon Street Reconstruction - Gordon Street Proposed Works – Station 4+690 to Station 4+855, As Recorded, by AECOM, dated December 2002.
- Dwg No. G-059 – Gordon Street Reconstruction – Gordon Street Proposed Works – Station 4+240 to Landsdown Drive, As Recorded, by the City of Guelph, dated January 1987.
- Dwg No. G-059B – Gordon Street Reconstruction – Gordon Street Proposed Works – Station 1+680 to Station 1+880, As Recorded, by IBI, dated May 2004.
- Dwg No. I-319 – Landsdown Drive Reconstruction – Station 1+110 to Station 1+260, As Recorded, by the City of Guelph, dated October 2009.

4.1 Storm Sewers

Based on record drawings I-319 and G-059 referenced in Section 4.0, there is a 300mm diameter storm sewer along north curb line of Landsdown Drive, starting to the east of the site and continuing to the west, eventually connecting to the 450mm diameter storm sewer on Gordon Street. This Gordon Street storm sewer flows west away from the site.

It is proposed that all runoff from the two apartment building roofs is to be conveyed through a clean water collector to a proposed Brentwood Module 25 Series infiltration gallery at the northwest end of the site. Overflow from the Brentwood infiltration system will be routed to an impermeable Brentwood system at the northwest end of the site that outlets to the Landsdown Drive storm sewer through a 300mm diameter pipe. The roadway through the site, other paved surfaces, and the rear roofs and rear yards of townhouses are proposed to be directly connected to the impermeable Brentwood System and bypass the infiltration gallery. The front half of the townhouse roofs and front yards of townhouses will runoff uncontrolled to Landsdown Drive. The southern area wrapping around the apartment buildings will flow uncontrolled south towards Gordon Street.

Based on record drawings 2D-103 referenced in Section 4.0, there is also a 300mm diameter storm sewer along south curb line of Gordon Street, starting in front of 1182 Gordon Street, and continuing east along Gordon Street. Currently, we do not propose any connections to this sewer.

[1] Chapman, L.J. and Putnam, D.F. 1985. Physiography of Southern Ontario – 3rd Edition. Ontario Geological Survey. Special Volume 2.
[2] Chapman, L.J. and Putnam, D.F. 1985. Physiography of Southern Ontario – 3rd Edition. Ontario Geological Survey. Special Volume 2.

4.2 Sanitary Sewers

Based on record drawing I-319 noted in Section 4.0, there is an existing 200mm diameter sanitary sewer on Landsdown Drive. The site is proposed to be serviced by a 200mm diameter pipe that will connect to the Landsdown Drive system at the north.

Based on record drawings 2D-103 referenced in Section 4.0, there is also a 200mm diameter sanitary sewer along the north curb line of Gordon Street. Currently, we do not propose any connections to this sewer.

4.3 Watermain

Based on record drawing I-319 noted in Section 4.0, there is a 150mm diameter PVC DR-25 watermain beneath the eastbound traffic lanes of Landsdown Drive. The site is proposed to be serviced by a 150mm diameter watermain connected to the existing 150mm diameter watermain on Landsdown Drive.

Based on record drawings 2D-103 referenced in Section 4.0, there is also a 400mm diameter watermain along the south curb line of Gordon Street. Currently, we do not propose any connections to this watermain.

5.0 STORMWATER MANAGEMENT

5.1 Criteria

The stormwater management criteria established by the City of Guelph, received by GMBP on October 4, 2021, are as follows:

1. Control Post Development discharge from site to Pre-development rates for the 2 to 100-year Guelph Design Storms.
2. Sites that do not have a positive outlet must be designed to provide storage on site for twice the 5-year design storm runoff volume.
3. For commercial, institutional and high-density residential developments, excess runoff for the 2-year design storm is to be stored underground or on roof tops.
4. Major storm flows are to be routed overland to the municipal stormwater drainage system.
5. Excess runoff from the 5-year design storm may pond in parking areas of least anticipated use to a maximum depth of 0.3 metres.
6. Clean runoff (roof water) should be directed to pervious areas for infiltration to encourage ground water recharge.
7. Quality control facilities are required to remove suspended solids (oil and grit) from areas draining driveways and parking lots.
8. The minimum acceptable water quality level for discharge to the municipal collection system is 70% TSS removal or an enhanced level 80% TSS removal - depending on the receiving water course.

5.2 Modelling Parameters

The City of Guelph mass rainfall data was used to model the full range of design storm events. The Chicago storm parameters and the total depth of rainfall for each storm are shown below in Table No. 1.

Table 1: Chicago Storm Parameters

	2 Year	5 Year	25 Year	100 Year
a =	743	1,593	3,158	4,688
b =	6	11	15	17
c =	0.799	0.879	0.936	0.962
R =	0.4	0.4	0.4	0.4
td =	170	170	210	210
Rainfall depth (mm)	33.816	46.775	69.476	88.830

The Horton infiltration method was used in the MIDUSS model. The following parameters summarized in Table No. 2 were used according to the City of Guelph Standards:

Table 2: MIDUSS Horton Parameters

	Impervious Areas	Pervious Areas
Manning's 'n'	0.013	0.300
Maximum Infiltration (mm/hr)	0.0	75.0
Minimum Infiltration (mm/hr)	0.0	12.5
Lag Constant (hr)	0.00	0.25
Depression Storage (mm)	1.5	5.0

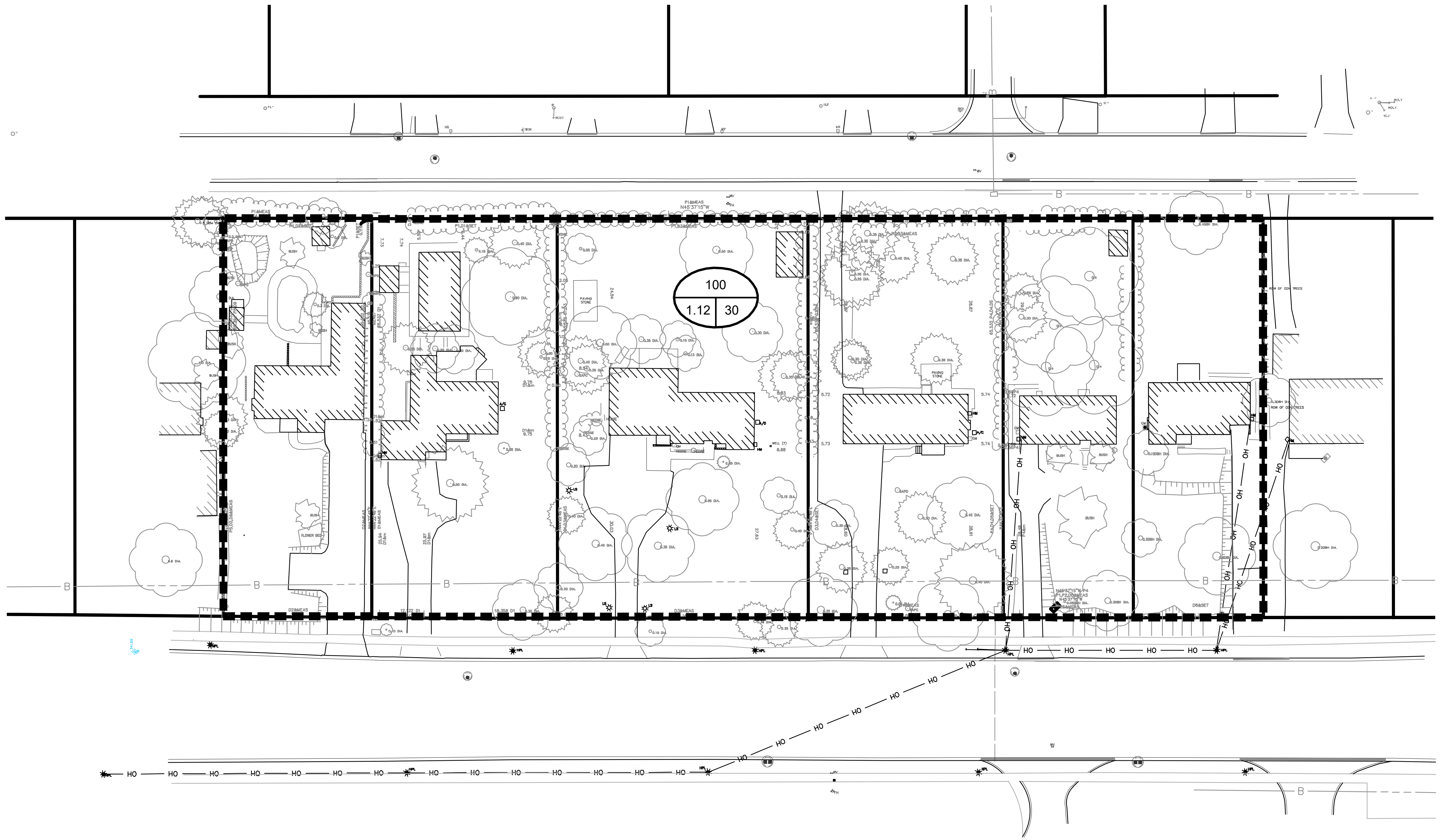
5.3 Pre-Development Conditions

For pre-development analysis purposes, the 1.12 hectare site was modelled as single drainage catchment due to the single outlet at the south end of the site. The pre-development drainage catchment is shown on Figure No. 2 and described below. The pre-development MIDUSS computer modeling is attached in Appendix 'A'.

Catchment 100 (1.12 hectares, 30% impervious) represents the entire site including multiple family dwellings, garages, sheds and asphalt driveways. Runoff from Catchment 100 flows overland south towards Gordon Street.

A summary of the pre-development peak flow from the site for various design storm events are provided in Table No. 3 below.

1166 - 1204 Gordon St
City of Guelph



LEGEND

- DRAINAGE AREA BOUNDARY
- 201 — CATCHMENT NUMBER
- 80 — % IMPERVIOUS
- 0.11 — CATCHMENT AREA IN HECTARES
- MAJOR OVERLAND FLOW ARROW

10 5 0 10 20 30
1:750 (m)

PRE DEVELOPMENT DRAINAGE AREA PLAN

Figure No. 1

GM BluePlan ENGINEERING

121139
MARCH 2022
Scale: 1:750 | NAD 1983 UTM Zone 17N

FILE:W:\Guelph\121-2021\121139 1166-1204 Gordon St ZBA\5 Work In Progress\Drafting\121139 SWM Fig 1.dwg LAYOUT:SWM Fig 1
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Table 3: Pre-development Conditions - Flow Rates

	Total Discharge to Adjacent Properties and Municipal right-of-way (Catchment 100) (m^3/s)
2 Year	0.072
5 Year	0.108
25 Year	0.212
100 Year	0.332

5.4 Post-Development Conditions

For post-development analysis purposes, the 1.12 hectare site was modelled as five (5) drainage catchments. The post-development drainage catchments are shown on Figure No. 3 and described below. The post-development MIDUSS computer modeling is attached in Appendix 'B'.

Catchment 200 (0.24 hectares, 100% impervious) represents the apartment building's rooftops. Stormwater runoff from Catchment 200 is proposed to be attenuated at a controlled rate by roof drains. Catchment 200 is modeled with seven roof drains, complete with three weirs in each. The roof drains are proposed to discharge into the infiltration gallery underneath the northwest entrance. Overflow form the infiltration gallery proceeds to the storm reservoir also under the northwest entrance and ultimately discharges to the Landsdown Drive storm sewer. The stage storage discharge calculations for the infiltration system, roof discharge controls, and storm reservoir are presented in Appendix B.

Catchment 201 (0.17 hectares, 85% impervious) represents the townhouse front yards and front half of roofs. Stormwater runoff from Catchment 200 is proposed to flow unattenuated to Landsdown Drive.

Catchment 202 (0.17 hectares, 60% impervious) represents the townhouse rear yards and rear half of roofs. The runoff generated from this catchment is directed to rear yards and overflows into catch basins throughout the asphalt area and will enter the storm system and ultimately discharge to the Landsdown Drive storm sewer.

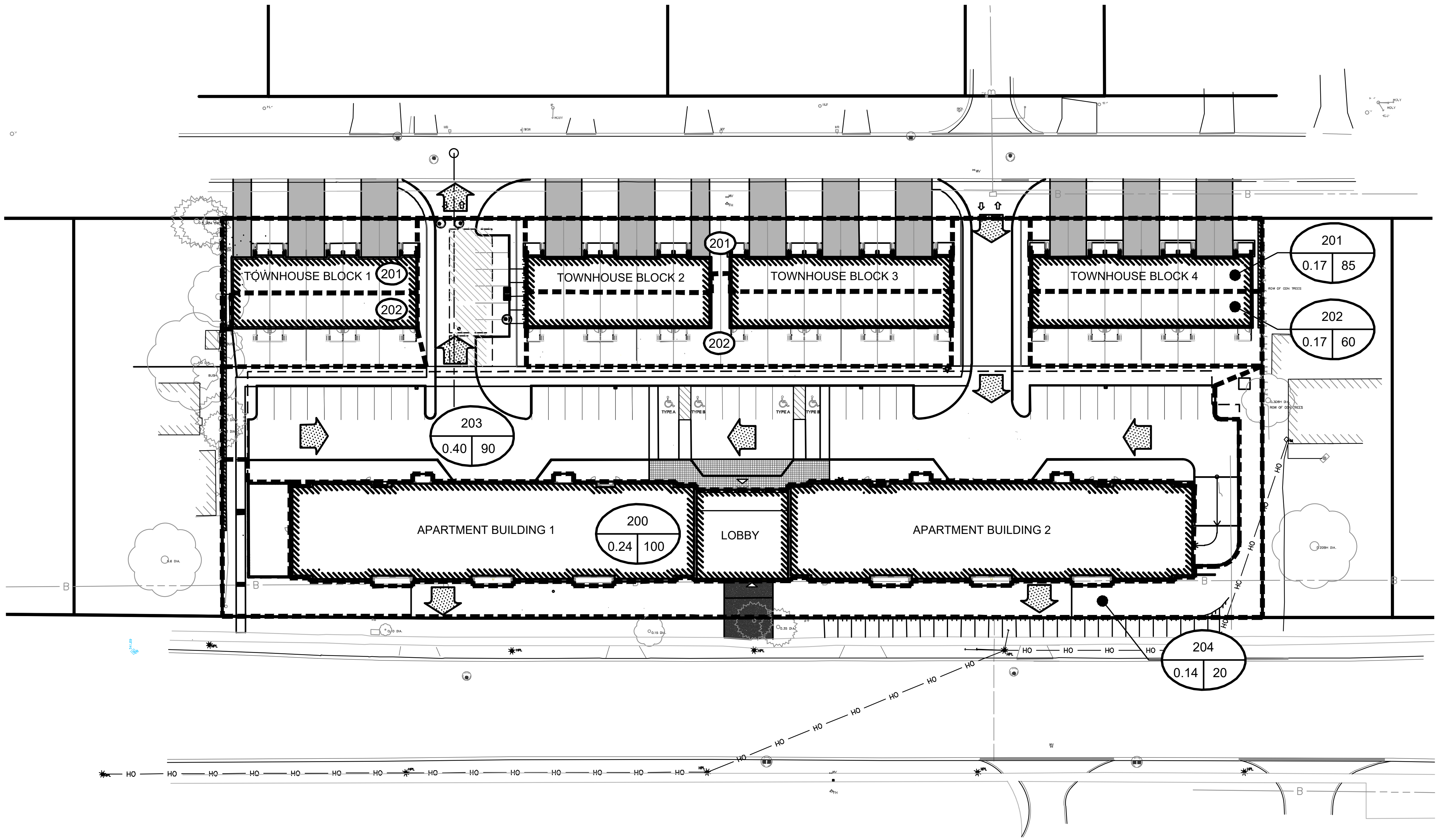
Catchment 203 (0.4 hectares, 90% impervious) represents the proposed parking lot, driving isles, side walks and some vegetated surfaces between the townhouse blocks and apartment buildings. Runoff from this catchment will be directed to the catch basins throughout the asphalt area and will enter the storm system and ultimately discharge to the Landsdown Drive storm sewer.

Catchment 204 (0.14 hectares, 20% impervious) represents the south side of the site, between apartment buildings and the Gordon Street right-of-way. This area includes grassed areas, sidewalks, and a portion of the site entrance. Under post-development conditions, this area will sheetflow overland towards the Gordon Street municipal right-of-way.

5.5 Infiltration

An infiltration gallery is proposed to be located under the northwest entrance to the apartment building site. This infiltration gallery is proposed to be a Stormtank Module 25 infiltration gallery and be 7 m long, 5 m wide, and have a depth of 0.75m. The proposed infiltration gallery will provide a base area of 35 m^2 and approximately 25.5 m^3 of stormwater storage.

1166 - 1204 Gordon St
City of Guelph



LEGEND

- DRAINAGE AREA BOUNDARY
- 201 — CATCHMENT NUMBER
- 80 — % IMPERVIOUS
- 0.11 — CATCHMENT AREA IN HECTARES
- MAJOR OVERLAND FLOW ARROW

10 5 0 10 20 30
1:750 (m)

POST DEVELOPMENT DRAINAGE AREA PLAN

Figure No. 2

GM BluePlan ENGINEERING

121139
MARCH 2022
Scale: 1:750 | NAD 1983 UTM Zone 17N

FILE:W:\Guelph\121-2021\121139 1166-1204 Gordon St ZBA\5 Work In Progress\Drafting\121139 SWM Fig 2.dwg LAYOUT:SWM Fig 2
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Insitu permeameter testing is proposed to be completed at one location. The permeameter test should be completed at the gallery below the northwest entrance. For the purposes of this report, as tests have not yet been completed, an infiltration rate of 20mm/hr has been assumed for infiltration gallery design and water balance calculations.

Table 4 below compares proposed grade of the infiltration gallery compared to interpreted groundwater elevations.

Table 4: Ground Water Table vs Underside of Infiltration Galleries

Location	Sub Location	Ground Water Elevation (m) *1	Grade Elevation (m)	Bottom of Infiltration Gallery Elevation (m) *2
Infiltration Gallery (under NW Entrance)	N/A	340.3	343.35	341.3

*1 Ground water levels are based on Figure 6 "Interpreted Groundwater Contour Plan" from the Hydrogeological Study report.

*2 Underside of infiltration galleries are to be 1.0m above seasonal ground water table elevations in order to meet City of Guelph requirements.

5.6 Routing

The hydrologic model MIDUSS was used to create the design storm runoff hydrographs and to route the hydrographs. The routing results for the proposed Infiltration Gallery 2, located under the northwest entrance, is summarized in Table 5 below.

Table 5: Brentwood Infiltration Gallery - Stage-Storage-Discharge Capacity

	Available Capacity			Actual Capacity Used		
	Peak Flow m^3/s	Storage Volume m^3	Storage Elevation m	Peak Flow m^3/s	Storage Volume m^3	Storage Elevation m
Bottom of Gallery	9.00E-05	0.00	341.3	---	---	---
Top of Gallery	9.00E-05	25.5	342.05	---	---	---
Overflow to Reservoir	0.143	26	342.06	---	---	---
2-Year Design Storm	---	---	---	0.009	25.56	342.07
100-Year Design Storm	---	---	---	0.026	25.68	342.10
Grade/Top of Grate	0.143	28.5	343.02	---	---	---

Peak flows in the above table for the design storm events are equivalent to the infiltration rate of the native soils except when overflowing to the storm reservoir.

Table 6 shows the stage-storage-discharge capacity at critical points in the storm reservoir located under the northwest entrance. The reservoir outlet is equipped with a 190 mm diameter orifice plate.

Table 6: Storm Reservoir - Stage-Storage-Discharge Capacity

	Available Capacity			Actual Capacity Used		
	Peak Flow m^3/s	**Storage Volume m^3**	**Storage Elevation m**	**Peak Flow m^3/s**	**Storage Volume m^3**	**Storage Elevation m**
Reservoir Outlet Invert/Invert of Orifice Plate	0.000	0.00	341.0	---	---	---
Bottom of Reservoir	0.000	0.00	341.0	---	---	---
2-Year Design Storm	---	---	---	0.045	54.51	341.46
5-Year Design Storm	---	---	---	0.059	84.79	341.71
25-Year Design Storm	---	---	---	0.079	142.14	342.19
Top of Reservoir	0.115	154.7	342.30	---	---	---
Top of CB Grate	0.146	167.2	343.02	---	---	---
Start of Overflow to Landsdown Drive	0.153	178.3	343.20	---	---	---
100-Year Design Storm	---	---	---	0.150	181.86	343.22
Top of Curb at Landsdown Outlet	0.500	199.1	343.32	---	---	---

A summary of the post-development peak flows from the site for the 2-year to 100-year design storm events are provided in Table 7 below.

Table 7: Proposed Peak Flow Rate from Site (m^3/s)

Catchment	2-Year	5-year	25-Year	100-Year
Catchment 200, 202, and 203 – To Storm System (Controlled)	0.045	0.059	0.079	0.150
Catchment 201 & 204 – To R.O.W. on Gordon Street/Landsdown Drive	0.043	0.059	0.095	0.133
Total Flow from Site	**0.072**	**0.101**	**0.159**	**0.209**

A summary of the pre- and post-development peak flow rates from the site for the 2-year to 100-year design storm events are provided in Table 8 below.

Table 8: Pre- and Post-Development Conditions: Peak Flow Rates – All Storms

	Peak Flow to Adjacent Properties / Gordon Street R.O.W. (m^3/s)
2 Year	
Pre-Development	0.072
Post-Development	0.072
5 Year	
Pre-Development	0.108
Post-Development	0.101
25 Year	
Pre-Development	0.212
Post-Development	0.159
100 Year	
Pre-Development	0.332
Post-Development	0.209

From Table 8 above, it can be observed that the proposed peak flow rate from the site, under the full range of design storm events, is estimated to be lower than or equal to the pre-development peak flow rate from site.

Upon completion of the development, all design storm flows from rooftops will be directed to the low impact development (LID) infiltration gallery and flows from storm events at or greater than the 100-year will be directed to the Landsdown Drive right-of-way.

5.7 Water Quality

Enhanced water quality treatment (80% TSS removal) for runoff generated from the asphalt area (Catchment 203) will be achieved by a treatment train approach routing runoff through a Stormceptor Model EFO4 oil/grit separator followed by an impermeable Brentwood system equipped with a Debris Row before exiting the site. Details of the oil/grit separator and Brentwood system have been included in Appendix “C”.

6.0 WATER BUDGET

The average annual precipitation for the area in which the study site is located is estimated to be about 916.3mm. This amount is based on precipitation data recorded at the Waterloo Wellington Airport meteorological station for the period from 1981 to 2010. The water balance has been calculated on a monthly basis based on the strategy provided in “Instructions and Tables for Computing Potential Evapotranspiration and the Water Balance” by Thornthwaite and Mather (dated 1957).

The 1.12-ha development site is understood to have underlying gravel and sand soils, with an estimated infiltration rate of 20mm/hr.

The existing pre-development site discharges to the south of the property via overland sheet flow. The 1.12-ha site is 30% impervious, given building and driveway characteristics, which produces approximately 2,293 m^3 of runoff annually.

Under pre-development conditions, the site currently produces approximately 2,918 m^3 of recharge volume annually.

The post-development site is approximately 78% impervious. The increase in impervious area results in additional precipitation being available for recharge and runoff, as evapotranspiration is reduced. The total annual runoff volume towards the infiltration gallery is 1,752 m^3. Under post-development conditions the total annual natural recharge volume (through pervious surfaces) is 1,227 m^3.

An infiltration gallery has been designed to facilitate recharge and try to satisfy the water balance requirements for the overall site. The gallery has been designed with 1 metre clearance from the seasonally high groundwater table and 1.2 m of frost protection, where feasible. The post development potential annual enhanced recharge volume available is 1,665 m^3, for a total potential annual recharge volume of 2,892 m^3.

Overall, the site development provides a decrease of 0.9% (26 m^3) of annual recharge volume from existing to proposed conditions. This minor reduction in recharge volume is insignificant and within accuracy of such theoretical calculations.

The results of the site water budget analysis, including the additional recharge provided by the infiltration gallery has been included in Appendix C.

7.0 MAINTENANCE PLAN

To ensure that the stormwater management system continues to function as designed and constructed, we recommend that the following inspections and maintenance activities be completed on an annual basis:

1. Infiltration galleries will be kept "off-line" until construction is complete. They will not serve as a sediment control device during site construction. Sediment will be prevented from entering the infiltration facility using super silt fence, diversion berms or other means.
2. We have specified clean outs at either end of the infiltration gallery to provide a means of inspecting and flushing them out as part of routine maintenance.
3. Maintenance typically consists of cleaning out leaves, debris and accumulated sediment caught in sumps in catchbasins and manholes and inspection and cleanout of inlets and outlets annually or as needed.
4. Inspection via observation in cleanouts will be performed to ensure the facility drains within the maximum acceptable length of time at least annually and following every major storm event (>25 mm). If the time required to fully drain exceeds 48 to 72 hours, they will be drained via pumping and clean out of the perforated distribution pipe. If slow drainage persists, the system may need removal and replacement of granular material and/or geotextile fabric.
5. Regular inspections and cleanings of the Stormceptor Model EFO4 oil/grit separator and Brentwood Stormtank complete with Debris Row will be required as a part of the standard maintenance procedures carried out annually by the Owner.

8.0 SEDIMENT AND EROSION CONTROL PLAN

Silt fence will be installed along the property boundary in all locations where runoff will discharge from the site to adjacent lands. The silt fence will serve to minimize the opportunity for water borne sediments to be washed on to the adjacent properties.

Upon completion of the grading, any area not subject to active construction within 30 days will be topsoiled and hydroseeded as per OPSS 572.

Inspection and maintenance of all silt fencing will start after installation is complete. The silt fence will be inspected on a weekly basis during active construction or after a rainfall event of 13mm or greater. Maintenance will be carried out, within 48 hours, on any part of the silt fence found to need repair.

Once construction and landscaping has been substantially completed, the silt fence will be removed, any accumulated sediment will be removed, and the landscaping will be completed.

Details of the proposed sediment and erosion control measures will be detailed on a drawing at the Site Plan Application stage of the project.

9.0 CONCLUSIONS

The 1166-1204 Gordon Street Stormwater Management and Functional Servicing report developed and clearly illustrated the following:

1. The post-development release rate from the site to municipal right-of-way is 0.209 m^3/s during the 100-year design storm event and is lower than pre-development release rate of 0.332 m3/s. Additionally, the post-development release rates for the 2-, 5-, and 25-year design storms are below or equal to the pre-development release rate and are summarized in Table 8.
2. Quality control for the stormwater collected from the paved surfaces will be provided through a treatment train approach by routing overland flows through a Stormceptor EFO4 oil/grit separator and Brentwood Debris Row prior to discharge into the Landsdown Drive storm system. The proposed water quality control measures are anticipated to achieve above 80% TSS removal.
3. The site will provide infiltration through the onsite infiltration gallery consisting of Brentwood Stormtank Module 25 or approved equivalent. The post-development annual recharge volume is approximately 0.9% below the pre-development recharge volume and is within modelling accuracy.
4. Prior to construction, a silt fence will be installed along the property boundary in all locations where runoff will discharge from the site to adjacent lands. This will minimize the transport of sediment off-site during the construction period.

All of which is respectfully submitted.

Yours truly,
GM BLUEPLAN ENGINEERING LIMITED
Per:

Jack Turner, P.Eng.

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Appendix A

Pre-Development MIDUSS Model Output

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"               MIDUSS Output ----------------------------------------------->"
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"               MIDUSS created                       Sunday, February 07, 2010"
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"               Company                                                       "
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" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      210.000   Max. Storm length"
"     2880.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"      743.000   Coefficient A"
"        6.000   Constant B"
"        0.799   Exponent C"
"        0.400   Fraction R"
"      170.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity           105.606    mm/hr"
"             Total depth                  33.816    mm"
"            6   002hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 100"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          100   Existing Site to Gordon Street"
"       30.000   % Impervious"
"        1.120   Total Area"
"       65.000   Flow length"
"        4.000   Overland Slope"
"        0.784   Pervious Area"
"       65.000   Pervious length"
"        4.000   Pervious slope"
"        0.336   Impervious Area"
"       65.000   Impervious length"
"        4.000   Impervious slope"
"        0.300   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
```

```
"                    0.072     0.000     0.000     0.000 c.m/sec"
"            Catchment 100          Pervious   Impervious Total Area "
"            Surface Area           0.784      0.336      1.120      hectare"
"            Time of concentration  31.975     2.573      6.508      minutes"
"            Time to Centroid       101.732    84.728     87.004     minutes"
"            Rainfall depth         33.816     33.816     33.816     mm"
"            Rainfall volume        265.12     113.62     378.74     c.m"
"            Rainfall losses        31.709     1.997      22.795     mm"
"            Runoff depth           2.107      31.819     11.021     mm"
"            Runoff volume          16.52      106.91     123.43     c.m"
"            Runoff coefficient     0.062      0.941      0.326      "
"            Maximum flow           0.008      0.072      0.072      c.m/sec"
" 40         HYDROGRAPH Add Runoff "
"           4   Add Runoff "
"                    0.072     0.072     0.000     0.000"
" 38         START/RE-START TOTALS 100"
"           3   Runoff Totals on EXIT"
"            Total Catchment area                      1.120    hectare"
"            Total Impervious area                     0.336    hectare"
"            Total % impervious                       30.000"
" 19         EXIT"
```

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"                 MIDUSS Output ----------------------------------------------->"
"                 MIDUSS version                           Version 2.25  rev. 473"
"                 MIDUSS created                        Sunday, February 07, 2010"
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"     2880.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     1593.000   Coefficient A"
"       11.000   Constant B"
"        0.879   Exponent C"
"        0.400   Fraction R"
"      170.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity          134.894    mm/hr"
"             Total depth                 46.775    mm"
"            6   005hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 100"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          100   Existing Site to Gordon Street"
"       30.000   % Impervious"
"        1.120   Total Area"
"       65.000   Flow length"
"        4.000   Overland Slope"
"        0.784   Pervious Area"
"       65.000   Pervious length"
"        4.000   Pervious slope"
"        0.336   Impervious Area"
"       65.000   Impervious length"
"        4.000   Impervious slope"
"        0.300   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
```

```
"                     0.108     0.000     0.000     0.000 c.m/sec"
"             Catchment 100          Pervious   Impervious Total Area "
"             Surface Area           0.784      0.336      1.120      hectare"
"             Time of concentration  22.134     2.333      9.522      minutes"
"             Time to Centroid       94.640     82.876     87.147     minutes"
"             Rainfall depth         46.775     46.775     46.775     mm"
"             Rainfall volume        366.72     157.16     523.88     c.m"
"             Rainfall losses        35.904     2.276      25.816     mm"
"             Runoff depth           10.871     44.499     20.959     mm"
"             Runoff volume          85.23      149.52     234.75     c.m"
"             Runoff coefficient     0.232      0.951      0.448      "
"             Maximum flow           0.049      0.098      0.108      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.108     0.108     0.000     0.000"
" 38          START/RE-START TOTALS 100"
"            3   Runoff Totals on EXIT"
"             Total Catchment area                    1.120    hectare"
"             Total Impervious area                   0.336    hectare"
"             Total % impervious                     30.000"
" 19          EXIT"
```

```
"               MIDUSS Output ----------------------------------------------->"
"               MIDUSS version                          Version 2.25  rev. 473"
"               MIDUSS created                     Sunday, February 07, 2010"
"          10   Units used:                                        ie METRIC"
"               Job folder:        C:\Users\smalicevic\Desktop\MIDUSS\121139\"
"                                                              2021-11-19\pre"
"               Output filename:                   121139 25-yr pre SM 2.out"
"               Licensee name:                                           gmbp"
"               Company                                                     "
"               Date & Time last used:                   2/8/2022 at 4:05:24 PM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      210.000   Max. Storm length"
"     2880.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     3158.000   Coefficient A"
"       15.000   Constant B"
"        0.936   Exponent C"
"        0.400   Fraction R"
"      210.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity          169.546    mm/hr"
"             Total depth                 69.476    mm"
"            6   025hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 100"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          100   Existing Site to Gordon Street"
"       30.000   % Impervious"
"        1.120   Total Area"
"       65.000   Flow length"
"        4.000   Overland Slope"
"        0.784   Pervious Area"
"       65.000   Pervious length"
"        4.000   Pervious slope"
"        0.336   Impervious Area"
"       65.000   Impervious length"
"        4.000   Impervious slope"
"        0.300   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
```

```
"                    0.212     0.000     0.000     0.000 c.m/sec"
"            Catchment 100          Pervious   Impervious Total Area "
"            Surface Area           0.784      0.336      1.120      hectare"
"            Time of concentration  16.237     2.129      9.156      minutes"
"            Time to Centroid       107.441    98.716     103.062    minutes"
"            Rainfall depth         69.476     69.476     69.476     mm"
"            Rainfall volume        544.70     233.44     778.14     c.m"
"            Rainfall losses        40.961     2.429      29.401     mm"
"            Runoff depth           28.515     67.047     40.075     mm"
"            Runoff volume          223.56     225.28     448.84     c.m"
"            Runoff coefficient     0.410      0.965      0.577      "
"            Maximum flow           0.148      0.140      0.212      c.m/sec"
" 40         HYDROGRAPH Add Runoff "
"           4   Add Runoff "
"                    0.212     0.212     0.000     0.000"
" 38         START/RE-START TOTALS 100"
"           3   Runoff Totals on EXIT"
"            Total Catchment area                    1.120    hectare"
"            Total Impervious area                   0.336    hectare"
"            Total % impervious                     30.000"
" 19         EXIT"
```

```
"                MIDUSS Output ----------------------------------------------->"
"                MIDUSS version                          Version 2.25  rev. 473"
"                MIDUSS created                       Sunday, February 07, 2010"
"           10   Units used:                                          ie METRIC"
"                Job folder:        C:\Users\smalicevic\Desktop\MIDUSS\121139\"
"                                                                2021-11-19\pre"
"                Output filename:                     121139 100-yr pre SM 2.out"
"                Licensee name:                                             gmbp"
"                Company                                                        "
"                Date & Time last used:                    2/8/2022 at 4:01:43 PM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      210.000   Max. Storm length"
"     2880.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     4688.000   Coefficient A"
"       17.000   Constant B"
"        0.962   Exponent C"
"        0.400   Fraction R"
"      210.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity          213.574    mm/hr"
"             Total depth                 88.830    mm"
"            6   100hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 100"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          100   Existing Site to Gordon Street"
"       30.000   % Impervious"
"        1.120   Total Area"
"       65.000   Flow length"
"        4.000   Overland Slope"
"        0.784   Pervious Area"
"       65.000   Pervious length"
"        4.000   Pervious slope"
"        0.336   Impervious Area"
"       65.000   Impervious length"
"        4.000   Impervious slope"
"        0.300   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
```

```
"                   0.332     0.000     0.000     0.000 c.m/sec"
"           Catchment 100          Pervious   Impervious Total Area "
"           Surface Area           0.784      0.336      1.120      hectare"
"           Time of concentration  13.410     1.941      8.270      minutes"
"           Time to Centroid       106.449    97.856     102.598    minutes"
"           Rainfall depth         88.830     88.830     88.830     mm"
"           Rainfall volume        696.43     298.47     994.89     c.m"
"           Rainfall losses        43.350     2.649      31.140     mm"
"           Runoff depth           45.480     86.181     57.690     mm"
"           Runoff volume          356.56     289.57     646.13     c.m"
"           Runoff coefficient     0.512      0.970      0.649      "
"           Maximum flow           0.227      0.177      0.332      c.m/sec"
" 40        HYDROGRAPH Add Runoff "
"          4   Add Runoff "
"                   0.332     0.332     0.000     0.000"
" 38        START/RE-START TOTALS 100"
"          3   Runoff Totals on EXIT"
"           Total Catchment area                     1.120    hectare"
"           Total Impervious area                    0.336    hectare"
"           Total % impervious                      30.000"
" 19        EXIT"
```

Appendix B

Post-Development MIDUSS Model Output
and Stage-Storage-Discharge Calculation Tables
and Oil/Grit Separator and Brentwood Stormtank Details

1166- 1204 Gordon Street
CITY OF GUELPH
OUR FILE: 121139
11-Feb-22

Catchment 200: Proposed Rooftop Storage

Design Discharge Rate =	1.50	l/min/mm/weir	2.50E-05	m^3/s/mm/weir
Max. Average Storage Depth =	100	mm		
Design Discharge =	150.0	l/min/weir	0.0015	m^3/s/weir
No. of Drains =	7			
No. Weirs/Drain =	3			
Allowable Release Rate =	3150.0	l/min	0.032	m^3/s
Rooftop Area =	2,400	m^2	(flat rooftop area that is available for storage)	

Therefore: 464.5 sq m/Roof Drain or 5000 sq ft/Roof Drain as per OBC

STAGE-STORAGE-DISCHARGE TABLE

Stage (m)	Storage (m^3)	Discharge (m^3/s)
0.000	0.0	0.000
0.025	60.0	0.013
0.050	120.0	0.026
0.075	180.0	0.039
0.100	240.0	0.053

1166- 1204 Gordon Street
CITY OF GUELPH
OUR FILE: 121139
4-Mar-22

CATCHMENT 200 - INFILTRATION GALLERY

STAGE STORAGE VOLUME CALCULATIONS

ELEV (m)	DEPTH (m)	SURFACE AREA (sq m)	INCR. VOLUME (cu m)	ACCUM. STORAGE VOLUME (cu m)	
341.30	0.000	35.0	0.0	0.0	Bottom of Gallery
341.40	0.100	35.0	3.4	3.4	
341.50	0.200	35.0	3.4	6.8	
341.60	0.300	35.0	3.4	10.2	
341.70	0.400	35.0	3.4	13.6	
341.80	0.500	35.0	3.4	17.0	
341.90	0.600	35.0	3.4	20.4	
342.00	0.700	35.0	3.4	23.8	
342.05	0.750	35.0	1.7	25.5	Top of Gallery
342.06	0.760	1.0	0.5	26.0	Overflow to outlet MH (with backflow preventer)
342.31	1.010	1.0	0.5	26.5	
342.39	1.090	1.0	0.5	27.0	
342.49	1.190	1.0	0.5	27.5	
342.59	1.290	1.0	0.5	28.0	
343.02	1.720	1.0	0.5	28.5	Top of Grate

BOTTOM INFILTRATION ONLY

L(dw) =	7.00	m
W(dw) =	5.00	m
Perimeter=	24.00	m
D(dw) =	0.70	m
A(c) =	35.0	sq m
VOL(dw)=	24.5	cu m
VOL(st)=	23.8	cu m
K =	5.56E-06	m/s

STAGE/STORAGE/DISCHARGE TABLE

ELEV. (m)	STAGE (m)	STORAGE VOLUME (m^3)	SOIL DISCHARGE (m^3/s)	Overflow DISCHARGE (m^3/s)	TOTAL DISCHARGE (m^3/s)	
341.30	0.000	0.0	0.0001944	0.00000	0.000194	Bottom of Gallery
341.40	0.100	3.4	0.0001944	0.00000	0.000194	
341.50	0.200	6.8	0.0001944	0.00000	0.000194	
341.60	0.300	10.2	0.0001944	0.00000	0.000194	
341.70	0.400	13.6	0.0001944	0.00000	0.000194	
341.80	0.500	17.0	0.0001944	0.00000	0.000194	
341.90	0.600	20.4	0.0001944	0.00000	0.000194	
342.00	0.700	23.8	0.0001944	0.00000	0.000194	Top of Gallery
342.05	0.750	25.5	0.0001944	0.00000	0.000194	Overflow to outlet MH (with backflow preventer)
342.06	0.760	26.0	0.0001944	0.00000	0.000194	
342.31	1.010	26.5	0.0001944	0.07150	0.071694	
342.39	1.090	27.0	0.0001944	0.14300	0.143194	
342.49	1.190	27.5	0.0001944	0.14300	0.143194	
342.59	1.290	28.0	0.0001944	0.14300	0.143194	
343.02	1.720	28.5	0.0001944	0.14300	0.143194	Top of Grate

1166- 1204 Gordon Street
CITY OF GUELPH
OUR FILE: 121139
2-Mar-22

CATCHMENT 200, 202, & 203 - IMPERMEABLE BRENTWOOD SYSTEM

Elevation (m)	Depth (m)	Surface Area (m^2)	Increase Active Volume (m^3)	Accum. Active Storage (m^3)	
341.00	0.00	119.00	0.00	0.00	B/Cistern Storage/ Invert of Pipe to outlet structure
341.15	0.15	119.00	17.85	17.85	
341.25	0.25	119.00	11.90	29.75	
341.50	0.50	119.00	29.75	59.50	
341.75	0.75	119.00	29.75	89.25	
341.85	0.85	119.00	11.90	101.15	
341.95	0.95	119.00	11.90	113.05	
342.30	1.30	119.00	95.20	154.70	Soffit of Tank
342.50	1.50	1.00	12.00	166.70	Top of Top Slab of tank
342.51	1.51	1.00	0.01	166.71	
342.60	1.60	1.00	0.09	166.80	
342.85	1.85	1.00	0.25	167.05	
343.02	2.02	1.00	0.17	167.22	Start of surface Ponding
343.03	2.03	1.00	0.01	167.23	
343.07	2.07	31.00	0.64	167.87	
343.20	2.20	129.00	10.40	178.27	Overflow to Landsdown Street ROW
343.25	2.25	167.00	7.40	185.67	
343.30	2.30	205.00	9.30	194.97	
343.32	2.32	205.00	4.10	199.07	

Outlet Str #1 Orifice Control 1 to Outlet Pipe			Overflow Weir		
Q =	0.112	cu m/s	Q =	0.343	cu m/s
Cd =	0.600		d1 =	2.320	m
H =	2.320	m	h =	2.200	m
2g =	19.620		H =	0.120	m
A =	0.028	sq m	2g =	19.620	
D =	0.190	m	L =	6.000	m
D/2 =	0.095	m			

Elevation (m)	Stage (m)	Storage (m^3)	Outlet Str #1 Orifice Control 1 (m^3/s)	Outlet Str #1 Discharge (m^3/s)	Overflow Weir (m^3/s)	Total System Discharge (m^3/s)	
341.00	0.00	0.00	0.000	0.000	0.000	0.0000	B/Cistern Storage/ Invert of Pipe to outlet structure
341.15	0.15	17.85	0.018	0.018	0.000	0.0177	
341.25	0.25	29.75	0.030	0.030	0.000	0.0297	
341.50	0.50	59.50	0.048	0.048	0.000	0.0480	
341.75	0.75	89.25	0.061	0.061	0.000	0.0610	
341.85	0.85	101.15	0.065	0.065	0.000	0.0655	
341.95	0.95	113.05	0.070	0.070	0.000	0.0697	
342.30	1.30	154.70	0.083	0.083	0.000	0.0827	Soffit of Tank
342.50	1.00	166.70	0.089	0.089	0.000	0.0893	Top of Top Slab of tank
342.51	1.01	166.71	0.090	0.090	0.000	0.0896	
342.60	1.10	166.80	0.092	0.092	0.000	0.0924	
342.85	1.35	167.05	0.100	0.100	0.000	0.0998	
343.02	1.52	167.22	0.105	0.105	0.000	0.1045	Start of surface Ponding
343.03	1.53	167.23	0.105	0.105	0.000	0.1048	
343.07	1.57	167.87	0.106	0.106	0.000	0.1059	
343.20	1.70	178.27	0.109	0.109	0.000	0.1093	Overflow to Landsdown Street ROW
343.25	1.75	185.67	0.111	0.111	0.091	0.2021	
343.30	1.80	194.97	0.112	0.112	0.260	0.3721	
343.32	1.82	199.07	0.112	0.112	0.343	0.4551	

```
"               MIDUSS Output ----------------------------------------------->"
"               MIDUSS version                          Version 2.25  rev. 473"
"               MIDUSS created                       Sunday, February 07, 2010"
"          10   Units used:                                           ie METRIC"
"               Job folder:        C:\Users\smalicevic\Desktop\MIDUSS\121139\"
"                                                                   2022-03-04"
"               Output filename:               121139 2-yr post SM Mar 4.out"
"               Licensee name:                                           gmbp"
"               Company                                                      "
"               Date & Time last used:                  3/4/2022 at 8:41:01 AM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      210.000   Max. Storm length"
"     4280.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"      743.000   Coefficient A"
"        6.000   Constant B"
"        0.799   Exponent C"
"        0.400   Fraction R"
"      170.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity          105.606    mm/hr"
"             Total depth                 33.816    mm"
"            6   002hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 200"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          200   Catch 200 Apartment Rooftops"
"      100.000   % Impervious"
"        0.240   Total Area"
"       10.000   Flow length"
"        1.000   Overland Slope"
"        0.000   Pervious Area"
"       10.000   Pervious length"
"        1.000   Pervious slope"
"        0.240   Impervious Area"
"       10.000   Impervious length"
"        1.000   Impervious slope"
"        0.300   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
```

```
"                     0.059     0.000     0.000     0.000 c.m/sec"
"             Catchment 200          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.240      0.240      hectare"
"             Time of concentration  15.764     1.269      1.269      minutes"
"             Time to Centroid       88.079     82.825     82.825     minutes"
"             Rainfall depth         33.816     33.816     33.816     mm"
"             Rainfall volume        0.00       81.16      81.16      c.m"
"             Rainfall losses        31.715     2.203      2.203      mm"
"             Runoff depth           2.101      31.613     31.613     mm"
"             Runoff volume          0.00       75.87      75.87      c.m"
"             Runoff coefficient     0.000      0.935      0.935      "
"             Maximum flow           0.000      0.059      0.059      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.059     0.059     0.000     0.000"
" 54          POND DESIGN"
"        0.059   Current peak flow    c.m/sec"
"        0.030   Target outflow    c.m/sec"
"         75.9   Hydrograph volume    c.m"
"           5.   Number of stages"
"        0.000   Minimum water level    metre"
"        3.000   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                  Level Discharge    Volume"
"                  0.000     0.000     0.000"
"                0.02500   0.01300    60.000"
"                0.05000   0.02600   120.000"
"                0.07500   0.03900   180.000"
"                 0.1000   0.05300   240.000"
"             Peak outflow                  0.010    c.m/sec"
"             Maximum level                 0.019    metre"
"             Maximum storage              44.866    c.m"
"             Centroidal lag                2.662   hours"
"                  0.059     0.059     0.010     0.000 c.m/sec"
" 40          HYDROGRAPH Next link "
"            5   Next link "
"                     0.059     0.010     0.010     0.000"
" 54          POND DESIGN"
"        0.010   Current peak flow    c.m/sec"
"        0.030   Target outflow    c.m/sec"
"         75.9   Hydrograph volume    c.m"
"          15.   Number of stages"
"        0.000   Minimum water level    metre"
"        1.720   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                  Level Discharge    Volume"
"                341.300   0.00019     0.000"
"                341.400   0.00019     3.400"
```

```
"                341.500   0.00019     6.800"
"                341.600   0.00019    10.200"
"                341.700   0.00019    13.600"
"                341.800   0.00019    17.000"
"                341.900   0.00019    20.400"
"                342.000   0.00019    23.800"
"                342.050   0.00019    25.500"
"                342.060   0.00019    26.000"
"                342.310   0.07169    26.500"
"                342.390    0.1432    27.000"
"                342.490    0.1432    27.500"
"                342.590    0.1432    28.000"
"                343.020    0.1432    28.500"
"             Peak outflow                  0.008    c.m/sec"
"             Maximum level               342.089    metre"
"             Maximum storage              26.059    c.m"
"             Centroidal lag               11.647   hours"
"                  0.059     0.010     0.008     0.000 c.m/sec"
" 40          HYDROGRAPH   Combine    2000"
"            6   Combine "
"         2000   Node #"
"                Outlet To Landsdown Storm System"
"             Maximum flow                  0.008    c.m/sec"
"             Hydrograph volume            74.742    c.m"
"                     0.059     0.010     0.008     0.008"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.059     0.000     0.008     0.008"
" 33          CATCHMENT 203"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          203   Catch 203 Remainder of Apartment Block"
"       90.000   % Impervious"
"        0.400   Total Area"
"       30.000   Flow length"
"        3.000   Overland Slope"
"        0.040   Pervious Area"
"       30.000   Pervious length"
"        3.000   Pervious slope"
"        0.360   Impervious Area"
"       30.000   Impervious length"
"        3.000   Impervious slope"
"        0.300   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
```

```
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.083     0.000     0.008     0.008 c.m/sec"
"              Catchment 203          Pervious   Impervious Total Area "
"              Surface Area           0.040      0.360      0.400      hectare"
"              Time of concentration  21.919     1.764      1.911      minutes"
"              Time to Centroid       93.239     83.461     83.532     minutes"
"              Rainfall depth         33.816     33.816     33.816     mm"
"              Rainfall volume        13.53      121.74     135.26     c.m"
"              Rainfall losses        31.710     1.965      4.940      mm"
"              Runoff depth           2.106      31.851     28.876     mm"
"              Runoff volume          0.84       114.66     115.51     c.m"
"              Runoff coefficient     0.062      0.942      0.854      "
"              Maximum flow           0.001      0.083      0.083      c.m/sec"
" 40           HYDROGRAPH Add Runoff "
"             4   Add Runoff "
"                     0.083     0.083     0.008     0.008"
" 40           HYDROGRAPH Copy to Outflow"
"             8   Copy to Outflow"
"                     0.083     0.083     0.083     0.008"
" 40           HYDROGRAPH   Combine    2000"
"             6   Combine "
"          2000   Node #"
"                 Outlet To Landsdown Storm System"
"              Maximum flow                  0.083    c.m/sec"
"              Hydrograph volume           190.245    c.m"
"                     0.083     0.083     0.083     0.083"
" 40           HYDROGRAPH Start - New Tributary"
"             2   Start - New Tributary"
"                     0.083     0.000     0.083     0.083"
" 33           CATCHMENT 202"
"             1   Triangular SCS"
"             1   Equal length"
"             2   Horton equation"
"           202   Catch 202 Townhouse Block to Rear"
"       60.000   % Impervious"
"        0.170   Total Area"
"       15.000   Flow length"
"        3.000   Overland Slope"
"        0.068   Pervious Area"
"       15.000   Pervious length"
"        3.000   Pervious slope"
"        0.102   Impervious Area"
"       15.000   Impervious length"
"        3.000   Impervious slope"
"        0.300   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
```

```
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.025     0.000     0.083     0.083 c.m/sec"
"              Catchment 202          Pervious   Impervious Total Area "
"              Surface Area           0.068      0.102      0.170      hectare"
"              Time of concentration  14.461     1.164      1.733      minutes"
"              Time to Centroid       87.020     82.643     82.830     minutes"
"              Rainfall depth         33.816     33.816     33.816     mm"
"              Rainfall volume        22.99      34.49      57.49      c.m"
"              Rainfall losses        31.706     2.339      14.085     mm"
"              Runoff depth           2.110      31.477     19.731     mm"
"              Runoff volume          1.44       32.11      33.54      c.m"
"              Runoff coefficient     0.062      0.931      0.583      "
"              Maximum flow           0.001      0.025      0.025      c.m/sec"
" 40           HYDROGRAPH Add Runoff "
"             4   Add Runoff "
"                     0.025     0.025     0.083     0.083"
" 40           HYDROGRAPH Copy to Outflow"
"             8   Copy to Outflow"
"                     0.025     0.025     0.025     0.083"
" 40           HYDROGRAPH   Combine    2000"
"             6   Combine "
"          2000   Node #"
"                 Outlet To Landsdown Storm System"
"              Maximum flow                 0.108    c.m/sec"
"              Hydrograph volume          223.787    c.m"
"                     0.025     0.025     0.025     0.108"
" 40           HYDROGRAPH   Confluence    2000"
"             7   Confluence "
"          2000   Node #"
"                 Outlet To Landsdown Storm System"
"              Maximum flow                 0.108    c.m/sec"
"              Hydrograph volume          223.787    c.m"
"                     0.025     0.108     0.025     0.000"
" 54           POND DESIGN"
"        0.108   Current peak flow    c.m/sec"
"        0.200   Target outflow    c.m/sec"
"        223.8   Hydrograph volume    c.m"
"          19.   Number of stages"
"        0.000   Minimum water level    metre"
"        3.000   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                   Level Discharge    Volume"
"                 341.000     0.000     0.000"
"                 341.150   0.01800    17.850"
```

```
"               341.250   0.03000    29.750"
"               341.500   0.04800    59.500"
"               341.750   0.06100    89.250"
"               341.850   0.06500   101.150"
"               341.950   0.07000   113.050"
"               342.300   0.08300   154.700"
"               342.500   0.08900   166.700"
"               342.510   0.09000   166.710"
"               342.600   0.09200   166.800"
"               342.850    0.1000   167.050"
"               343.020    0.1050   167.220"
"               343.030    0.1050   167.230"
"               343.070    0.1060   167.870"
"               343.200    0.1090   178.270"
"               343.250    0.2020   185.670"
"               343.300    0.3720   194.970"
"               343.320    0.4550   199.070"
"            Peak outflow                  0.045    c.m/sec"
"            Maximum level               341.458    metre"
"            Maximum storage              54.509    c.m"
"            Centroidal lag                5.103   hours"
"                 0.025     0.108     0.045     0.000 c.m/sec"
" 40         HYDROGRAPH   Combine    3000"
"           6   Combine "
"        3000   Node #"
"               Total Flow Leaving Site"
"            Maximum flow                  0.045    c.m/sec"
"            Hydrograph volume           223.968    c.m"
"                    0.025     0.108     0.045     0.045"
" 40         HYDROGRAPH Start - New Tributary"
"           2   Start - New Tributary"
"                    0.025     0.000     0.045     0.045"
" 33         CATCHMENT 201"
"           1   Triangular SCS"
"           1   Equal length"
"           2   Horton equation"
"         201   Catch 201 Townhouse Block to Landsdown"
"      85.000   % Impervious"
"       0.170   Total Area"
"      11.000   Flow length"
"       5.000   Overland Slope"
"       0.025   Pervious Area"
"      11.000   Pervious length"
"       5.000   Pervious slope"
"       0.145   Impervious Area"
"      11.000   Impervious length"
"       5.000   Impervious slope"
"       0.300   Pervious Manning 'n'"
"      75.000   Pervious Max.infiltration"
"      12.500   Pervious Min.infiltration"
```

```
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.036     0.000     0.045     0.045 c.m/sec"
"             Catchment 201          Pervious   Impervious Total Area "
"             Surface Area           0.025      0.145      0.170      hectare"
"             Time of concentration  10.300     0.829      0.941      minutes"
"             Time to Centroid       83.376     82.192     82.206     minutes"
"             Rainfall depth         33.816     33.816     33.816     mm"
"             Rainfall volume        8.62       48.86      57.49      c.m"
"             Rainfall losses        31.723     2.967      7.281      mm"
"             Runoff depth           2.093      30.849     26.535     mm"
"             Runoff volume          0.53       44.58      45.11      c.m"
"             Runoff coefficient     0.062      0.912      0.785      "
"             Maximum flow           0.001      0.036      0.036      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.036     0.036     0.045     0.045"
" 33          CATCHMENT 204"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          204   South Easement"
"       20.000   % Impervious"
"        0.140   Total Area"
"        7.000   Flow length"
"        2.000   Overland Slope"
"        0.112   Pervious Area"
"        7.000   Pervious length"
"        2.000   Pervious slope"
"        0.028   Impervious Area"
"        7.000   Impervious length"
"        2.000   Impervious slope"
"        0.300   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.007     0.036     0.045     0.045 c.m/sec"
"             Catchment 204          Pervious   Impervious Total Area "
"             Surface Area           0.112      0.028      0.140      hectare"
```

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"              Time of concentration  10.338     0.832      2.862      minutes"
"              Time to Centroid       83.416     82.189     82.451     minutes"
"              Rainfall depth         33.816     33.816     33.816     mm"
"              Rainfall volume        37.87      9.47       47.34      c.m"
"              Rainfall losses        31.722     2.960      25.969     mm"
"              Runoff depth           2.094      30.856     7.847      mm"
"              Runoff volume          2.35       8.64       10.99      c.m"
"              Runoff coefficient     0.062      0.912      0.232      "
"              Maximum flow           0.003      0.007      0.007      c.m/sec"
" 40           HYDROGRAPH Add Runoff "
"             4   Add Runoff "
"                      0.007     0.043     0.045     0.045"
" 40           HYDROGRAPH Copy to Outflow"
"             8   Copy to Outflow"
"                      0.007     0.043     0.043     0.045"
" 40           HYDROGRAPH   Combine    3000"
"             6   Combine "
"          3000   Node #"
"                 Total Flow Leaving Site"
"              Maximum flow                  0.072    c.m/sec"
"              Hydrograph volume           280.063    c.m"
"                      0.007     0.043     0.043     0.072"
" 38           START/RE-START TOTALS 204"
"             3   Runoff Totals on EXIT"
"              Total Catchment area                      1.120    hectare"
"              Total Impervious area                     0.874    hectare"
"              Total % impervious                       78.080"
" 19           EXIT"
```

```
"               MIDUSS Output ----------------------------------------------->"
"               MIDUSS version                          Version 2.25  rev. 473"
"               MIDUSS created                       Sunday, February 07, 2010"
"          10   Units used:                                          ie METRIC"
"               Job folder:        C:\Users\smalicevic\Desktop\MIDUSS\121139\"
"                                                                   2022-03-04"
"               Output filename:            121139 5-yr post SM Mar 4 2.out"
"               Licensee name:                                            gmbp"
"               Company                                                       "
"               Date & Time last used:                  3/4/2022 at 8:58:08 AM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      210.000   Max. Storm length"
"     4280.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     1593.000   Coefficient A"
"       11.000   Constant B"
"        0.879   Exponent C"
"        0.400   Fraction R"
"      170.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity           134.894    mm/hr"
"             Total depth                  46.775    mm"
"            6   005hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 200"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          200   Catch 200 Apartment Rooftops"
"      100.000   % Impervious"
"        0.240   Total Area"
"       10.000   Flow length"
"        1.000   Overland Slope"
"        0.000   Pervious Area"
"       10.000   Pervious length"
"        1.000   Pervious slope"
"        0.240   Impervious Area"
"       10.000   Impervious length"
"        1.000   Impervious slope"
"        0.300   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
```

```
"                    0.077     0.000     0.000     0.000 c.m/sec"
"            Catchment 200          Pervious   Impervious Total Area "
"            Surface Area           0.000      0.240      0.240      hectare"
"            Time of concentration  10.913     1.150      1.150      minutes"
"            Time to Centroid       84.773     81.244     81.244     minutes"
"            Rainfall depth         46.775     46.775     46.775     mm"
"            Rainfall volume        0.00       112.26     112.26     c.m"
"            Rainfall losses        35.901     2.639      2.639      mm"
"            Runoff depth           10.874     44.136     44.136     mm"
"            Runoff volume          0.00       105.93     105.93     c.m"
"            Runoff coefficient     0.000      0.944      0.944      "
"            Maximum flow           0.000      0.077      0.077      c.m/sec"
" 40         HYDROGRAPH Add Runoff "
"           4   Add Runoff "
"                    0.077     0.077     0.000     0.000"
" 54         POND DESIGN"
"       0.077   Current peak flow    c.m/sec"
"       0.030   Target outflow    c.m/sec"
"       105.9   Hydrograph volume    c.m"
"          5.   Number of stages"
"       0.000   Minimum water level    metre"
"       3.000   Maximum water level    metre"
"       0.000   Starting water level    metre"
"           0   Keep Design Data: 1 = True; 0 = False"
"                 Level Discharge    Volume"
"                 0.000     0.000     0.000"
"               0.02500   0.01300    60.000"
"               0.05000   0.02600   120.000"
"               0.07500   0.03900   180.000"
"                0.1000   0.05300   240.000"
"            Peak outflow                 0.014    c.m/sec"
"            Maximum level                0.027    metre"
"            Maximum storage             64.099    c.m"
"            Centroidal lag               2.636   hours"
"                 0.077     0.077     0.014     0.000 c.m/sec"
" 40         HYDROGRAPH Next link "
"           5   Next link "
"                    0.077     0.014     0.014     0.000"
" 54         POND DESIGN"
"       0.014   Current peak flow    c.m/sec"
"       0.030   Target outflow    c.m/sec"
"       105.9   Hydrograph volume    c.m"
"         15.   Number of stages"
"       0.000   Minimum water level    metre"
"       1.720   Maximum water level    metre"
"       0.000   Starting water level    metre"
"           0   Keep Design Data: 1 = True; 0 = False"
"                 Level Discharge    Volume"
"               341.300   0.00019     0.000"
"               341.400   0.00019     3.400"
```

```
"                341.500   0.00019     6.800"
"                341.600   0.00019    10.200"
"                341.700   0.00019    13.600"
"                341.800   0.00019    17.000"
"                341.900   0.00019    20.400"
"                342.000   0.00019    23.800"
"                342.050   0.00019    25.500"
"                342.060   0.00019    26.000"
"                342.310   0.07169    26.500"
"                342.390    0.1432    27.000"
"                342.490    0.1432    27.500"
"                342.590    0.1432    28.000"
"                343.020    0.1432    28.500"
"             Peak outflow                  0.013    c.m/sec"
"             Maximum level               342.107    metre"
"             Maximum storage              26.093    c.m"
"             Centroidal lag                9.330   hours"
"                  0.077     0.014     0.013     0.000 c.m/sec"
" 40          HYDROGRAPH   Combine    2000"
"            6   Combine "
"         2000   Node #"
"                Outlet To Landsdown Storm System"
"             Maximum flow                  0.013    c.m/sec"
"             Hydrograph volume           104.238    c.m"
"                     0.077     0.014     0.013     0.013"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.077     0.000     0.013     0.013"
" 33          CATCHMENT 203"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          203   Catch 203 Remainder of Apartment Block"
"       90.000   % Impervious"
"        0.400   Total Area"
"       30.000   Flow length"
"        3.000   Overland Slope"
"        0.040   Pervious Area"
"       30.000   Pervious length"
"        3.000   Pervious slope"
"        0.360   Impervious Area"
"       30.000   Impervious length"
"        3.000   Impervious slope"
"        0.300   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
```

```
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.112     0.000     0.013     0.013 c.m/sec"
"              Catchment 203          Pervious   Impervious Total Area "
"              Surface Area           0.040      0.360      0.400      hectare"
"              Time of concentration  15.173     1.599      1.956      minutes"
"              Time to Centroid       88.550     81.788     81.966     minutes"
"              Rainfall depth         46.775     46.775     46.775     mm"
"              Rainfall volume        18.71      168.39     187.10     c.m"
"              Rainfall losses        35.918     2.140      5.517      mm"
"              Runoff depth           10.857     44.636     41.258     mm"
"              Runoff volume          4.34       160.69     165.03     c.m"
"              Runoff coefficient     0.232      0.954      0.882      "
"              Maximum flow           0.003      0.112      0.112      c.m/sec"
" 40           HYDROGRAPH Add Runoff "
"             4   Add Runoff "
"                     0.112     0.112     0.013     0.013"
" 40           HYDROGRAPH Copy to Outflow"
"             8   Copy to Outflow"
"                     0.112     0.112     0.112     0.013"
" 40           HYDROGRAPH   Combine    2000"
"             6   Combine "
"          2000   Node #"
"                 Outlet To Landsdown Storm System"
"              Maximum flow                  0.112    c.m/sec"
"              Hydrograph volume           269.273    c.m"
"                     0.112     0.112     0.112     0.112"
" 40           HYDROGRAPH Start - New Tributary"
"             2   Start - New Tributary"
"                     0.112     0.000     0.112     0.112"
" 33           CATCHMENT 202"
"             1   Triangular SCS"
"             1   Equal length"
"             2   Horton equation"
"           202   Catch 202 Townhouse Block to Rear"
"       60.000   % Impervious"
"        0.170   Total Area"
"       15.000   Flow length"
"        3.000   Overland Slope"
"        0.068   Pervious Area"
"       15.000   Pervious length"
"        3.000   Pervious slope"
"        0.102   Impervious Area"
"       15.000   Impervious length"
"        3.000   Impervious slope"
"        0.300   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
```

```
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.034     0.000     0.112     0.112 c.m/sec"
"              Catchment 202          Pervious   Impervious Total Area "
"              Surface Area           0.068      0.102      0.170      hectare"
"              Time of concentration  10.010     1.055      2.315      minutes"
"              Time to Centroid       83.897     81.099     81.492     minutes"
"              Rainfall depth         46.775     46.775     46.775     mm"
"              Rainfall volume        31.81      47.71      79.52      c.m"
"              Rainfall losses        35.989     2.874      16.120     mm"
"              Runoff depth           10.786     43.902     30.655     mm"
"              Runoff volume          7.33       44.78      52.11      c.m"
"              Runoff coefficient     0.231      0.939      0.655      "
"              Maximum flow           0.007      0.033      0.034      c.m/sec"
" 40           HYDROGRAPH Add Runoff "
"             4   Add Runoff "
"                     0.034     0.034     0.112     0.112"
" 40           HYDROGRAPH Copy to Outflow"
"             8   Copy to Outflow"
"                     0.034     0.034     0.034     0.112"
" 40           HYDROGRAPH   Combine    2000"
"             6   Combine "
"         2000   Node #"
"                 Outlet To Landsdown Storm System"
"              Maximum flow                  0.146    c.m/sec"
"              Hydrograph volume           321.386    c.m"
"                     0.034     0.034     0.034     0.146"
" 40           HYDROGRAPH   Confluence    2000"
"             7   Confluence "
"         2000   Node #"
"                 Outlet To Landsdown Storm System"
"              Maximum flow                  0.146    c.m/sec"
"              Hydrograph volume           321.386    c.m"
"                     0.034     0.146     0.034     0.000"
" 54           POND DESIGN"
"        0.146   Current peak flow    c.m/sec"
"        0.200   Target outflow    c.m/sec"
"        321.4   Hydrograph volume    c.m"
"          19.   Number of stages"
"        0.000   Minimum water level    metre"
"        3.000   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                   Level Discharge    Volume"
"                 341.000     0.000     0.000"
"                 341.150   0.01800    17.850"
```

```
"               341.250   0.03000    29.750"
"               341.500   0.04800    59.500"
"               341.750   0.06100    89.250"
"               341.850   0.06500   101.150"
"               341.950   0.07000   113.050"
"               342.300   0.08300   154.700"
"               342.500   0.08900   166.700"
"               342.510   0.09000   166.710"
"               342.600   0.09200   166.800"
"               342.850    0.1000   167.050"
"               343.020    0.1050   167.220"
"               343.030    0.1050   167.230"
"               343.070    0.1060   167.870"
"               343.200    0.1090   178.270"
"               343.250    0.2020   185.670"
"               343.300    0.3720   194.970"
"               343.320    0.4550   199.070"
"            Peak outflow                 0.059    c.m/sec"
"            Maximum level              341.713    metre"
"            Maximum storage             84.792    c.m"
"            Centroidal lag               4.267   hours"
"                 0.034     0.146     0.059     0.000 c.m/sec"
" 40         HYDROGRAPH   Combine    3000"
"           6   Combine "
"        3000   Node #"
"               Total Flow Leaving Site"
"            Maximum flow                 0.059    c.m/sec"
"            Hydrograph volume          321.192    c.m"
"                    0.034     0.146     0.059     0.059"
" 40         HYDROGRAPH Start - New Tributary"
"           2   Start - New Tributary"
"                    0.034     0.000     0.059     0.059"
" 33         CATCHMENT 201"
"           1   Triangular SCS"
"           1   Equal length"
"           2   Horton equation"
"         201   Catch 201 Townhouse Block to Landsdown"
"      85.000   % Impervious"
"       0.170   Total Area"
"      11.000   Flow length"
"       5.000   Overland Slope"
"       0.025   Pervious Area"
"      11.000   Pervious length"
"       5.000   Pervious slope"
"       0.145   Impervious Area"
"      11.000   Impervious length"
"       5.000   Impervious slope"
"       0.300   Pervious Manning 'n'"
"      75.000   Pervious Max.infiltration"
"      12.500   Pervious Min.infiltration"
```

```
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.047     0.000     0.059     0.059 c.m/sec"
"             Catchment 201          Pervious   Impervious Total Area "
"             Surface Area           0.025      0.145      0.170      hectare"
"             Time of concentration  7.130      0.751      1.023      minutes"
"             Time to Centroid       81.566     80.775     80.808     minutes"
"             Rainfall depth         46.775     46.775     46.775     mm"
"             Rainfall volume        11.93      67.59      79.52      c.m"
"             Rainfall losses        36.010     4.036      8.832      mm"
"             Runoff depth           10.765     42.739     37.943     mm"
"             Runoff volume          2.75       61.76      64.50      c.m"
"             Runoff coefficient     0.230      0.914      0.811      "
"             Maximum flow           0.003      0.047      0.047      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.047     0.047     0.059     0.059"
" 33          CATCHMENT 204"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          204   South Easement"
"       20.000   % Impervious"
"        0.140   Total Area"
"        7.000   Flow length"
"        2.000   Overland Slope"
"        0.112   Pervious Area"
"        7.000   Pervious length"
"        2.000   Pervious slope"
"        0.028   Impervious Area"
"        7.000   Impervious length"
"        2.000   Impervious slope"
"        0.300   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.017     0.047     0.059     0.059 c.m/sec"
"             Catchment 204          Pervious   Impervious Total Area "
"             Surface Area           0.112      0.028      0.140      hectare"
```

```
"              Time of concentration  7.156      0.754      3.968      minutes"
"              Time to Centroid       81.596     80.774     81.187     minutes"
"              Rainfall depth         46.775     46.775     46.775     mm"
"              Rainfall volume        52.39      13.10      65.49      c.m"
"              Rainfall losses        36.003     4.021      29.607     mm"
"              Runoff depth           10.772     42.754     17.168     mm"
"              Runoff volume          12.06      11.97      24.04      c.m"
"              Runoff coefficient     0.230      0.914      0.367      "
"              Maximum flow           0.014      0.009      0.017      c.m/sec"
" 40           HYDROGRAPH Add Runoff "
"             4   Add Runoff "
"                      0.017     0.059     0.059     0.059"
" 40           HYDROGRAPH Copy to Outflow"
"             8   Copy to Outflow"
"                      0.017     0.059     0.059     0.059"
" 40           HYDROGRAPH   Combine    3000"
"             6   Combine "
"          3000   Node #"
"                 Total Flow Leaving Site"
"              Maximum flow                  0.101    c.m/sec"
"              Hydrograph volume           409.729    c.m"
"                      0.017     0.059     0.059     0.101"
" 38           START/RE-START TOTALS 204"
"             3   Runoff Totals on EXIT"
"              Total Catchment area                        1.120    hectare"
"              Total Impervious area                       0.874    hectare"
"              Total % impervious                         78.080"
" 19           EXIT"
```

```
"                MIDUSS Output ----------------------------------------------->"
"                MIDUSS version                            Version 2.25  rev. 473"
"                MIDUSS created                        Sunday, February 07, 2010"
"           10   Units used:                                           ie METRIC"
"                Job folder:         C:\Users\smalicevic\Desktop\MIDUSS\121139\"
"                                                                     2022-03-04"
"                Output filename:            121139 25-yr post SM Mar 4 2.out"
"                Licensee name:                                             gmbp"
"                Company                                                        "
"                Date & Time last used:                     3/4/2022 at 8:50:44 AM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      210.000   Max. Storm length"
"     4280.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     3158.000   Coefficient A"
"       15.000   Constant B"
"        0.936   Exponent C"
"        0.400   Fraction R"
"      210.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity           169.546    mm/hr"
"             Total depth                  69.476    mm"
"            6   025hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 200"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          200   Catch 200 Apartment Rooftops"
"      100.000   % Impervious"
"        0.240   Total Area"
"       10.000   Flow length"
"        1.000   Overland Slope"
"        0.000   Pervious Area"
"       10.000   Pervious length"
"        1.000   Pervious slope"
"        0.240   Impervious Area"
"       10.000   Impervious length"
"        1.000   Impervious slope"
"        0.300   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
```

```
"                      0.098     0.000     0.000     0.000 c.m/sec"
"              Catchment 200          Pervious   Impervious Total Area "
"              Surface Area           0.000      0.240      0.240      hectare"
"              Time of concentration  8.005      1.050      1.050      minutes"
"              Time to Centroid       99.905     97.326     97.326     minutes"
"              Rainfall depth         69.476     69.476     69.476     mm"
"              Rainfall volume        0.00       166.74     166.74     c.m"
"              Rainfall losses        40.831     3.655      3.655      mm"
"              Runoff depth           28.646     65.821     65.821     mm"
"              Runoff volume          0.00       157.97     157.97     c.m"
"              Runoff coefficient     0.000      0.947      0.947      "
"              Maximum flow           0.000      0.098      0.098      c.m/sec"
" 40           HYDROGRAPH Add Runoff "
"             4   Add Runoff "
"                      0.098     0.098     0.000     0.000"
" 54           POND DESIGN"
"        0.098   Current peak flow    c.m/sec"
"        0.030   Target outflow    c.m/sec"
"        158.0   Hydrograph volume    c.m"
"           5.   Number of stages"
"        0.000   Minimum water level    metre"
"        3.000   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                  Level Discharge    Volume"
"                  0.000     0.000     0.000"
"                0.02500   0.01300    60.000"
"                0.05000   0.02600   120.000"
"                0.07500   0.03900   180.000"
"                 0.1000   0.05300   240.000"
"              Peak outflow                  0.020    c.m/sec"
"              Maximum level                 0.039    metre"
"              Maximum storage              94.387    c.m"
"              Centroidal lag                2.904   hours"
"                  0.098     0.098     0.020     0.000 c.m/sec"
" 40           HYDROGRAPH Next link "
"             5   Next link "
"                      0.098     0.020     0.020     0.000"
" 54           POND DESIGN"
"        0.020   Current peak flow    c.m/sec"
"        0.030   Target outflow    c.m/sec"
"        158.0   Hydrograph volume    c.m"
"          15.   Number of stages"
"        0.000   Minimum water level    metre"
"        1.720   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                  Level Discharge    Volume"
"                341.300   0.00019     0.000"
"                341.400   0.00019     3.400"
```

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"                341.500   0.00019     6.800"
"                341.600   0.00019    10.200"
"                341.700   0.00019    13.600"
"                341.800   0.00019    17.000"
"                341.900   0.00019    20.400"
"                342.000   0.00019    23.800"
"                342.050   0.00019    25.500"
"                342.060   0.00019    26.000"
"                342.310   0.07169    26.500"
"                342.390    0.1432    27.000"
"                342.490    0.1432    27.500"
"                342.590    0.1432    28.000"
"                343.020    0.1432    28.500"
"             Peak outflow                 0.020    c.m/sec"
"             Maximum level              342.131    metre"
"             Maximum storage             26.141    c.m"
"             Centroidal lag               7.527   hours"
"                  0.098     0.020     0.020     0.000 c.m/sec"
" 40          HYDROGRAPH   Combine    2000"
"            6   Combine "
"         2000   Node #"
"                Outlet To Landsdown Storm System"
"             Maximum flow                 0.020    c.m/sec"
"             Hydrograph volume          155.090    c.m"
"                     0.098     0.020     0.020     0.020"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.098     0.000     0.020     0.020"
" 33          CATCHMENT 203"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          203   Catch 203 Remainder of Apartment Block"
"       90.000   % Impervious"
"        0.400   Total Area"
"       30.000   Flow length"
"        3.000   Overland Slope"
"        0.040   Pervious Area"
"       30.000   Pervious length"
"        3.000   Pervious slope"
"        0.360   Impervious Area"
"       30.000   Impervious length"
"        3.000   Impervious slope"
"        0.300   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
```

```
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.150     0.000     0.020     0.020 c.m/sec"
"             Catchment 203          Pervious   Impervious Total Area "
"             Surface Area           0.040      0.360      0.400      hectare"
"             Time of concentration  11.130     1.459      1.899      minutes"
"             Time to Centroid       102.628    97.778     97.998     minutes"
"             Rainfall depth         69.476     69.476     69.476     mm"
"             Rainfall volume        27.79      250.12     277.91     c.m"
"             Rainfall losses        40.827     2.549      6.377      mm"
"             Runoff depth           28.649     66.928     63.100     mm"
"             Runoff volume          11.46      240.94     252.40     c.m"
"             Runoff coefficient     0.412      0.963      0.908      "
"             Maximum flow           0.009      0.144      0.150      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.150     0.150     0.020     0.020"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.150     0.150     0.150     0.020"
" 40          HYDROGRAPH   Combine    2000"
"            6   Combine "
"         2000   Node #"
"                Outlet To Landsdown Storm System"
"             Maximum flow                  0.150    c.m/sec"
"             Hydrograph volume           407.492    c.m"
"                     0.150     0.150     0.150     0.150"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.150     0.000     0.150     0.150"
" 33          CATCHMENT 202"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          202   Catch 202 Townhouse Block to Rear"
"       60.000   % Impervious"
"        0.170   Total Area"
"       15.000   Flow length"
"        3.000   Overland Slope"
"        0.068   Pervious Area"
"       15.000   Pervious length"
"        3.000   Pervious slope"
"        0.102   Impervious Area"
"       15.000   Impervious length"
"        3.000   Impervious slope"
"        0.300   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
```

```
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.052     0.000     0.150     0.150 c.m/sec"
"              Catchment 202          Pervious   Impervious Total Area "
"              Surface Area           0.068      0.102      0.170      hectare"
"              Time of concentration  7.343      0.963      2.394      minutes"
"              Time to Centroid       99.157     97.210     97.647     minutes"
"              Rainfall depth         69.476     69.476     69.476     mm"
"              Rainfall volume        47.24      70.87      118.11     c.m"
"              Rainfall losses        41.117     4.103      18.908     mm"
"              Runoff depth           28.359     65.374     50.568     mm"
"              Runoff volume          19.28      66.68      85.97      c.m"
"              Runoff coefficient     0.408      0.941      0.728      "
"              Maximum flow           0.019      0.042      0.052      c.m/sec"
" 40           HYDROGRAPH Add Runoff "
"             4   Add Runoff "
"                     0.052     0.052     0.150     0.150"
" 40           HYDROGRAPH Copy to Outflow"
"             8   Copy to Outflow"
"                     0.052     0.052     0.052     0.150"
" 40           HYDROGRAPH   Combine    2000"
"             6   Combine "
"          2000   Node #"
"                 Outlet To Landsdown Storm System"
"              Maximum flow                 0.202    c.m/sec"
"              Hydrograph volume          493.458    c.m"
"                     0.052     0.052     0.052     0.202"
" 40           HYDROGRAPH   Confluence    2000"
"             7   Confluence "
"          2000   Node #"
"                 Outlet To Landsdown Storm System"
"              Maximum flow                 0.202    c.m/sec"
"              Hydrograph volume          493.458    c.m"
"                     0.052     0.202     0.052     0.000"
" 54           POND DESIGN"
"        0.202   Current peak flow    c.m/sec"
"        0.200   Target outflow    c.m/sec"
"        493.5   Hydrograph volume    c.m"
"          19.   Number of stages"
"        0.000   Minimum water level    metre"
"        3.000   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                   Level Discharge    Volume"
"                 341.000     0.000     0.000"
"                 341.150   0.01800    17.850"
```

```
"                341.250   0.03000    29.750"
"                341.500   0.04800    59.500"
"                341.750   0.06100    89.250"
"                341.850   0.06500   101.150"
"                341.950   0.07000   113.050"
"                342.300   0.08300   154.700"
"                342.500   0.08900   166.700"
"                342.510   0.09000   166.710"
"                342.600   0.09200   166.800"
"                342.850    0.1000   167.050"
"                343.020    0.1050   167.220"
"                343.030    0.1050   167.230"
"                343.070    0.1060   167.870"
"                343.200    0.1090   178.270"
"                343.250    0.2020   185.670"
"                343.300    0.3720   194.970"
"                343.320    0.4550   199.070"
"             Peak outflow                 0.079    c.m/sec"
"             Maximum level              342.185    metre"
"             Maximum storage            141.059    c.m"
"             Centroidal lag               3.859   hours"
"                  0.052     0.202     0.079     0.000 c.m/sec"
" 40          HYDROGRAPH   Combine    3000"
"            6   Combine "
"         3000   Node #"
"                Total Flow Leaving Site"
"             Maximum flow                 0.079    c.m/sec"
"             Hydrograph volume          493.544    c.m"
"                     0.052     0.202     0.079     0.079"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.052     0.000     0.079     0.079"
" 33          CATCHMENT 201"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          201   Catch 201 Townhouse Block to Landsdown"
"       85.000   % Impervious"
"        0.170   Total Area"
"       11.000   Flow length"
"        5.000   Overland Slope"
"        0.025   Pervious Area"
"       11.000   Pervious length"
"        5.000   Pervious slope"
"        0.145   Impervious Area"
"       11.000   Impervious length"
"        5.000   Impervious slope"
"        0.300   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
```

```
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.061     0.000     0.079     0.079 c.m/sec"
"             Catchment 201          Pervious   Impervious Total Area "
"             Surface Area           0.025      0.145      0.170      hectare"
"             Time of concentration  5.230      0.686      1.022      minutes"
"             Time to Centroid       97.133     96.896     96.913     minutes"
"             Rainfall depth         69.476     69.476     69.476     mm"
"             Rainfall volume        17.72      100.39     118.11     c.m"
"             Rainfall losses        40.897     6.309      11.497     mm"
"             Runoff depth           28.579     63.168     57.979     mm"
"             Runoff volume          7.29       91.28      98.57      c.m"
"             Runoff coefficient     0.411      0.909      0.835      "
"             Maximum flow           0.007      0.059      0.061      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.061     0.061     0.079     0.079"
" 33          CATCHMENT 204"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          204   South Easement"
"       20.000   % Impervious"
"        0.140   Total Area"
"        7.000   Flow length"
"        2.000   Overland Slope"
"        0.112   Pervious Area"
"        7.000   Pervious length"
"        2.000   Pervious slope"
"        0.028   Impervious Area"
"        7.000   Impervious length"
"        2.000   Impervious slope"
"        0.300   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.039     0.061     0.079     0.079 c.m/sec"
"             Catchment 204          Pervious   Impervious Total Area "
"             Surface Area           0.112      0.028      0.140      hectare"
```

```
"              Time of concentration  5.250      0.688      3.626      minutes"
"              Time to Centroid       97.153     96.895     97.061     minutes"
"              Rainfall depth         69.476     69.476     69.476     mm"
"              Rainfall volume        77.81      19.45      97.27      c.m"
"              Rainfall losses        40.895     6.281      33.973     mm"
"              Runoff depth           28.581     63.195     35.504     mm"
"              Runoff volume          32.01      17.69      49.71      c.m"
"              Runoff coefficient     0.411      0.910      0.511      "
"              Maximum flow           0.029      0.011      0.039      c.m/sec"
" 40           HYDROGRAPH Add Runoff "
"             4   Add Runoff "
"                     0.039     0.095     0.079     0.079"
" 40           HYDROGRAPH Copy to Outflow"
"             8   Copy to Outflow"
"                     0.039     0.095     0.095     0.079"
" 40           HYDROGRAPH   Combine    3000"
"             6   Combine "
"          3000   Node #"
"                 Total Flow Leaving Site"
"              Maximum flow                 0.159    c.m/sec"
"              Hydrograph volume          641.813    c.m"
"                     0.039     0.095     0.095     0.159"
" 38           START/RE-START TOTALS 204"
"             3   Runoff Totals on EXIT"
"              Total Catchment area                       1.120    hectare"
"              Total Impervious area                      0.874    hectare"
"              Total % impervious                        78.080"
" 19           EXIT"
```

```
"               MIDUSS Output ----------------------------------------------->"
"               MIDUSS version                         Version 2.25  rev. 473"
"               MIDUSS created                      Sunday, February 07, 2010"
"          10   Units used:                                        ie METRIC"
"               Job folder:        C:\Users\smalicevic\Desktop\MIDUSS\121139\"
"                                                                  2022-03-04"
"               Output filename:             121139 100-yr post SM Mar 4.out"
"               Licensee name:                                          gmbp"
"               Company                                                     "
"               Date & Time last used:                 3/4/2022 at 8:49:18 AM"
" 31         TIME PARAMETERS"
"        5.000   Time Step"
"      210.000   Max. Storm length"
"     4280.000   Max. Hydrograph"
" 32         STORM Chicago storm"
"            1   Chicago storm"
"     4688.000   Coefficient A"
"       17.000   Constant B"
"        0.962   Exponent C"
"        0.400   Fraction R"
"      210.000   Duration"
"        1.000   Time step multiplier"
"            Maximum intensity           213.574    mm/hr"
"            Total depth                  88.830    mm"
"            6   100hyd   Hydrograph extension used in this file"
" 33         CATCHMENT 200"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          200   Catch 200 Apartment Rooftops"
"      100.000   % Impervious"
"        0.240   Total Area"
"       10.000   Flow length"
"        1.000   Overland Slope"
"        0.000   Pervious Area"
"       10.000   Pervious length"
"        1.000   Pervious slope"
"        0.240   Impervious Area"
"       10.000   Impervious length"
"        1.000   Impervious slope"
"        0.300   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
```

```
"                     0.124     0.000     0.000     0.000 c.m/sec"
"             Catchment 200          Pervious   Impervious Total Area "
"             Surface Area           0.000      0.240      0.240      hectare"
"             Time of concentration  6.611      0.957      0.957      minutes"
"             Time to Centroid       99.535     96.633     96.633     minutes"
"             Rainfall depth         88.830     88.830     88.830     mm"
"             Rainfall volume        0.00       213.19     213.19     c.m"
"             Rainfall losses        43.947     4.892      4.892      mm"
"             Runoff depth           44.883     83.938     83.938     mm"
"             Runoff volume          0.00       201.45     201.45     c.m"
"             Runoff coefficient     0.000      0.945      0.945      "
"             Maximum flow           0.000      0.124      0.124      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.124     0.124     0.000     0.000"
" 54          POND DESIGN"
"        0.124   Current peak flow    c.m/sec"
"        0.030   Target outflow    c.m/sec"
"        201.5   Hydrograph volume    c.m"
"           5.   Number of stages"
"        0.000   Minimum water level    metre"
"        3.000   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                  Level Discharge    Volume"
"                  0.000     0.000     0.000"
"                0.02500   0.01300    60.000"
"                0.05000   0.02600   120.000"
"                0.07500   0.03900   180.000"
"                 0.1000   0.05300   240.000"
"             Peak outflow                  0.026    c.m/sec"
"             Maximum level                 0.050    metre"
"             Maximum storage             120.706    c.m"
"             Centroidal lag                2.893   hours"
"                  0.124     0.124     0.026     0.000 c.m/sec"
" 40          HYDROGRAPH Next link "
"            5   Next link "
"                     0.124     0.026     0.026     0.000"
" 54          POND DESIGN"
"        0.026   Current peak flow    c.m/sec"
"        0.030   Target outflow    c.m/sec"
"        201.5   Hydrograph volume    c.m"
"          15.   Number of stages"
"        0.000   Minimum water level    metre"
"        1.720   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                  Level Discharge    Volume"
"                341.300   0.00019     0.000"
"                341.400   0.00019     3.400"
```

```
"                341.500   0.00019     6.800"
"                341.600   0.00019    10.200"
"                341.700   0.00019    13.600"
"                341.800   0.00019    17.000"
"                341.900   0.00019    20.400"
"                342.000   0.00019    23.800"
"                342.050   0.00019    25.500"
"                342.060   0.00019    26.000"
"                342.310   0.07169    26.500"
"                342.390    0.1432    27.000"
"                342.490    0.1432    27.500"
"                342.590    0.1432    28.000"
"                343.020    0.1432    28.500"
"             Peak outflow                  0.026    c.m/sec"
"             Maximum level               342.151    metre"
"             Maximum storage              26.181    c.m"
"             Centroidal lag                6.562   hours"
"                  0.124     0.026     0.026     0.000 c.m/sec"
" 40          HYDROGRAPH   Combine    2000"
"            6   Combine "
"         2000   Node #"
"                Outlet To Landsdown Storm System"
"             Maximum flow                  0.026    c.m/sec"
"             Hydrograph volume           198.113    c.m"
"                     0.124     0.026     0.026     0.026"
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.124     0.000     0.026     0.026"
" 33          CATCHMENT 203"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          203   Catch 203 Remainder of Apartment Block"
"       90.000   % Impervious"
"        0.400   Total Area"
"       30.000   Flow length"
"        3.000   Overland Slope"
"        0.040   Pervious Area"
"       30.000   Pervious length"
"        3.000   Pervious slope"
"        0.360   Impervious Area"
"       30.000   Impervious length"
"        3.000   Impervious slope"
"        0.300   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
```

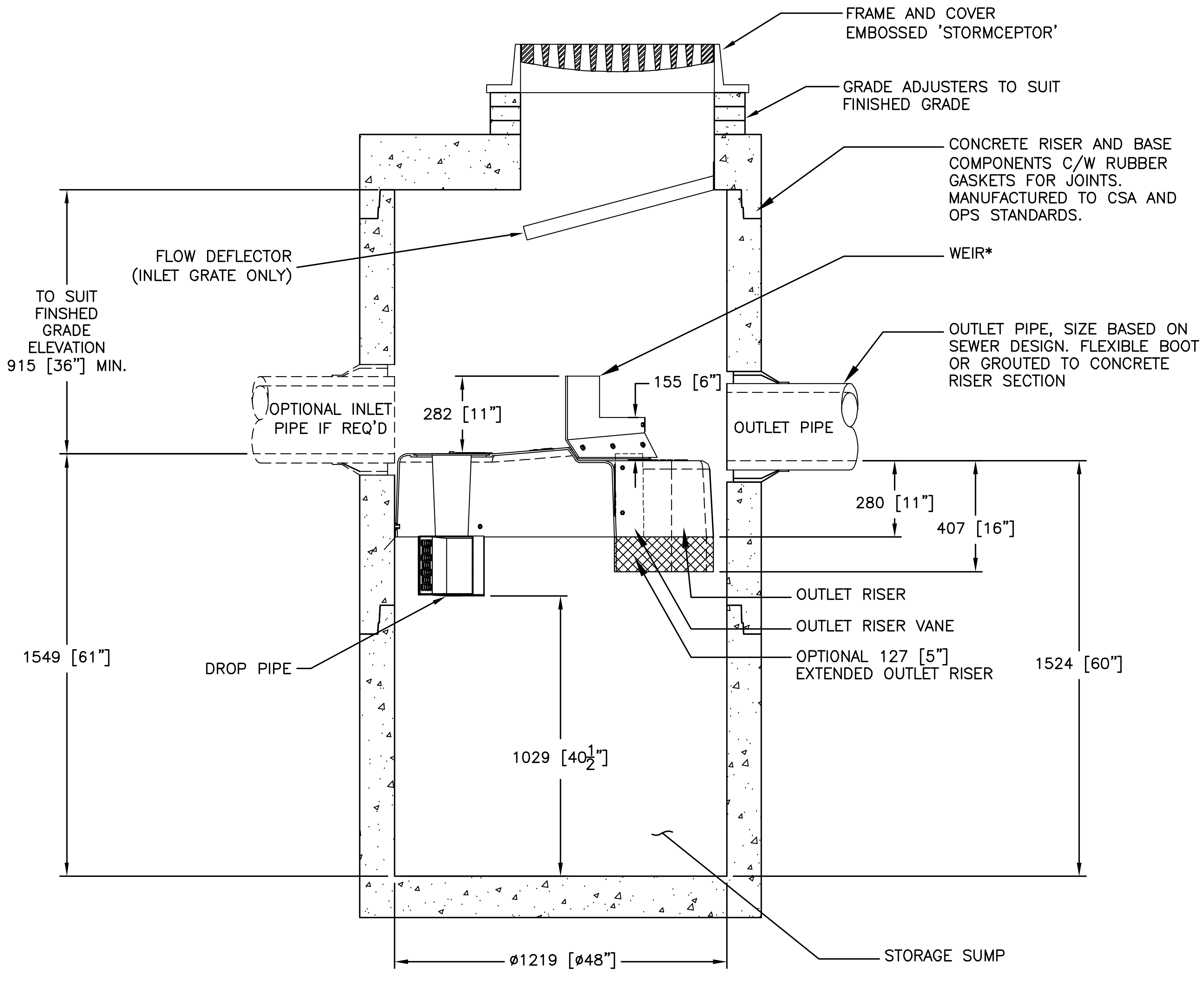
```
"         0.000   Impervious Min.infiltration"
"         0.001   Impervious Lag constant (hours)"
"         1.500   Impervious Depression storage"
"                       0.192     0.000     0.026     0.026 c.m/sec"
"              Catchment 203          Pervious   Impervious Total Area "
"              Surface Area           0.040      0.360      0.400      hectare"
"              Time of concentration  9.192      1.331      1.765      minutes"
"              Time to Centroid       102.017    97.031     97.307     minutes"
"              Rainfall depth         88.830     88.830     88.830     mm"
"              Rainfall volume        35.53      319.79     355.32     c.m"
"              Rainfall losses        43.671     3.096      7.154      mm"
"              Runoff depth           45.159     85.733     81.676     mm"
"              Runoff volume          18.06      308.64     326.70     c.m"
"              Runoff coefficient     0.508      0.965      0.919      "
"              Maximum flow           0.014      0.183      0.192      c.m/sec"
" 40           HYDROGRAPH Add Runoff "
"             4   Add Runoff "
"                       0.192     0.192     0.026     0.026"
" 40           HYDROGRAPH Copy to Outflow"
"             8   Copy to Outflow"
"                       0.192     0.192     0.192     0.026"
" 40           HYDROGRAPH   Combine    2000"
"             6   Combine "
"          2000   Node #"
"                 Outlet To Landsdown Storm System"
"              Maximum flow                  0.192    c.m/sec"
"              Hydrograph volume           524.817    c.m"
"                       0.192     0.192     0.192     0.192"
" 40           HYDROGRAPH Start - New Tributary"
"             2   Start - New Tributary"
"                       0.192     0.000     0.192     0.192"
" 33           CATCHMENT 202"
"             1   Triangular SCS"
"             1   Equal length"
"             2   Horton equation"
"           202   Catch 202 Townhouse Block to Rear"
"        60.000   % Impervious"
"         0.170   Total Area"
"        15.000   Flow length"
"         3.000   Overland Slope"
"         0.068   Pervious Area"
"        15.000   Pervious length"
"         3.000   Pervious slope"
"         0.102   Impervious Area"
"        15.000   Impervious length"
"         3.000   Impervious slope"
"         0.300   Pervious Manning 'n'"
"        75.000   Pervious Max.infiltration"
"        12.500   Pervious Min.infiltration"
"         0.250   Pervious Lag constant (hours)"
```

```
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.073     0.000     0.192     0.192 c.m/sec"
"             Catchment 202          Pervious   Impervious Total Area "
"             Surface Area           0.068      0.102      0.170      hectare"
"             Time of concentration  6.065      0.878      2.254      minutes"
"             Time to Centroid       98.913     96.529     97.162     minutes"
"             Rainfall depth         88.830     88.830     88.830     mm"
"             Rainfall volume        60.40      90.61      151.01     c.m"
"             Rainfall losses        43.743     5.562      20.834     mm"
"             Runoff depth           45.087     83.268     67.996     mm"
"             Runoff volume          30.66      84.93      115.59     c.m"
"             Runoff coefficient     0.508      0.937      0.765      "
"             Maximum flow           0.027      0.053      0.073      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.073     0.073     0.192     0.192"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.073     0.073     0.073     0.192"
" 40          HYDROGRAPH   Combine    2000"
"            6   Combine "
"         2000   Node #"
"                Outlet To Landsdown Storm System"
"             Maximum flow                  0.265    c.m/sec"
"             Hydrograph volume           640.409    c.m"
"                     0.073     0.073     0.073     0.265"
" 40          HYDROGRAPH   Confluence    2000"
"            7   Confluence "
"         2000   Node #"
"                Outlet To Landsdown Storm System"
"             Maximum flow                  0.265    c.m/sec"
"             Hydrograph volume           640.409    c.m"
"                     0.073     0.265     0.073     0.000"
" 54          POND DESIGN"
"        0.265   Current peak flow    c.m/sec"
"        0.200   Target outflow    c.m/sec"
"        640.4   Hydrograph volume    c.m"
"          19.   Number of stages"
"        0.000   Minimum water level    metre"
"        3.000   Maximum water level    metre"
"        0.000   Starting water level    metre"
"            0   Keep Design Data: 1 = True; 0 = False"
"                  Level Discharge    Volume"
"                341.000     0.000     0.000"
"                341.150   0.01800    17.850"
```

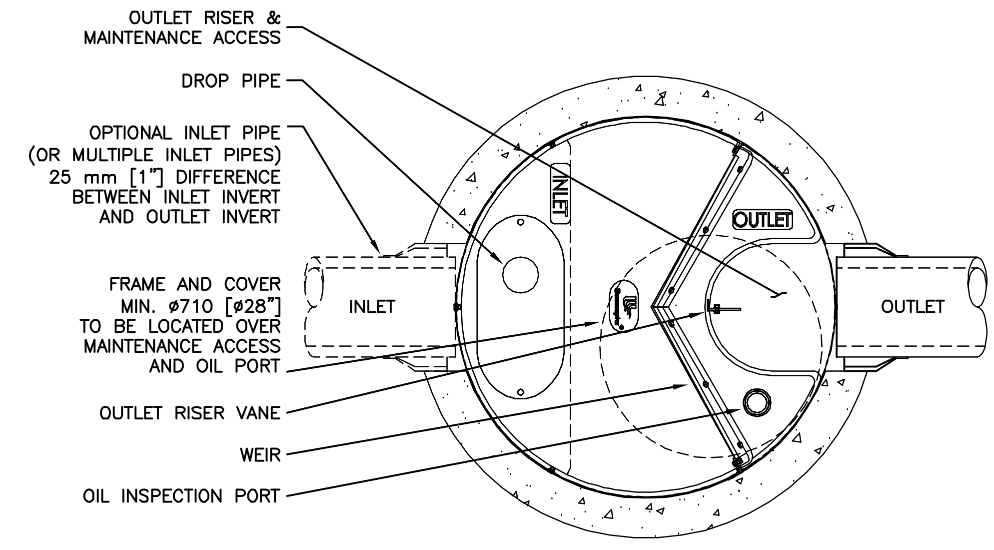
```
"               341.250   0.03000    29.750"
"               341.500   0.04800    59.500"
"               341.750   0.06100    89.250"
"               341.850   0.06500   101.150"
"               341.950   0.07000   113.050"
"               342.300   0.08300   154.700"
"               342.500   0.08900   166.700"
"               342.510   0.09000   166.710"
"               342.600   0.09200   166.800"
"               342.850    0.1000   167.050"
"               343.020    0.1050   167.220"
"               343.030    0.1050   167.230"
"               343.070    0.1060   167.870"
"               343.200    0.1090   178.270"
"               343.250    0.2020   185.670"
"               343.300    0.3720   194.970"
"               343.320    0.4550   199.070"
"            Peak outflow                  0.132    c.m/sec"
"            Maximum level               343.219    metre"
"            Maximum storage             181.085    c.m"
"            Centroidal lag                3.548   hours"
"                 0.073     0.265     0.132     0.000 c.m/sec"
" 40         HYDROGRAPH   Combine    3000"
"           6   Combine "
"        3000   Node #"
"               Total Flow Leaving Site"
"            Maximum flow                  0.132    c.m/sec"
"            Hydrograph volume           638.334    c.m"
"                    0.073     0.265     0.132     0.132"
" 40         HYDROGRAPH Start - New Tributary"
"           2   Start - New Tributary"
"                    0.073     0.000     0.132     0.132"
" 33         CATCHMENT 201"
"           1   Triangular SCS"
"           1   Equal length"
"           2   Horton equation"
"         201   Catch 201 Townhouse Block to Landsdown"
"      85.000   % Impervious"
"       0.170   Total Area"
"      11.000   Flow length"
"       5.000   Overland Slope"
"       0.025   Pervious Area"
"      11.000   Pervious length"
"       5.000   Pervious slope"
"       0.145   Impervious Area"
"      11.000   Impervious length"
"       5.000   Impervious slope"
"       0.300   Pervious Manning 'n'"
"      75.000   Pervious Max.infiltration"
"      12.500   Pervious Min.infiltration"
```

```
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.079     0.000     0.132     0.132 c.m/sec"
"             Catchment 201          Pervious   Impervious Total Area "
"             Surface Area           0.025      0.145      0.170      hectare"
"             Time of concentration  4.320      0.625      0.959      minutes"
"             Time to Centroid       97.133     96.278     96.355     minutes"
"             Rainfall depth         88.830     88.830     88.830     mm"
"             Rainfall volume        22.65      128.36     151.01     c.m"
"             Rainfall losses        43.691     8.704      13.952     mm"
"             Runoff depth           45.139     80.126     74.878     mm"
"             Runoff volume          11.51      115.78     127.29     c.m"
"             Runoff coefficient     0.508      0.902      0.843      "
"             Maximum flow           0.011      0.074      0.079      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.079     0.079     0.132     0.132"
" 33          CATCHMENT 204"
"            1   Triangular SCS"
"            1   Equal length"
"            2   Horton equation"
"          204   South Easement"
"       20.000   % Impervious"
"        0.140   Total Area"
"        7.000   Flow length"
"        2.000   Overland Slope"
"        0.112   Pervious Area"
"        7.000   Pervious length"
"        2.000   Pervious slope"
"        0.028   Impervious Area"
"        7.000   Impervious length"
"        2.000   Impervious slope"
"        0.300   Pervious Manning 'n'"
"       75.000   Pervious Max.infiltration"
"       12.500   Pervious Min.infiltration"
"        0.250   Pervious Lag constant (hours)"
"        5.000   Pervious Depression storage"
"        0.013   Impervious Manning 'n'"
"        0.000   Impervious Max.infiltration"
"        0.000   Impervious Min.infiltration"
"        0.001   Impervious Lag constant (hours)"
"        1.500   Impervious Depression storage"
"                     0.060     0.079     0.132     0.132 c.m/sec"
"             Catchment 204          Pervious   Impervious Total Area "
"             Surface Area           0.112      0.028      0.140      hectare"
```

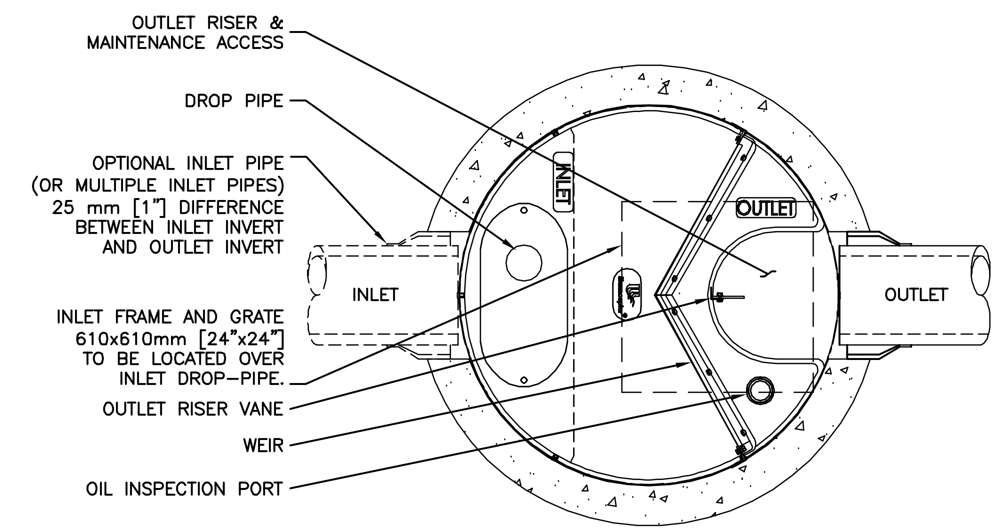
```
"              Time of concentration  4.336      0.628      3.196      minutes"
"              Time to Centroid       97.151     96.278     96.883     minutes"
"              Rainfall depth         88.830     88.830     88.830     mm"
"              Rainfall volume        99.49      24.87      124.36     c.m"
"              Rainfall losses        43.676     8.665      36.674     mm"
"              Runoff depth           45.154     80.164     52.156     mm"
"              Runoff volume          50.57      22.45      73.02      c.m"
"              Runoff coefficient     0.508      0.902      0.587      "
"              Maximum flow           0.048      0.014      0.060      c.m/sec"
" 40           HYDROGRAPH Add Runoff "
"             4   Add Runoff "
"                      0.060     0.133     0.132     0.132"
" 40           HYDROGRAPH Copy to Outflow"
"             8   Copy to Outflow"
"                      0.060     0.133     0.133     0.132"
" 40           HYDROGRAPH   Combine    3000"
"             6   Combine "
"          3000   Node #"
"                 Total Flow Leaving Site"
"              Maximum flow                 0.209    c.m/sec"
"              Hydrograph volume          838.644    c.m"
"                      0.060     0.133     0.133     0.209"
" 38           START/RE-START TOTALS 204"
"             3   Runoff Totals on EXIT"
"              Total Catchment area                     1.120    hectare"
"              Total Impervious area                    0.874    hectare"
"              Total % impervious                      78.080"
" 19           EXIT"
```



SECTION VIEW



PLAN VIEW (STANDARD)



PLAN VIEW (INLET TOP)

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).

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 EF4 AND 535 L/min/m^2 (13.1 gpm/ft^2) FOR STORMCEPTOR EFO4 (OIL CAPTURE CONFIGURATION). WEIR HEIGHT IS 150 mm (6 INCH) FOR EF04.

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 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.

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	EFO4
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	UPDATES	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: 10/13/2017	
DESIGNED: JSK	DRAWN: JSK
CHECKED: BSF	APPROVED: SP
PROJECT No.: EFO4	SEQUENCE No.: *
SHEET: 1 OF 1	

Stormceptor®

FORTERRA

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

02/09/2022

Province:	Ontario
City:	Guelph
Nearest Rainfall Station:	WATERLOO WELLINGTON AP
Climate Station Id:	6149387
Years of Rainfall Data:	34
Site Name:	
Drainage Area (ha):	0.40
% Imperviousness:	90.00

Runoff Coefficient 'c': 0.84

Project Name:	Gordon Street
Project Number:	57660
Designer Name:	Jack Turner
Designer Company:	GM BluePlan ENgineering
Designer Email:	jack.turner@gmblueplan.ca
Designer Phone:	519-824-8150
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Particle Size Distribution:	Fine
Target TSS Removal (%):	80.0
Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	13.38
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	80
EFO6	89
EFO8	94
EFO10	97
EFO12	98

Recommended Stormceptor EFO Model: **EFO4**

Estimated Net Annual Sediment (TSS) Load Reduction (%): **80**

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)

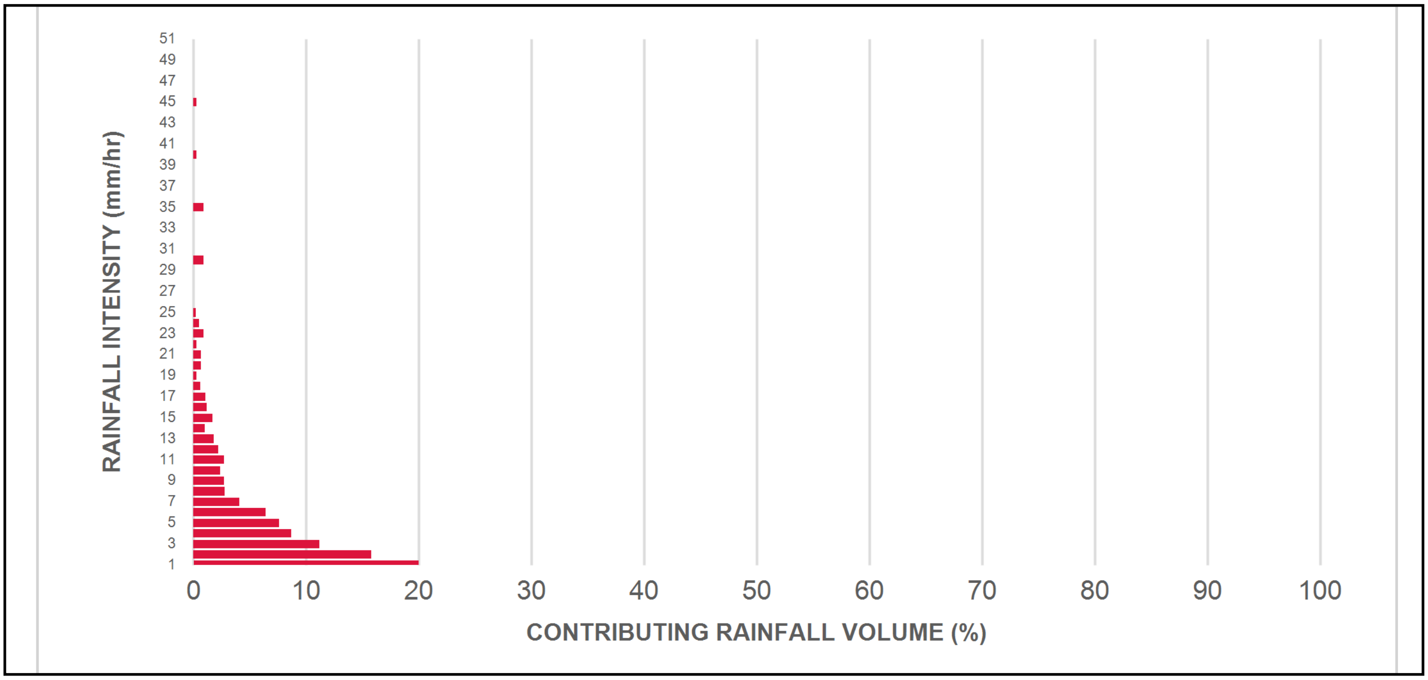
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a 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

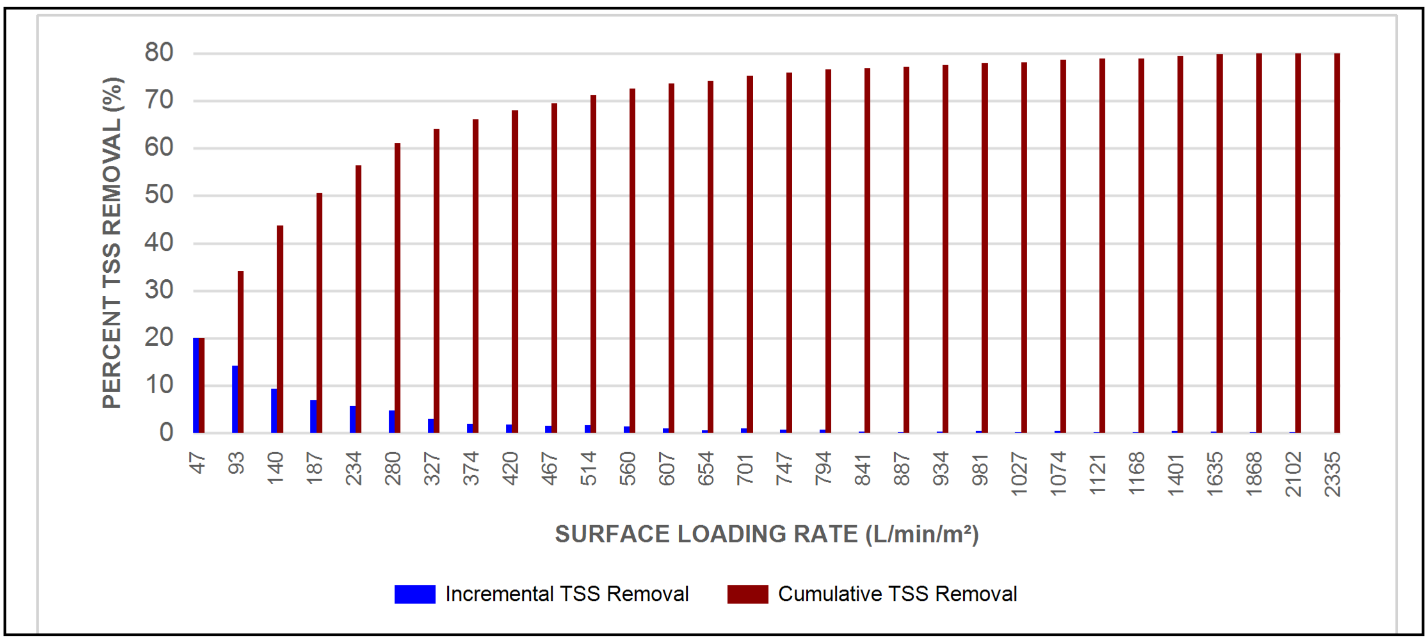
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	20.0	20.0	0.93	56.0	47.0	100	20.0	20.0
2	15.8	35.8	1.87	112.0	93.0	90	14.2	34.2
3	11.2	47.0	2.80	168.0	140.0	84	9.4	43.7
4	8.7	55.7	3.74	224.0	187.0	80	7.0	50.6
5	7.6	63.3	4.67	280.0	234.0	76	5.7	56.4
6	6.4	69.7	5.60	336.0	280.0	74	4.7	61.1
7	4.1	73.8	6.54	392.0	327.0	72	3.0	64.1
8	2.8	76.7	7.47	448.0	374.0	70	2.0	66.1
9	2.7	79.4	8.41	504.0	420.0	68	1.8	67.9
10	2.4	81.7	9.34	560.0	467.0	66	1.6	69.4
11	2.7	84.5	10.27	616.0	514.0	64	1.7	71.2
12	2.2	86.7	11.21	673.0	560.0	62	1.3	72.5
13	1.8	88.4	12.14	729.0	607.0	60	1.1	73.6
14	1.0	89.5	13.08	785.0	654.0	60	0.6	74.2
15	1.7	91.2	14.01	841.0	701.0	59	1.0	75.2
16	1.2	92.3	14.95	897.0	747.0	59	0.7	75.9
17	1.1	93.5	15.88	953.0	794.0	59	0.7	76.6
18	0.6	94.1	16.81	1009.0	841.0	58	0.3	76.9
19	0.3	94.3	17.75	1065.0	887.0	58	0.1	77.1
20	0.7	95.0	18.68	1121.0	934.0	58	0.4	77.5
21	0.7	95.7	19.62	1177.0	981.0	57	0.4	77.9
22	0.3	96.0	20.55	1233.0	1027.0	57	0.2	78.1
23	0.9	96.9	21.48	1289.0	1074.0	56	0.5	78.6
24	0.5	97.4	22.42	1345.0	1121.0	55	0.3	78.8
25	0.2	97.6	23.35	1401.0	1168.0	54	0.1	78.9
30	0.9	98.5	28.02	1681.0	1401.0	49	0.5	79.4
35	0.9	99.4	32.69	1962.0	1635.0	42	0.4	79.8
40	0.3	99.7	37.36	2242.0	1868.0	37	0.1	79.9
45	0.3	100.0	42.03	2522.0	2102.0	32	0.1	79.9
50	0.0	100.0	46.70	2802.0	2335.0	29	0.0	79.9
							Estimated Net Annual Sediment (TSS) Load Reduction =	**80 %**

Climate Station ID: 6149387 *Years of Rainfall Data*: 34

RAINFALL DATA FROM WATERLOO WELLINGTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter		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

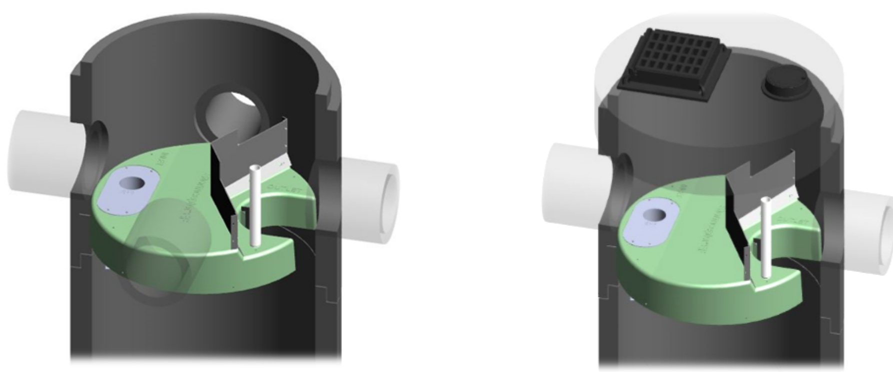
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test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

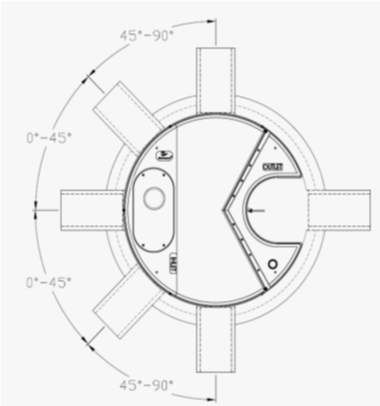
DESIGN FLEXIBILITY

►**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

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

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

PART 1 – GENERAL

1.1 WORK INCLUDED

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

1.2 REFERENCE STANDARDS & PROCEDURES

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

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

1.3 SUBMITTALS

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

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

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

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

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

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

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

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

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing of the OGS shall be determined by use of a minimum ten (10) years of local historical rainfall data provided by Environment Canada, 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

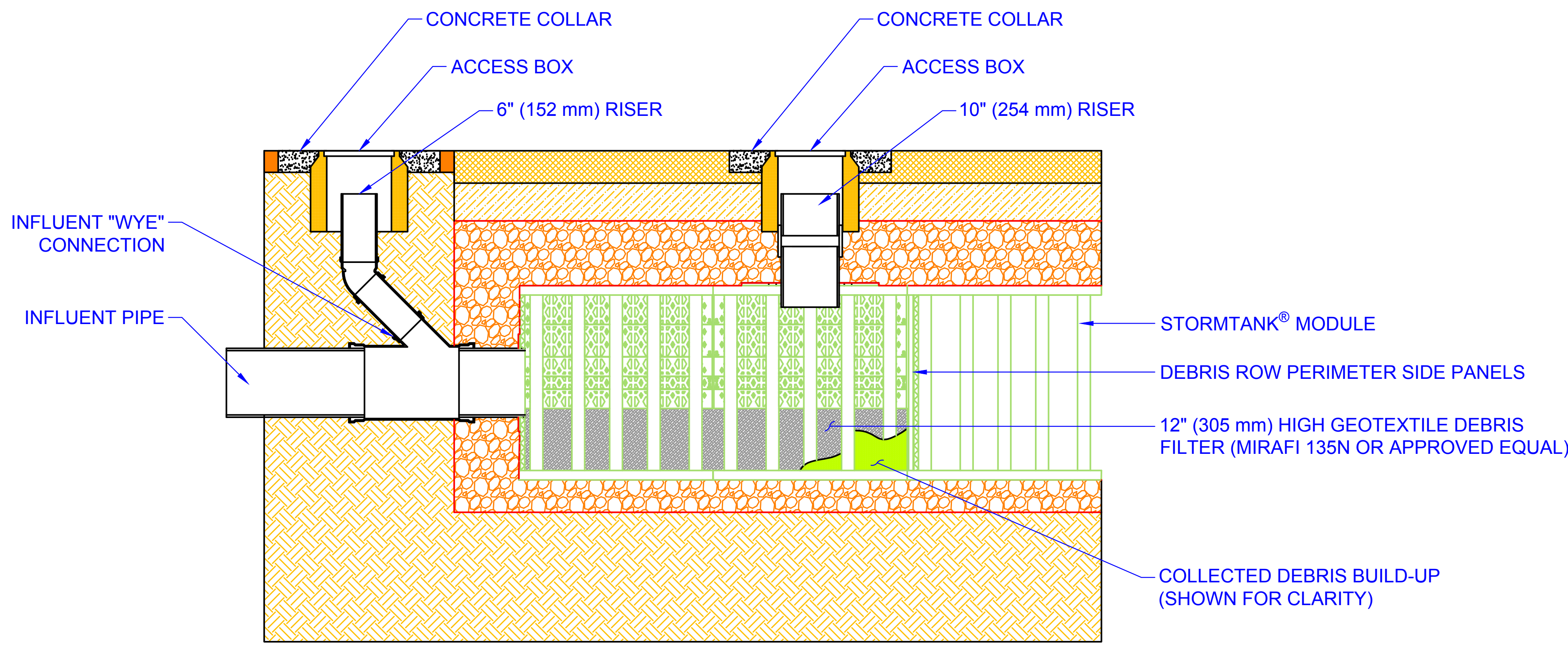
The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

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.

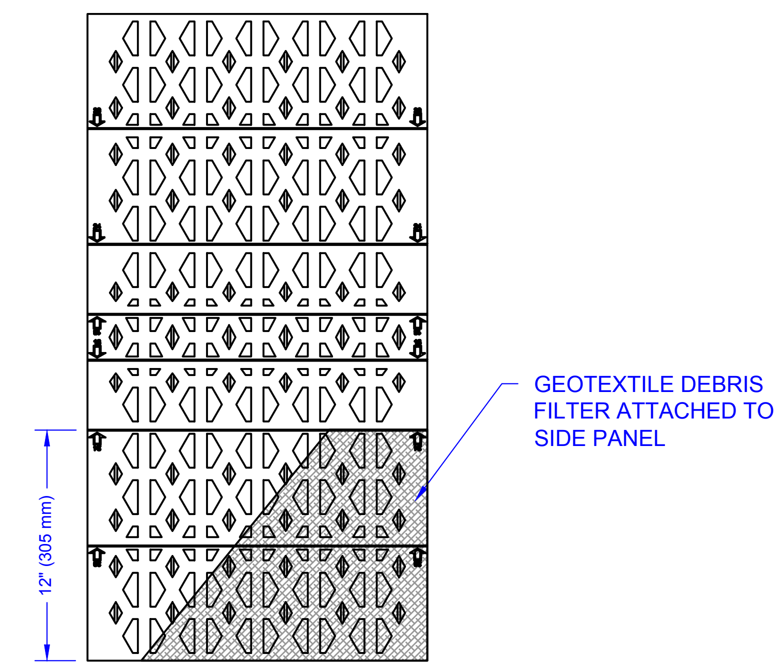
3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

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.



CROSS-SECTION



SIDE PANEL DETAIL

NOTES:

a. REFERENCE CURRENT INSTALLATION INSTRUCTIONS FOR PROPER INSTALLATION PRACTICES.
b. DEBRIS ROW CONFIGURATIONS AND PORT LOCATIONS ON SHEET 2 OF 2.
c. CONCRETE COLLAR REQUIRED AROUND ACCESS BOXES TO MEET HS-20 AND HS-25 LOAD RATING (DESIGN BY ENGINEER OF RECORD).

REV.	DATE	RECORD OF CHANGES	BY	APPRV.
B	9/12/13	UPDATED DRAWING FORMAT	JKB	JKB
A	9/10/12	INITIAL RELEASE	JKB	FK

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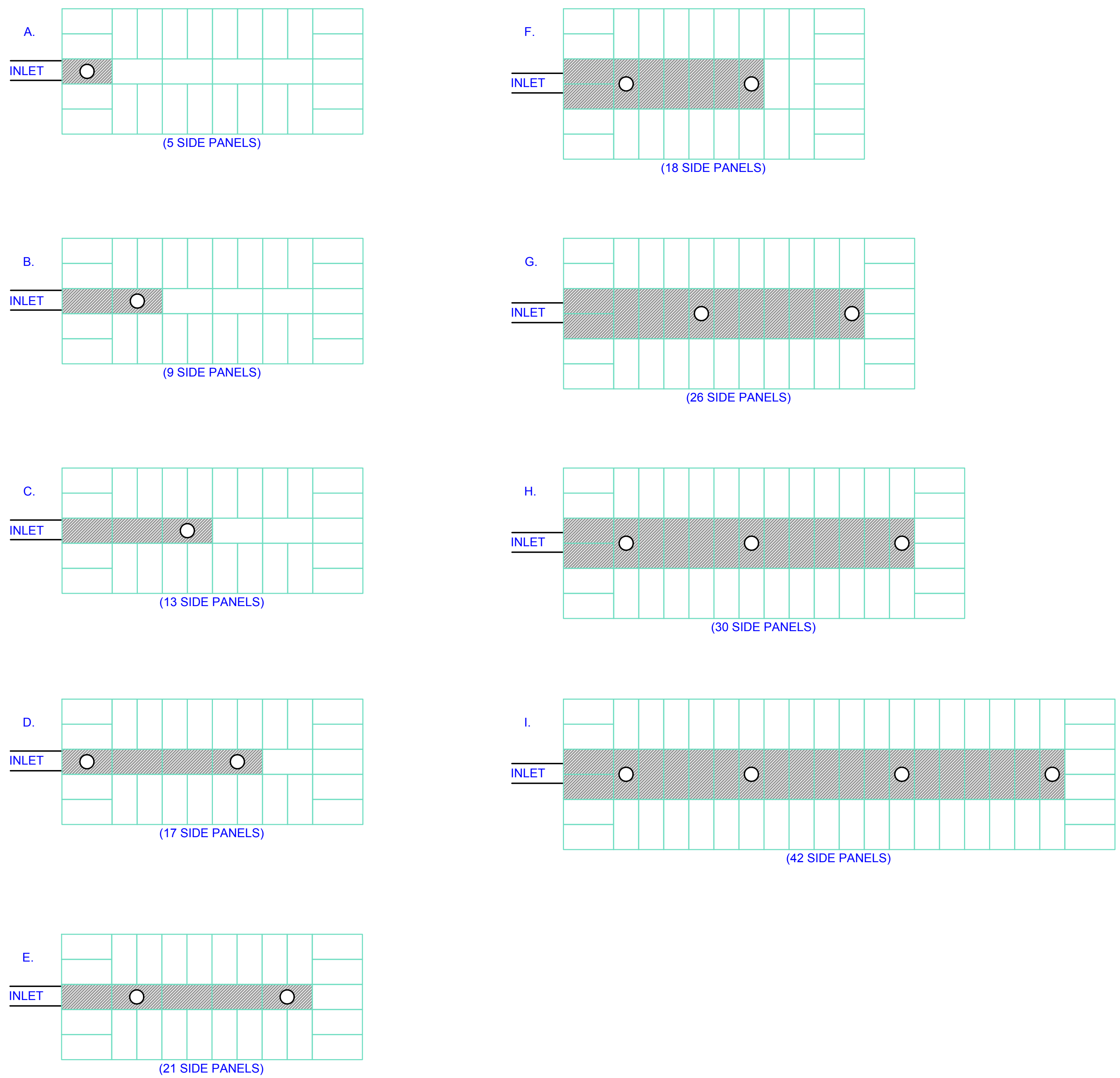
Project Name: DEBRIS ROW SECTION DETAIL

Title: STORMTANK® MODULE

Drawn By	Date
J.BAILEY	9/10/12

Drawing No.	Sheet	Scale
STM-005-00	1 of 2	NTS



ST-36 and ST-30 STORMTANK SYSTEM

INFLUENT PIPE DIA.		FIGURE	REQ'D NUMBER OF SIDE PANELS	REQ'D NUMBER OF SUCTION PORTS
IMPERIAL	METRIC		QTY	QTY
4"	102 mm	A	5	1
6"	152 mm	A	5	1
8"	203 mm	A	5	1
10"	254 mm	B	9	1
12"	305 mm	B	9	1
14"	356 mm	C	13	1
18"	457mm	F	18	2
24"	610 mm	G	26	2
30"*	762 mm	I	42	4

* 30" (762 mm) INFLUENT PIPE ONLY APPLICABLE TO ST-36 MODULE

ST-24 STORMTANK SYSTEM

INFLUENT PIPE DIA.		FIGURE	REQ'D NUMBER OF SIDE PANELS	REQ'D NUMBER OF SUCTION PORTS
IMPERIAL	METRIC		QTY	QTY
4"	102 mm	A	5	1
6"	152 mm	A	5	1
8"	203 mm	B	9	1
10"	254 mm	C	13	1
12"	305 mm	D	17	2
14"	356 mm	E	21	2
18"	457mm	H	30	3

ST-18 STORMTANK SYSTEM

INFLUENT PIPE DIA.		FIGURE	REQ'D NUMBER OF SIDE PANELS	REQ'D NUMBER OF SUCTION PORTS
IMPERIAL	METRIC		QTY	QTY
4"	102 mm	B	9	1
6"	152 mm	B	9	1
8"	203 mm	B	9	1
10"	254 mm	C	13	1
12"	305 mm	C	13	1

DEBRIS ROW LAYOUTS

CONCEPTUAL USE:

DEBRIS ROW MINIMUM DESIGN REQUIREMENTS ARE BASED ON THE INFLUENT PIPE CROSS SECTIONAL AREA. SEE TABLES FOR THE MINIMUM REQUIRED DEBRIS ROW INTERNAL SIDE PANEL INTERFACES TO MEET PROPER HYDRAULIC PERFORMANCE AS CONFIGURATIONS MAY VARY.

REV.	DATE	RECORD OF CHANGES	BY	APPRV.
B	9/12/13	UPDATED DRAWING FORMAT	JKB	JKB
A	9/10/12	INITIAL RELEASE	JKB	FK

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Project Name: DEBRIS ROW LAYOUT DETAIL

Title: STORMTANK MODULE

Drawn By: J.BAILEY | Date: 9/10/12

Drawing No.: STM-005-00 | Sheet: 2 of 2 | Scale: NTS

StormTank® Hydraulic Performance and Sediment Removal Efficiency

Karl Koch

Executive Summary
Testing for the hydraulic performance and sediment removal efficiency of the Brentwood Industries StormTank® Debris Row was conducted at the Brentwood Industries Research and Development Facilities following ASTM Standard C1746/C1746M-12, Standard Test Method for Measurement of Suspended Sediment Removal Efficiency of Hydrodynamic Stormwater Separators and Underground Settling Devices. Trapping efficiencies for AGSCO Silica Sand #110 was greater than 95% at all flow ranges tested. Hydraulic performance was limited only by the design of the test rig, namely the flow into the 8” slotted effluent pipe, with flow ranges tested up to nearly 27 GPM/ft^2. The hydraulic data was used to determine detention times and ultimately slurry feed and sampling rates.

The StormTank® Debris Row trapping efficiencies were determined using both a direct and indirect method. The direct method physically weighed the sediment injected into the system, the sediment trapped within the Debris Row, and the sediment trapped within the Effluent Sump. Mass Balances for each test accounted for over 97% of all solids mixed into the feed slurry. The indirect method followed Standard D3977-97, Standard Test Methods for Determining Sediment Concentration in Water Samples. Five evenly spaced samples were drawn from the both the Influent and Effluent flow streams, from which the average concentrations were used to determine the StormTank® Debris Row trapping efficiencies.

Introduction
The Brentwood StormTank system is a rugged yet lightweight subsurface stormwater storage unit. The simple to assemble and install modules, designed to exceed the AASHTO HS-25 load rating, are utilized under most surfaces for detention, infiltration, harvesting, and flood mitigation of rain water. Integral to the system is a Debris Row; a series of StormTank modules subsequential to the inlet pipe and isolated by a series of internally installed side panels with a geotextile fabric liner on the bottom and extending 12” up the side panels. The dual purpose of this Debris Row is: (1) the isolation of larger debris; (2) filtration of sediment.

Purpose

The purpose of this study is: (1) to quantify the hydraulic performance, in terms of stage and detention time for testing purposes; (2) to quantify the sediment removal efficiency of a StormTank® Debris Row system subjected to simulated stormwater runoff conditions.

Scope

Construct a 12’ x 6’ x 4’ Test Basin capable of holding 12’ x 6’ x 1’ #2 Angular stone, a three StormTank® module Debris Row, and a seven StormTank® module system surrounding the Debris Row. Set up a system capable of controlled water flow ranges of 90 – 400 GPM (7.0 – 30.6 GPM/ft^2), with a means of injecting a sediment slurry simulating stormwater runoff. Construct a 10’ x 6’ x 2’ sump to capture the simulated stormwater runoff and filter the effluent for recirculation. Have the means to directly weigh the sediment before and after addition to the test apparatus to determine the removal efficiency. Have the means to indirectly determine the influent and effluent sediment concentrations to determine the removal efficiency.

Apparatus (Appendix A – System Overview)

4000 gallon Reservoir Tank
(4) - 4” Ball Valve
Grundfos E-Pump, Model# CRE90-1-1AN-G-A-E-HQQE
DCT-7088 Portable Digital Correlation Transit Time Ultrasonic Flowmeter
Masterflex B/T variable-speed wash-down modular pump, 12-321rpm, Model# K-77110-40
30 gallon Slurry Tank
Dayton Tank Mixer, Model# 2M168D
8” Ball Valve
12” Inlet Connection, Brentwood Industries
12’ x 6’ x 4’ Test Basin with 12’ x 6’ x 1’ of #2 Angular stone
10’ x 6’ x 2’ Sump
8” Slotted High – Density Polyethylene Pipe, 12’
50 micron filter sock
(2) ISCO 4700 Refrigerated Samplers

Considerations

ASTM Standard C1746/C1746M-12 was followed with the following exceptions:

6.1, 6.4 – The influent system consists of an 8” pipe 78” long, with a slurry injection port 60” from the influent point, and a ball valve / mixing valve 40” from the influent point. This valve remains 100% open.

8.1.1 – Specific gravity and particle-size distribution is not necessary as the sediment is a specialty blend with included technical data sheets (Appendix B).

Conclusions

Using the flow/volume relationship to determine the Detention (residence) Time it can be concluded that the water load limiting factor is the test rig itself rather than any aspect of the StormTank® system through the flow levels tested. (See Test Results and Discussion)

At all flow levels tested sediment removal efficiency is greater than 95% by direct measurement and greater than 97% by indirect sampling. (See Test Results and Discussion)

Evaluation

Test Sample

(10) – 18” StormTank Modules, ST-18
(14) – 18” Side Panels
Geotextile Fabric (Appendix C)
AGSCO Silica Sand #110, Item# SSS000110—B5MBNK (Appendix B)

Test Method

Set-up and Test Run

1. Fill out the initial section of the StormTank Water Quality Test Data Sheet (Appendix D).
2. Record the tare weights of the Influent and Effluent sample containers in the StormTank Water Quality Test Data Sheet and place the crucibles and filter papers in the oven to dry. (See Sample Analysis Procedure, steps 40 – 43)
3. Ensure that the Reservoir Tank has ≥2000 gallons of water.
4. Cut approximately ½” behind the ring of a 50micron filter sock to remove the ring.
5. Weigh the filter sock and one Vacuum Filter as a unit and record in the StormTank Water Quality Test Data Sheet.
6. Cut and weigh the following three pieces of Geotextile 601 Fabric and record in the StormTank Water Quality Test Data Sheet:
    a. 2 pieces Geotextile @ 150” x 24”
    b. 1 piece Geotextile @ 150” x 80”

7. Place the 150" x 80" piece of geotextile fabric over the stone in the Test Basin, cutting around the well pipe.
8. Position the three StormTank Modules (STM's) that make up the Debris Row down the center of the Test Basin. Module DB1 is placed on the influent pipe and placed against the Test Rig wall, with modules DB2 and DB3 lined up behind.
9. Place the two 150" x 24" geotextile fabric pieces on either side of the Debris Row with 12" lying against the Debris Row and 12" lying on the 150" x 80" piece of geotextile fabric. Each side will extend 12" past module DB1.
10. Cut the excess geotextile fabric near the inlet pipe in line with the wall.
    a. Tuck the vertical flaps between DB1 and the wall.
    b. Fold the vertical flaps up against the basin wall.
11. Position STM's 1 – 3 and 4 – 6 on either side of the Debris Row, on top of the 150" x 24" geotextile fabric. Place one 25 lb weight on top of each STM.
12. Cut the geotextile fabric at approximately 45° from the corners of DB3 to allow wrapping of the fabric around the module. Position STM 7 against this fabric.
13. Cable tie the 12" of geotextile fabric between the debris and outer row to the side panels of the outer row.
14. Insert the Sump Effluent Filter sock frame into the sock and cable tie it around the 4" sump effluent line.
15. Position and attach the Influent Sampler to the Influent Sampler Port on the Influent Pipe. Program the sampler to the parameters listed in Table 1 – Hydraulic Performance for the testing conditions to be performed.
16. Position and attach the Effluent Sampler to the Effluent Sampler Line in the Test Basin Effluent Pipe. Program the sampler to the parameters listed in Table 1 – Hydraulic Performance for the testing conditions to be performed.
17. Attach the Slurry Pump to the Injection Port. Mix sediment slurry per the following:
    a. Add 20 gallons of water to the Slurry Tank.
    b. Plug in the Mixer Motor and Slurry Pump
    c. Slowly add 27.5 lbs of AGSCO #110 sediment.
    d. Fill with water until the mixture reaches the 25 gallon mark, cycling the mixer to achieve the correct volume.
    e. Power on the Slurry Pump but do not start.
18. Attach the flowmeter to the sensors and power on.
19. Open valves 1 and 4.
20. Open the bleeder valve on the Pump to extricate any air in the influent piping and pump.
21. Power on the Pump, and set the desired flow rate.
22. When the fill line is reached in the Sump open valve 2 and slowly close valve 1. To maintain the water level slowly open / close valve 1 as needed.
23. Record the time as the Equilibration Start Time. The test will need to equilibrate for 10 detention times. During this time:

   a. Take the Sump water temperature
   b. Program the Slurry Pump per Table 1
   c. Remove crucibles and filters from drying oven and place in desiccator.
   d. Record the actual flow rate on the StormTank Water Quality Test Data Sheet.
24. After 10 Detention Times record the time as the Equilibration End Time.
25. Start the Influent Sampler and record the time.
26. After 11 Detention Times start the Effluent Sampler and record the time.
27. Start the Slurry Pump.
28. Start the test timer.
29. Record the Sump water temperature and the time taken.
30. Halt the Influent and Effluent Sampler programs until the sampling interval has been met on the test timer.
   a. When the sampling interval has been met restart the Influent Sampler on bottle 2.
   b. After one detention time restart the Effluent Sampler on bottle 2.
31. Measure the maximum stage at the well and record in the StormTank Water Quality Test Data Sheet.
32. At this time the water in the reservoir Tank can begin to be replaced by a garden hose.
33. A few minutes before the end of the test, measure the water level in the StormTank chamber and record in the StormTank Water Quality Test Data Sheet.
34. When the Test Length has been met *and* the Influent Sampler has recovered the seventh sample, shut down the Influent Sampler and the Slurry Pump. Record the time.
35. When one more detention time has elapsed *and* the final Effluent grab sample has been recovered, shut down the Effluent Sampler. Record the time.
36. Record the Sump water temperature and the time taken.
37. Reduce the pump to the minimum flow rate and shut down the pump.
38. Close all the valves.
39. Check the water level in the Reservoir Tank and shut down the water if ≥2000 gallons.

Shutdown and Cleanout Procedure

40. Cut the cable ties holding the geotextile fabric to the STM side panels and carefully rinse each STM onto the Geotextile as it is removed from the Test Basin.
   a. Carefully fold the Geotextile lengthwise and remove from the Test Basin.
   b. Allow the geotextile to dry thoroughly before weighing and recording in the StormTank Water Quality Test Data Sheet.
41. Remove the slurry pump Influent Line and wash out the contents into the Slurry Tank.
42. Empty the contents of the Slurry Tank onto a tarp and allow to dry.
43. Carefully remove the filter sock from the Test Basin Sump effluent pipe and allow to dry thoroughly.

44. Using a sump pump placed in the Sump, begin a flow through the garden hose and then disconnect the garden hose from the sump pump, ensuring that it remains submerged at all times, and set on the floor of the Sump. Allow it to siphon to the sanitary sewer.
45. Disconnect the Flow Meter.
46. Disconnect the Influent Sampler from the influent pipe.
47. Disconnect the Effluent Sampler from the effluent pipe.
48. When the Sump has been drained, vacuum the remaining water and sediment with a vacuum containing the clean tared filter, disposing of the water in the sanitary sewer.
49. Place the Vacuum Filter with the Filter Sock and allow to dry thoroughly.
    a. Weight the Vacuum Filter and Filter Sock as a unit and record in the StormTank Water Quality Test Data Sheet.

Sample Analysis Procedure

50. Weigh and record tare weights for the 7 Influent and 7 Effluent Sample bottles making sure to include the lids. Weights are to be recorded on the data sheet in the Bottle Chart under the column Tare (g).
51. Wash the glass-fiber filter disc with water to remove soluble compounds. Record pore size and diameter on the data sheet.
52. Place the filter inside a crucible.
53. Dry the filter and its crucible in the drying oven for 1H at 105°C.
54. Weigh each of the 7 Influent and 7 Effluent Sample bottles with their samples inside and record on the data sheet in the Bottle chart under the column Gross (g).
55. Transfer the crucible and filter paper to the desiccator, then, after the parts have cooled to room temperature, weigh them to the nearest 0.0001 g and record the reading on the data sheet.
56. Place the crucible inside a crucible holder.
57. Place the crucible holder into the vacuum flask that is attached to the vacuum pump.
58. While a vacuum is being applied to the bottom of the crucible, filter sample into the crucible. Flush the inner surfaces of the sample bottle with water several times to complete the transfer.
59. As filtering proceeds, inspect the filtrate. If it is turbid, pour the filtrate back through the filter a second and possibly a third time. If the filtrate is still turbid, the filter may be leaking. In this case, substitute a new filter and repeat from step 51. If the filtrate is transparent but discolored, a natural dye is present; re-filtration is not necessary.
60. When filtration is complete, place the crucible and its contents in the drying oven for 1H at 105°C.
61. Remove crucible and filter from oven and place in desiccator. After the crucible has cooled, weigh to the nearest 0.0001 g and record on the data sheet.
62. Place crucible and filter back in oven for 1H at 105°C.
63. Remove crucible and filter from oven and place in desiccator. After the crucible has

cooled, weigh to the nearest 0.0001 g and record on the data sheet.

64. If values from steps 61 and 63 are less than 4% or 0.5 mg (whichever is smaller) different, then drying complete.
65. If values from steps 61 and 63 are more than 4% or 0.5 mg different, then repeat steps 52 – 53.
66. Enter all values in the Excel Spreadsheet "StormTank Water Quality Test Data Sheet".

Test Results and Discussion

Looking at the flow/volume relationship, determined by measuring the stage at each flow rate by means of a well installed midway through the test basin, several expected results occur: (1) the stage increases along with flow, (2) the volume increases along with flow, (3) the test length required to inject 21 pounds of sediment at an approximate concentration of 200 mg/L decreases as flow increases, (4) the indirect sampling interval decreases as the flow increases.

Table 1- Hydraulic Performance

Flow (cfs)	Flow (gpm)	Flow (gpm/ft^2)	Stage Relative to Outlet (in)	Total Volume (ft^3)	Total Volume (gal)	Detention Time, *X* (min)	Test Length (min)	Pump Speed to Deliver 20 gallons (GPM)	Sampling Interval (min)
0.21	95	7.0	5.03	30.08	225.00	2.37	139	0.14	23.1
0.30	133	10.0	6.09	36.44	272.52	2.05	99	0.20	16.5
0.42	192	14.0	8.34	49.89	373.14	1.94	69	0.29	11.4
0.50	217	16.6	9.97	59.60	445.81	2.05	61	0.33	10.1
0.61	276	20.3	13.03	77.92	582.77	2.11	48	0.42	8.0
0.69	305	22.9	15.22	91.00	680.59	2.23	43	0.46	7.2
0.80	357	26.6	19.41	116.03	867.86	2.43	37	0.54	6.2
0.92	413	30.6	25.00	149.48	1118.02	2.71	32	0.63	5.3
1.02	453	33.9	29.25	174.89	1308.08	2.89	29	0.69	4.8

However, the Detention Time, expected to decrease as flow increased, follows more of a second-order polynomial (See Chart 1 – Flow vs Detention Time). Considering the mechanism through which the water exits the test basin, an 8" slotted pipe, the increase in Detention Time can be explained by assuming a maximum flow through the total area of the slots dependent on head pressure. After passing through the StormTank® system, the geotextile, and the stone, the water must infiltrate the culvert pipe through the slots. For the first three data points, to 14.0 GPM/ft^2, the maximum flow through the pipe wall is not achieved, therefore, the results are as expected, a linear increase in the stage with decreasing Detention Times (See Chart 2 – Flow vs Stage). For the flows greater than 16.6 GPM/ft^2 the maximum flow through the pipe wall is achieved at equilibrium with head pressure, therefore, we see the stage increasing as a second-order polynomial with Detention Times increasing (See Chart 2 – Flow vs Stage).

Chart 1 - Flow vs Detention Time

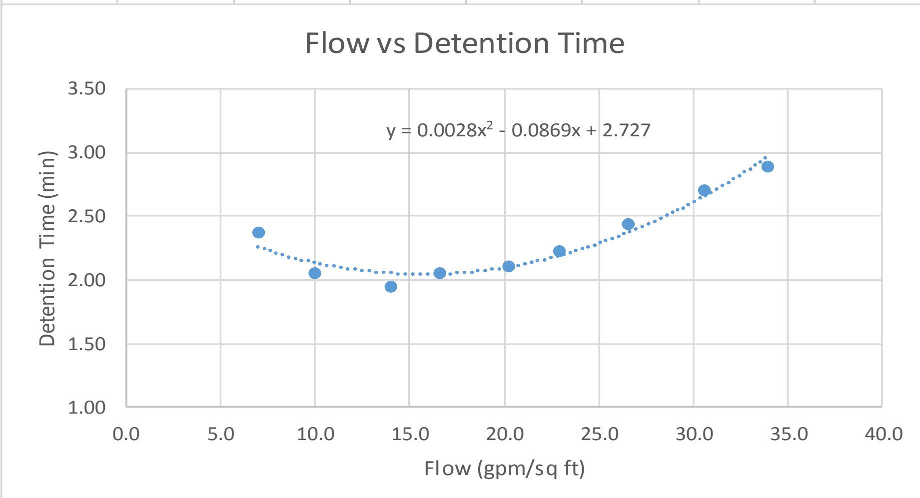
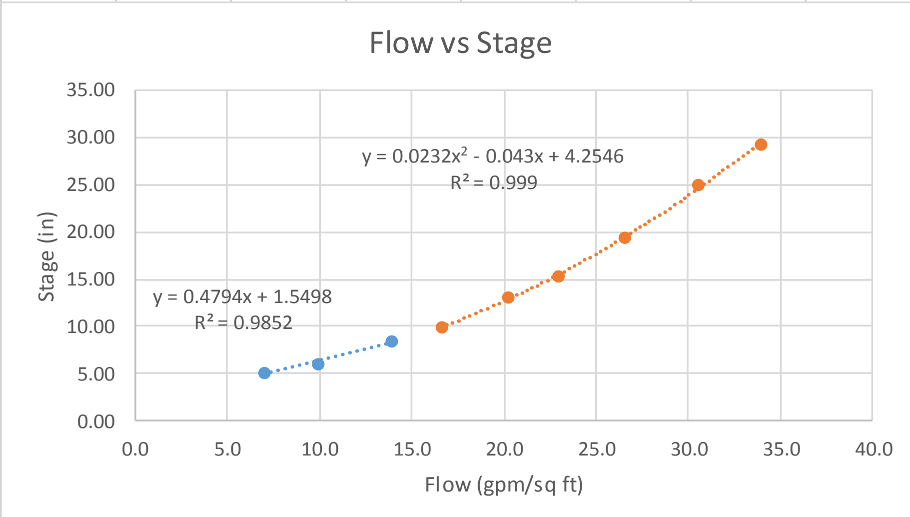


Chart 2 - Flow vs Stage



At all water flow rates tested, both the direct and indirect measurement methods indicated sediment trapping efficiencies greater than 95%. The direct method is the standard method and shows a 2% decline in sediment trapping efficiency, 97% to 95%, as the flow increases 400%, from 7.0 GPM/ft^2 to 26.9 GPM/ft^2 .The direct method also allows a mass balance to be performed between the sediment weighed from the packaging and the sediment collected at the completion of each test run. This mass balance shows that we can account for greater than 97% of the solids used.

Table 2- Sediment Removal Efficiency

Flow (gpm/ft^2)	Direct Sediment Measurements, Weight		Indirect Concentration Measurements		Removal Efficiency		Mass Balance (%)
	Injected in Influent Flow (lbs)	Retained in Debris Row (lbs)	Influent (mg/L)	Effluent (mg/L)	Direct Method (%)	Indirect Method (%)	
7.0	20.1	19.5	128.0	2.7	97.0	97.9	98.2
14.3	22.5	21.9	685.9	12.2	97.3	98.2	98.2
20.6	25.6	24.7	197.9	2.1	96.5	98.9	97.6
20.3*	18.1	17.2	346.4	0.0	95.0	100.0	97.1
26.9	20.5	19.7	410.4	1.5	96.1	99.6	97.8

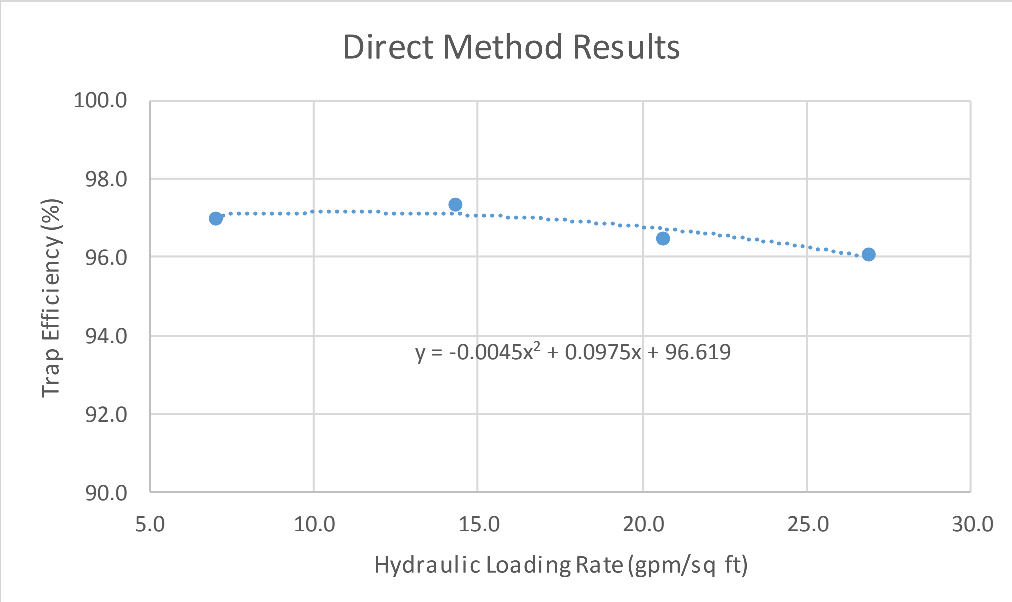
*Witnessed by Craig Momose, P.E.; Systems Design Engineering, Inc., October 15, 2015

The direct method for determining the sediment removal efficiency of the Brentwood StormTank® Debris Row utilizes a calibrated scale to weigh the sediment in the feed slurry, the sediment collected in the Debris Row, and the sediment deposited in the Effluent Sump. The sediment remaining in the slurry tank is also dried and weighed at the end of a test run to calculate the amount of sediment actually fed to the system. Through this measurement system the percentage of injected sediment trapped by the Debris Row is directly measured:

Trap Efficiency = (DB/IS) x 100

Where, DB is the sediment captured by the Debris Row
And, IS is the Injected Sediment (Total added to the slurry tank – Total remaining at the end)

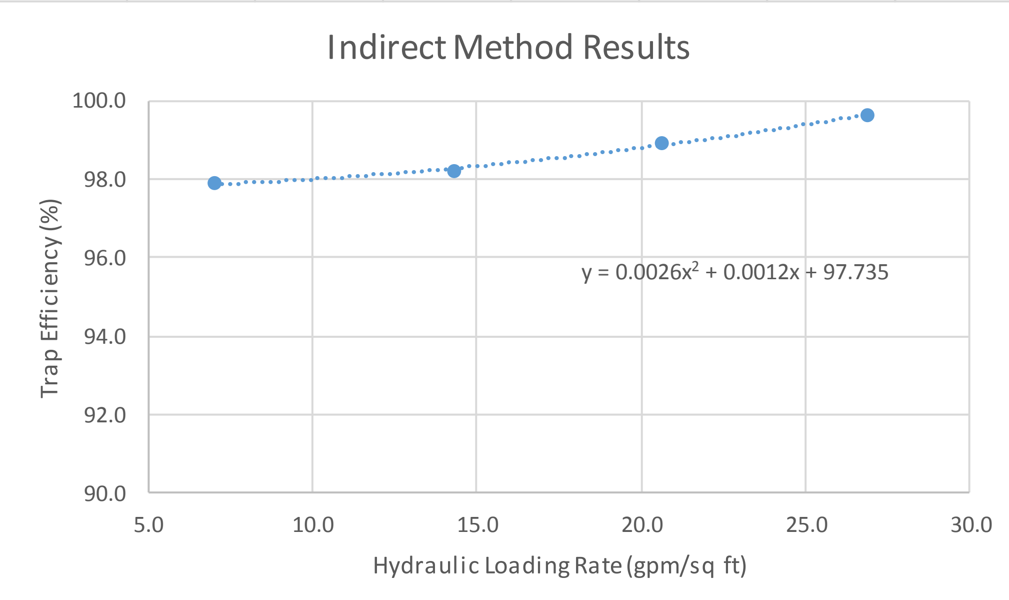
Chart 3 - Sediment Removal Efficiency, Direct Method



For the purposes of the evaluations in Chart 3 and Chart 4 the duplicate run (20.3 GPM/ft^2) for Systems Design Engineering, Inc. was omitted. Only 18.1 pounds of sediment were added, outside of the standard method. Additionally, there was no detectable sediment in the effluent samples, leading to a 100% trapping efficiency, which may lead one to question the validity of the results. However, the purpose of that test run was to allow the outside firm to verify our methods, not our results, and that was accomplished with the run.

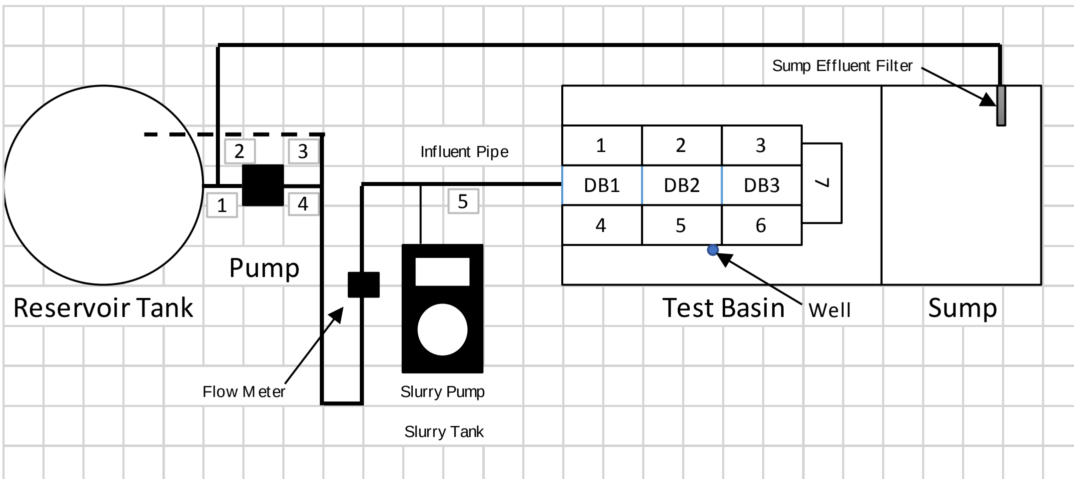
Brentwood utilized dormant resources to employ an indirect method to verify the results of the direct measurements. This was meant to be a broad verification, as the numerous steps involved and small concentrations of sediment, coupled with the difficulty of obtaining discrete well - mixed samples representative of the average concentrations, introduce compounding errors. Surprisingly, most of the results were within 3% of the direct method with the exception of the duplicate test, showing sediment trapping efficiencies greater than 97%. The results show a trend toward increasing sediment trapping efficiency as the flow increases. This could be due to numerous error factors: balance errors to the .00001g, humidity fluctuations, a decreasing sample cross-section as the water level in the effluent pipe increased (the sample line was set in the effluent pipe at the bottom counter to the flow).

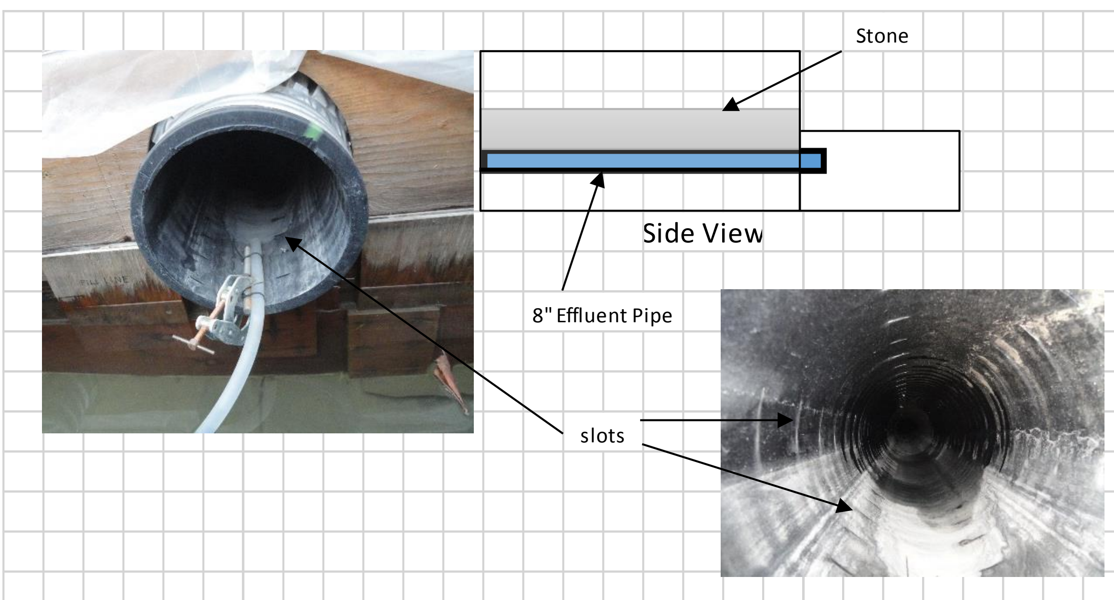
Chart 4 - Sediment Removal Efficiency, Indirect Method



Appendices

Appendix A – System Overview





Appendix B – AGSCO #110 Screen Analysis

AGSCO CORPORATION

TECHNICAL DATA

103,000# For wheeling

AGSCO SILICA SAND

TYPICAL SCREEN ANALYSIS

ROUND GRAIN SAND

(Percent Retained)

US SIEVE	20-40	(#1) 35-50	(#2) 40-70	50-80	(#7) 70-100	(#10) 100-140	(#110) 140-200	(#16) 140-270
12								
14								
16								
18								
20	0.2							
25	7.0	0.3						
30	20.6	2.0	0.3					
35	42.8	20.5	5.2					
40	23.3	35.3	16.5	2.7	2.9	1.2	0.3	
50	6.0	32.7	37.0	39.3	17.4	2.9	1.5	
60		4.7	14.2	23.8	---	---	---	
70		2.2	9.3	16.2	39.9	13.2	4.4	
80		2.3	5.5	9.1	---	---	---	
100			4.8	5.4	27.7	41.4	19.8	
120			7.2	3.5	---	---	---	---
140					11.2	36.3	42.8	27.8
170					---	---	---	---
200					0.9	4.8	20.5	50.9
230						---	---	---
270						0.1	8.3	19.3
325/PAN							2.3	2.0
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

AFS Grain Number	25	35	47	50	59.6	80.3	111.8	144
Effective Size (mm).	0.43	0.30	.15	.15	.11			

SILICA FLOUR

(Typical Percent Retained)

U.S. Sieve	#70 / 250	#140 / 106	#200 / 90	#325 / 45
70	3			
100	11	T		
140	8	1	T	
200	14	6	3	
270	9	10	7	T
325	5	8	7	2
Passing 325	50	75	83	98
Totals	100	100	100	100

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Wheeling, Ilinois 60090
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Pine Brook, New Jersey 07058
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Appendix C: GEOTEX 601 Product Data

GEOTEX® BY PROPEX

Product Data
GEOTEX® 601

GEOTEX® 601 is a polypropylene, staple fiber, needlepunched nonwoven geotextile produced by Propex, and will meet the following Minimum Average Roll Values (MARV) when tested in accordance with the methods listed below. The fibers are needled to form a stable network that retains dimensional stability relative to each other. The geotextile is resistant to ultraviolet degradation and to biological and chemical environments normally found in soils.

GEOTEX 601 conforms to the property values listed below[1]. Propex performs internal Manufacturing Quality Control (MQC) tests that have been accredited by the Geosynthetic Accreditation Institute – Laboratory Accreditation Program (GAI-LAP). This product is NTPEP approved for AASHTO standards.

		MARV[2]	
PROPERTY	TEST METHOD	ENGLISH	METRIC
ORIGIN OF MATERIALS			
% U.S. Manufactured Inputs		100%	100%
% U.S. Manufactured		100%	100%
MECHANICAL			
Tensile Strength (Grab)	ASTM D-4632	160 lbs	712 N
Elongation	ASTM D-4632	50%	50%
CBR Puncture	ASTM D-6241	410 lbs	1824 N
Trapezoidal Tear	ASTM D-4533	60 lbs	267 N
ENDURANCE			
UV Resistance % Retained at 500 hrs	ASTM D-4355	70%	70%
HYDRAULIC			
Apparent Opening Size (AOS)[3]	ASTM D-4751	70 US Std. Sieve	0.212 mm
Permittivity	ASTM D-4491	1.3 sec^{-1}	1.3 sec^{-1}
Water Flow Rate	ASTM D-4491	110 gpm/ft^2	4482 $l/min/m^2$

ROLL SIZES		12.5 ft x 360 ft 15 ft x 300 ft	3.81 m x 109.8 m 4.57 m x 91.5 m

NOTES:
1. The property values listed above are effective 04/2011 and are subject to change without notice.
2. Values shown are in weaker principal direction. Minimum average roll values (MARV) are calculated as the typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any samples taken from quality assurance testing will exceed the value reported.
3. Maximum average roll value.

Appendix D – StormTank Water Quality Test Data Sheet

BRENTWOOD®

StormTank™ Water Quality Test Data Sheet

Date

Page 1 of 3

Test Name:		
Test Length:		min
Detention Time:		min
Target Influent Concentration:		mg/L
Slurry Concentration:		lbs/gal
Slurry Pump Speed:		gpm
Sampling Interval:		min
Glass-fiber Filter Diameter:		mm
Glass-fiber Filter Pore Size:		µm

Geotex Weight $_{Initial}$:		lbs
Geotex Weight $_{Final}$:		lbs
Filter Sock and Vacuum Filter Weight $_{Initial}$:		lbs
Filter Sock and Vacuum Filter Weight $_{Final}$:		lbs
Tarp Weight $_{Initial}$:		lbs
Tarp Weight $_{Final}$:		lbs
Flow $_{water}$:		cfs
Water Load:	0	gpm/ft^2
Maximum Stage $_{Rig}$:		in
Depth in Chamber:		in
Total Volume:	0.00	gal
Equilibration Start Time:		
Equilibration End Time:		
Sump Water Temperature / Time:		°F /
Sampler $_{Influent}$ Start Time:		
Sampler $_{Effluent}$ Start Time:		
Test / Slurry Pump Start Time:		
Sump Water Temperature / Time:		°F /
Sampler $_{Influent}$ End Time:		
Sampler $_{Effluent}$ End Time:		
Test / Slurry Pump End Time:		
Sump Water Temperature / Time:		°F /

StormTank™ Water Quality Test Data Sheet

Date

Page 2 of 3

Sample Bottle Weight Table

Sample	Tare (g)	Gross (g)	Net (g)	Solids (mg)	Water (mL)	Concentration (mg/L)
Influent 0			0.0000	0.0	0.0	#DIV/0!
Influent 1			0.0000	0.0	0.0	#DIV/0!
Influent 2			0.0000	0.0	0.0	#DIV/0!
Influent 3			0.0000	0.0	0.0	#DIV/0!
Influent 4			0.0000	0.0	0.0	#DIV/0!
Influent 5			0.0000	0.0	0.0	#DIV/0!
Influent 6			0.0000	0.0	0.0	#DIV/0!
Effluent 0			0.0000	0.0	0.0	#DIV/0!
Effluent 1			0.0000	0.0	0.0	#DIV/0!
Effluent 2			0.0000	0.0	0.0	#DIV/0!
Effluent 3			0.0000	0.0	0.0	#DIV/0!
Effluent 4			0.0000	0.0	0.0	#DIV/0!
Effluent 5			0.0000	0.0	0.0	#DIV/0!
Effluent 6			0.0000	0.0	0.0	#DIV/0!

Crucible Weight Table

Sample	Tare (g)	1H @ 105°C (g)	1H @ 105°C (g)	Solids (mg)
Influent 0				0.0
Influent 1				0.0
Influent 2				0.0
Influent 3				0.0
Influent 4				0.0
Influent 5				0.0
Influent 6				0.0
Effluent 0				0.0
Effluent 1				0.0
Effluent 2				0.0
Effluent 3				0.0
Effluent 4				0.0
Effluent 5				0.0
Effluent 6				0.0

StormTank™ Water Quality Test Data Sheet

Date

Page 3 of 3

Geotex Tare weight (lbs)	Dry Geotex Weight (lbs)	Solids (lbs)
0	0	0.0

Solids Remaining in Slurry Tank (lbs)	0

Vacuum Filter and Filter Sock Tare weight (lbs)	Dry Vacuum Filter and Filter Sock Weight (lbs)	Solids (lbs)
0	0	0.0

	Accounted	Unaccounted	Slurry
Mass Balance (lbs)	0.0	0.0	

Direct Removal Efficiency:	0	%
Indirect Removal Efficiency:	#DIV/0!	%

Appendix E – Sample Completed StormTank Water Quality Test Data Sheet

BRENTWOOD®

StormTank™ Water Quality Test Data Sheet

September 25, 2015

Page 1 of 3

Test Name:	WQ 0.4 cfs 2015 09 25		
Test Length:	69	min	
Detention Time:	1.94	min	
Target Influent Concentration:	200	mg/L	
Slurry Concentration:	1.1	lbs/gal	
Slurry Pump Speed:	0.29	gpm	
Sampling Interval:	11.0	min	
Glass-fiber Filter Diameter:	34	mm	
Glass-fiber Filter Pore Size:	1.5	µm	
Geotex Weight $_{Initial}$:	5.2	lbs	
Geotex Weight $_{Final}$:	27.1	lbs	
Filter Sock and Vacuum Filter Weight $_{Initial}$:	0.9	lbs	
Filter Sock and Vacuum Filter Weight $_{Final}$:	1.0	lbs	
Tarp Weight $_{Initial}$:	6.8	lbs	
Tarp Weight $_{Final}$:	11.8	lbs	
Flow $_{water}$:	0.43	cfs	
Water Load:	14.3	gpm/ft^2	
Maximum Stage $_{Rig}$:	9.88	in	
Depth in Chamber:	5.75	in	
Total Volume:	490.0	gal	
Equilibration Start Time:	9:55		
Equilibration End Time:	10:14		
Sump Water Temperature / Time:	71.8	°F /	9:56
Sampler $_{Influent}$ Start Time:	10:14		
Sampler $_{Effluent}$ Start Time:	10:16		
Test / Slurry Pump Start Time:	10:16		
Sump Water Temperature / Time:	72	°F /	10:17
Pause - Influent feed line not working; re-start at 10:31			
Sampler $_{Influent}$ End Time:	11:37		
Sampler $_{Effluent}$ End Time:	11:39		
Test / Slurry Pump End Time:	11:40		
Sump Water Temperature / Time:	72.3	°F /	11:39

StormTank™ Water Quality Test Data Sheet

September 25, 2015

Page 2 of 3

Sample Bottle Weight Table

Sample	Tare (g)	Gross (g)	Net (g)	Solids (mg)*	Water (mL)	Concentration (mg/L)
Influent 0	117.1047	211.1727	94.0680	1.0	94.1	10.6
Influent 1	113.7627	199.6820	85.9193	59.5	85.9	693.6
Influent 2	120.2428	205.2000	84.9572	77.9	84.9	917.2
Influent 3	119.0744	210.0568	90.9824	72.5	90.9	796.9
Influent 4	116.4428	212.7409	96.2981	69.1	96.2	718.1
Influent 5	116.5622	203.3854	86.8232	51.1	86.8	589.5
Influent 6	115.9707	206.8581	90.8874	36.3	90.9	400.1
Effluent 0	115.6987	203.4775	87.7788	1.2	87.8	13.1
Effluent 1	116.0757	205.6834	89.6077	1.1	89.6	12.3
Effluent 2	120.8946	215.6025	94.7079	1.5	94.7	15.8
Effluent 3	119.1743	214.1430	94.9687	1.6	95.0	16.8
Effluent 4	119.0589	231.6127	112.5538	0.7	112.6	5.8
Effluent 5	119.7286	214.6678	94.9392	1.0	94.9	10.5
Effluent 6	118.2419	211.6760	93.4341	1.1	93.4	11.8

*Negative values are recorded as zero

Crucible Weight Table

Sample	Tare (g)	1H @ 105°C (g)	1H @ 105°C (g)	Solids (mg)
Influent 0	44.5359	44.5362	44.5376	1.0
Influent 1	44.0679	44.1264	44.1285	59.5
Influent 2	44.9158	44.9929	44.9944	77.9
Influent 3	44.5755	44.6473	44.6486	72.5
Influent 4	43.5355	43.6040	43.6052	69.1
Influent 5	44.3170	44.3674	44.3689	51.1
Influent 6	44.4361	44.4718	44.4731	36.3
Effluent 0	44.3461	44.3469	44.3476	1.2
Effluent 1	44.4199	44.4204	44.4216	1.1
Effluent 2	44.5589	44.5595	44.5613	1.5
Effluent 3	44.4879	44.4889	44.4901	1.6
Effluent 4	44.2916	44.2916	44.2929	0.7
Effluent 5	44.3202	44.3207	44.3217	1.0
Effluent 6	44.2992	44.2998	44.3008	1.1

Brentwood Industries, Inc.

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StormTank™ Water Quality Test Data Sheet

September 25, 2015

Page 3 of 3

Geotex Tare weight (lbs)	Dry Geotex Weight (lbs)	Solids (lbs)
5.2	27.1	21.9

Solids Remaining in Slurry Tank (lbs)	5

Vacuum Filter and Filter Sock Tare weight (lbs)	Dry Vacuum Filter and Filter Sock Weight (lbs)	Solids (lbs)
0.9	1	0.1

	Accounted	Unaccounted	Slurry	
Mass Balance (lbs)	27.0	0.5	27.5	98.2%

Direct Removal Efficiency:	97.3	%
Indirect Removal Efficiency:	98.2	%

Brentwood Industries, Inc.

610 Morgantown Road, Reading, PA 19611, USA

Phone: 610.374.5109

Fax: 610.376.6022

SYSTEMS DESIGN ENGINEERING, INC
"A Passion for Engineering Excellence"
sdei.net

November 12, 2015

Karl Koch, Supervisor
Brentwood Industries, Inc.
Research & Development Laboratories
610 Morgantown Road
Reading, PA 19611

Re: StormTank Debris Row
Sediment Removal Efficiency
Certification of Testing

Dear Karl:

I have reviewed your technical report entitled, "StormTank® Hydraulic Performance and Sediment Removal Efficiency," dated November 11, 2015. Based on my personal observations of the test performed on October 15, 2015, I hereby certify that the testing procedure and results summarized in the technical report accurately describes the test that I observed.

If you require additional information, please do not hesitate to contact me.

Sincerely,

Craig Momose, P.E.
Director of Civil Engineering

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
CRAIG MOMOSE
ENGINEER
No. PE039211E

I:\Projects\Brentwood Industries\2015-11-12 Certification Letter.docx

1032 James Drive, Leesport, PA 19533 • P: 610.916.8500 • F: 610.916.8501
Schuylkill Haven, PA • P: 570.385.5549 Boyertown, PA • P: 610.369.1319

Appendix C
Water Budget Analysis

1166- 1204 Gordon Street
CITY OF GUELPH
OUR FILE: 121139
2-Mar-22

EXISTING CONDITION

Contributing Catchments: 100
Contributing Area = 1.12 ha
Percent Impervious = 30.0%

Soil Type: Silt Loam
Vegetation: Shallow-rooted crops
Root Zone Depth = 0.62m
Soil Moisture Retention Capacity = 125 mm

Runoff Factor = 0.44
Evapotranspiration Factor for Impervious Surfaces = 0.33

Month	Daily Average Temperature	Monthly Heat Index	Unadjusted Daily Potential Evapotranspiration	Correction Factors	Adjusted Potential Evapotranspiration	Average Precipitation	P-PE	Accum. Pot. Water Loss	Storage	ΔS	Actual Evapotrans-piration	Moisture Surplus	Water Runoff	Snow Melt Runoff	Total Recharge & Runoff	Actual Runoff	Runoff Volume	Recharge Volume
	(°C)		(mm)		(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m^3)	(m^3)
Jan	-6.5	0.00	0.0	24.3	0.0	65.2	65.2		261.4	0.0	0.0	0.0	8.6	0.0	8.6	3.8	42	54
Feb	-5.5	0.00	0.0	24.6	0.0	54.9	54.9		316.3	0.0	0.0	0.0	4.3	0.0	4.3	1.9	21	27
Mar	-1.0	0.00	0.0	30.6	0.0	61.0	61.0		377.3	0.0	0.0	0.0	2.1	0.0	2.1	0.9	11	13
Apr	6.2	1.39	1.0	33.6	33.6	74.5	40.9		125.0	0.0	26.8	47.7	23.9	25.2	49.1	21.6	242	308
May	12.5	4.00	2.0	37.8	75.6	82.3	6.7		125.0	0.0	60.3	22.0	22.9	113.5	136.5	60.0	672	856
Jun	17.6	6.72	2.9	38.4	111.4	82.4	-29.0	-29.0	99.0	-26.0	86.5	21.9	22.4	56.8	79.2	34.8	390	497
Jul	20.0	8.16	3.4	38.7	131.6	98.6	-33.0	-61.9	75.0	-24.0	97.8	24.8	23.6	28.4	52.0	22.9	256	326
Aug	18.9	7.49	3.2	36.0	115.2	83.9	-31.3	-93.2	58.0	-17.0	80.5	20.4	22.0	14.2	36.2	15.9	178	227
Sep	14.5	5.01	2.4	31.2	74.9	87.8	12.9		70.9	12.9	59.7	15.2	18.6	7.1	25.7	11.3	127	161
Oct	8.2	2.12	1.3	28.5	37.1	67.4	30.4		101.3	30.4	29.5	7.5	13.0	4.0	17.1	7.5	84	107
Nov	2.5	0.35	0.4	24.3	9.7	87.1	77.4		125.0	23.7	7.8	55.6	34.3	2.0	36.4	16.0	179	228
Dec	-3.3	0.00	0.0	23.1	0.0	71.2	71.2		196.2	0.0	0.0	0.0	17.2	1.0	18.2	8.0	90	114
Total		**35.2**				**916.3**	**327.3**				**448.8**	**215.2**	**213.0**	**252.3**	**465.3**	**204.7**	**2,293**	**2,918**

POST-DEVELOPMENT CONDITION

Contributing Catchments: Non-Apartment Roo 201, 202, 203, C204
Contributing Area = 0.88 ha
Percent Impervious = 72%

Soil Type: Silt Loam
Vegetation: Shallow-rooted crops
Root Zone Depth = 0.62m
Soil Moisture Retention Capacity = 125 mm

Runoff Factor = 0.78
Evapotranspiration Factor for Impervious Surfaces = 0.33

Month	Daily Average Temperature	Monthly Heat Index	Unadjusted Daily Potential Evapotranspiration	Correction Factors	Adjusted Potential Evapotranspiration	Average Precipitation	P-PE	Accum. Pot. Water Loss	Storage	ΔS	Actual Evapotrans-piration	Moisture Surplus	Water Runoff	Snow Melt Runoff	Total Recharge & Runoff	Actual Runoff	Runoff Volume	Recharge Volume
	(°C)		(mm)		(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m^3)	(m^3)
Jan	-6.5	0.00	0.0	24.3	0.0	65.2	65.2		261.4	0.0	0.0	0.0	11.1	0.0	11.1	8.7	76	22
Feb	-5.5	0.00	0.0	24.6	0.0	54.9	54.9		316.3	0.0	0.0	0.0	5.6	0.0	5.6	4.3	38	11
Mar	-1	0.00	0.0	30.6	0.0	61.0	61.0		377.3	0.0	0.0	0.0	2.8	0.0	2.8	2.2	19	5
Apr	6.2	1.39	1.0	33.6	33.6	74.5	40.9		125.0	0.0	17.3	57.2	28.6	25.2	53.9	41.8	368	106
May	12.5	4.00	2.0	37.8	75.6	82.3	6.7		125.0	0.0	38.8	43.5	36.1	113.5	149.6	116.2	1,023	294
Jun	17.6	6.72	2.9	38.4	111.4	82.4	-29.0	-29.0	99.0	-26.0	55.7	52.7	44.4	56.8	101.2	78.6	692	199
Jul	20	8.16	3.4	38.7	131.6	98.6	-33.0	-61.9	75.0	-24.0	62.9	59.7	52.0	28.4	80.4	62.5	550	158
Aug	18.9	7.49	3.2	36.0	115.2	83.9	-31.3	-93.2	58.0	-17.0	51.8	49.1	50.6	14.2	64.8	50.3	443	127
Sep	14.5	5.01	2.4	31.2	74.9	87.8	12.9		70.9	12.9	38.4	36.4	43.5	7.1	50.6	39.3	346	99
Oct	8.2	2.12	1.3	28.5	37.1	67.4	30.4		101.3	30.4	19.0	18.0	30.8	4.0	34.8	27.0	238	68
Nov	2.5	0.35	0.4	24.3	9.7	87.1	77.4		125.0	23.7	5.0	58.4	44.6	2.0	46.6	36.2	319	92
Dec	-3.3	0.00	0.0	23.1	0.0	71.2	71.2		196.2	0.0	0.0	0.0	22.3	1.0	23.3	18.1	159	46
Total		**35.2**				**916.3**	**327.3**				**288.9**	**375.1**	**372.3**	**252.3**	**624.6**	**485.2**	**4,269**	**1,227**

Notes: Precipitation and Temperature data from Environment Canada Climate Normals 1981-2010 for Waterloo Wellington A
Monthly water balance strategy as outlined in the document *Instructions and Tables for Computing Potential Evapotranspiration and the Water Balance (Thornthwaite and Mather, 1957)*

1166- 1204 Gordon Street
CITY OF GUELPH
OUR FILE: 121139
2-Mar-22

POST-DEVELOPMENT CONDITION

Contributing Catchments: Apartment Roofs C200
Contributing Area = 0.24 ha
Percent Impervious = 100%

Soil Type: Silt Loam
Vegetation: Shallow-rooted crops
Root Zone Depth = 0.62m
Soil Moisture Retention Capacity = 125 mm

Runoff Factor = 1.00
Evapotranspiration Factor for Impervious Surfaces = 0.33

Month	Daily Average Temperature	Monthly Heat Index	Unadjusted Daily Potential Evapotranspiration	Correction Factors	Adjusted Potential Evapotranspiration	Average Precipitation	P-PE	Accum. Pot. Water Loss	Storage	ΔS	Actual Evapotrans-piration	Moisture Surplus	Water Runoff	Snow Melt Runoff	Total Recharge & Runoff	Total Recharge & Runoff	Enhanced Recharge	Runoff Volume	Recharge Through Pervious Surfaces	Total Recharge Volume
	(°C)		(mm)		(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)
Jan	-6.5	0.00	0.0	24.3	0.0	65.2	65.2		261.4	0.0	0.0	0.0	12.8	0.0	12.8	30.8	29	1.8	0	29
Feb	-5.5	0.00	0.0	24.6	0.0	54.9	54.9		316.3	0.0	0.0	0.0	6.4	0.0	6.4	15.4	15	0.4	0.0	15.0
Mar	-1	0.00	0.0	30.6	0.0	61.0	61.0		377.3	0.0	0.0	0.0	3.2	0.0	3.2	7.7	7	0.7	0.0	7.0
Apr	6.2	1.39	1.0	33.6	33.6	74.5	40.9		125.0	0.0	10.9	63.6	31.8	25.2	57.0	136.8	130	6.8	0.0	130.0
May	12.5	4.00	2.0	37.8	75.6	82.3	6.7		125.0	0.0	24.6	57.7	44.8	113.5	158.3	379.9	361	18.9	0.0	361.0
Jun	17.6	6.72	2.9	38.4	111.4	82.4	-29.0	-29.0	99.0	-26.0	35.3	73.1	59.0	56.8	115.7	277.7	264	13.7	0.0	264.0
Jul	20	8.16	3.4	38.7	131.6	98.6	-33.0	-61.9	75.0	-24.0	39.9	82.7	70.8	28.4	99.2	238.1	226	12.1	0.0	226.0
Aug	18.9	7.49	3.2	36.0	115.2	83.9	-31.3	-93.2	58.0	-17.0	32.8	68.1	69.5	14.2	83.7	200.8	191	9.8	0.0	191.0
Sep	14.5	5.01	2.4	31.2	74.9	87.8	12.9		70.9	12.9	24.4	50.5	60.0	7.1	67.1	161.0	153	8.0	0.0	153.0
Oct	8.2	2.12	1.3	28.5	37.1	67.4	30.4		101.3	30.4	12.0	25.0	42.5	4.0	46.5	111.7	106	5.7	0.0	106.0
Nov	2.5	0.35	0.4	24.3	9.7	87.1	77.4		125.0	23.7	3.2	60.2	51.4	2.0	53.4	128.1	122	6.1	0.0	122.0
Dec	-3.3	0.00	0.0	23.1	0.0	71.2	71.2		196.2	0.0	0.0	0.0	25.7	1.0	26.7	64.1	61	3.1	0.0	61.0
Total		**35.2**				**916.3**	**327.3**				**183.0**	**481.0**	**477.8**	**252.3**	**730.1**	**1,752.2**	**1,665.0**	**87.2**	**0.0**	**1,665.0**

Notes: Precipitation and Temperature data from Environment Canada Climate Normals 1981-2010 for Waterloo Wellington A
Monthly water balance strategy as outlined in the document *Instructions and Tables for Computing Potential Evapotranspiration and the Water Balance (Thornthwaite and Mather, 1957)*

1166- 1204 Gordon Street
CITY OF GUELPH
OUR FILE: 121139
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Infiltration Gallery Catchment 201

Site Infiltration Gallery

Structure Length = 7.00 m
Structure Width = 5.00 m
Structure Depth = 0.75 m

Contact Area of Gallery = 53.00 sq m

Volume of Gallery = 26.25 cu m

Storage Volume of Gallery = 25.46 cu m

A = contact area of structure = 53.00 sq m
V = runoff volume to be infiltrated = 25.46 cu m
P = percolation rate of native soils = 20.0 mm/hr
n = porosity of storage media (weighted) = 0.97
T = retention time = Solve for T

Note: Drawdown is based on flow from sides and bottom of gallery

T = (1000 x V) / (P x n x A) = 24.76 hours or 1.0 day draindown period

Contributing Area 0.240 ha (Area to Infiltration Gallery)
Recharge Time 24.76 hours / 1.03 days
Recharge Volume Potential 25.46 m^3

Month	Total Recharge & Runoff (mm)	No. of days	Max Potential Recharge (m^3)	Available Recharge (m^3)	Enhanced Recharge (m^3)
Jan	12.8	31	765	31	29
Feb	6.4	28	691	15	15
Mar	3.2	31	765	8	7
Apr	57.0	30	740	137	130
May	158.3	31	765	380	361
Jun	115.7	30	740	278	264
Jul	99.2	31	765	238	226
Aug	83.7	31	765	201	191
Sep	67.1	30	740	161	153
Oct	46.5	31	765	112	106
Nov	53.4	30	740	128	122
Dec	26.7	31	765	64	61
Total	**730.1**	**365.0**	**9,007.0**	**1,752.2**	**1,665.0**

1166- 1204 Gordon Street
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Month	Site				
	Existing **Recharge** Volume	Proposed **Recharge** Volume	Proposed **Recharge** Volume	Proposed **Recharge** Volume	Percent Change
	Total Site	Catch. 201, 202, 203, C204	Catch. 200	Total Site	
	(m^3)	(m^3)	(m^3)	(m^3)	(%)
Jan	54	22	29	51	-5.5%
Feb	27	11	15	26	-3.6%
Mar	13	5	7	12	-7.3%
Apr	308	106	130	236	-23.4%
May	856	294	361	655	-23.5%
Jun	497	199	264	463	-6.9%
Jul	326	158	226	384	17.7%
Aug	227	127	191	318	40.1%
Sep	161	99	153	252	56.6%
Oct	107	68	106	174	62.6%
Nov	228	92	122	214	-6.4%
Dec	114	46	61	107	-6.4%
Total	**2,918**	**1,227**	**1,665**	**2,892**	**-0.9%**