Stormwater Management Report

COMMERCIAL DEVELOPMENT

428 AND 432 KING STREET EAST

COBOURG, ONTARIO

March 10, 2020

Project No. n 1943

Prepared By:

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1.0 Introduction

n Architecture was retained by PLAZACOMM to be the civil engineering consultants responsible for the preparation of plans for site grading, site servicing and erosion and sediment control plans and obtaining approval from the town of Cobourg for a commercial development.

2.0 Site Location

The site is located at the north-east corner of the intersection of King Street East and Brook Road North as shown at Figure 1. The municipal (mailing) address is 428 and 432 King Street East, Cobourg. This rectangle shaped property is legally described as Part of lot 12, concession A Geographic township of Hamilton, Town of Cobourg, County of Northumberland.

3.0 Development Proposal

The proponent for this site proposes to develop the property consisting of four canopied fuel pumps, a C-store, Tim Horton's and retail stores with associated parking areas and driveways.. The total area of the property is 0.81 ha.

Potential stormwater management (SWM) strategies to mitigate any potential impacts per Ganaraska Region Conservation Authority design guidelines are presented in the report. New site servicing requirements for sanitary and water supply will also be discussed in the following sections.

FIGURE 1: KEY PLAN

4.0 Existing Conditions

FIGURE 2 – SITE EXISTING CONDITION

4.1 Site Characteristics / Topography

The site is mostly covered with grassed area, where also there is one storey house and some paved areas.

The site is sloped naturally from north to the south with highest point 87.0 at North West and lowest point 85.50 at south west, intersection of King St. E. and Brook Rd. N.

4.2 Vegetation

The majority of the site is grassed with some trees at north side.

4.3 Drainage

Currently there is no internal stormwater system within the property and the overall overland flow is in the south direction, towards the King Street. The pre development drainage pattern is shown on DR-101.

4.4 Existing Services

On King Street East, there are 750 mm dia. storm sewer, 200 mm dia. sanitary sewer and 400 mm watermain available and Also on Brook Road North, there are 400 mm Watermain, 300 mm sanitary sewer and 750 mm storm sewer available.

5.0 Proposed Development

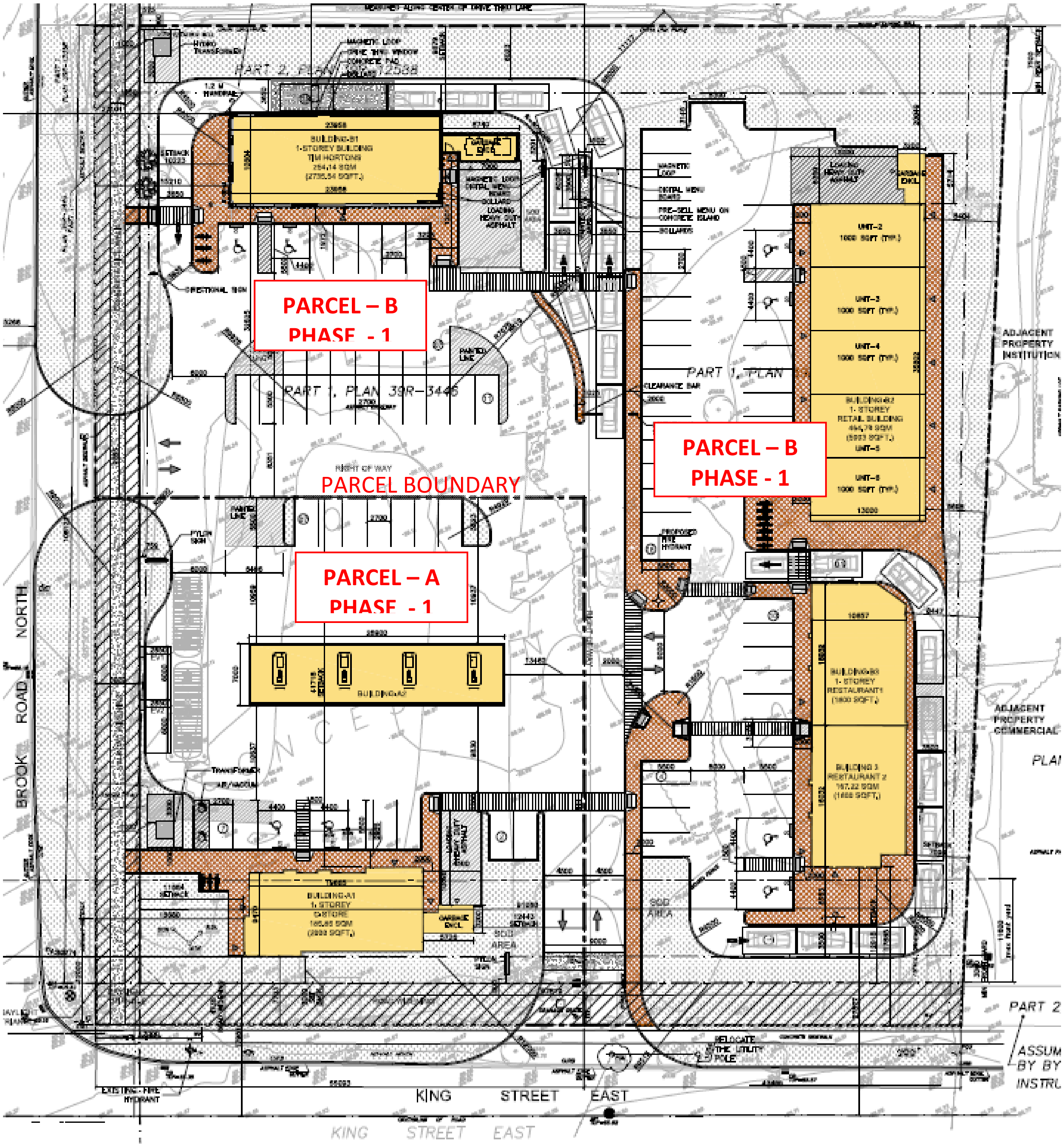

FIGURE 3 – PROPOSED DEVELOPMENT PLAN

Site is proposed to divide in two Parcels – namely Parcel A and Parcel B. Parcel A and Part of Parcel B proposed to developed in phase 1 and rest of parcel B proposed to develop in phase 2 (Refer: Figure 3). Parcel A proposed to have a gas station consist of canopied 8 pumps and a one story convenient store. Parcel B phase 1 development proposed to have a Tim Horton's restaurant. Total Area of the site is 1.13 ha. before road widening and 1.03 ha. after road widening. Area of Parcel A after road widening is 0.27 ha and Parcel B is 0.27 ha.

Site servicing and stormwater management will be proposed separately for Parcel A and Parcel B. Since site plan for phase 2 of Parcel B is not final yet – it will be considered as a separate development and provision for servicing will be provided based on the concept plan.

6.0 Stormwater Management Criteria

The proposed development shall follow the respective criteria/guidelines of the *"Technical and Engineering Guidelines for Stormwater Management Submissions" December 2014*, Ganaraska Region Conservation Authority. The criteria for proposed developments summarized as follows:

- **Water Quantity Control** – Post development storm discharge is to be controlled to pre-development levels of for 2 year through 100 years;
- **Water Quality Control** - long-term average removal of 80% of total suspended solids (TSS) on an annual loading basis from all runoff leaving the site;
- **Roof Drain Discharge Rate:** Roof drains should be selected to give a maximum discharge of 42 lps/ha of roof area.

6.0 Water Quantity Control Plan

Rainfall intensity calculated using Ganaraska Region Conservation Authority rainfall intensity formulas (Beyond Clarington) as follows:

$$I = \frac{a}{(b + T_d)}$$

Where:

I = Rainfall Intensity (mm/hr)

a = coefficient

b = coefficient

T_d= Time in Hour

Table 1: IDF Curve

Return Period (Years)	2 -Years	5-Years	10 -Years	25 -Years	50 -Years	100-Years
A	1778.0	2464.0	2819.0	3886.0	4750.0	5588.0
B	13.0	16.0	16.0	18.0	24.0	28.0

Design runoff calculated as follows:

$Q = 0.002778\ CIA$

Where:
Q = volume of runoff (m^3/sec)
C = runoff coefficient
A = contributing Area (hectares)
I = rainfall intensity (mm/hr)

7.0 Runoff Quantity Control for the Site

7.1 Quantity Control

Objective of Quantity Control is to achieve a target of post development discharge be controlled to the pre-development levels for the 2 year through 100 year event and a regional storm event with storage up to and including the 100 year storm event.

This site considered as "not developed" previously, therefore calculated composite runoff co-efficient and pre-deployment runoff volume are shown in Appendix B.

Considering proposed development runoff coefficients and volume of post-development runoff calculated and presented in Appendix B.

Pre and post-development runoff coefficient and flows from 2-year to 100-year rainfall event are summarized in Table 1.

Table 2A: Runoff Coefficient and Flows Summary (Parcel A)

Land-use	Run-off Co-efficient	2-yrs	5-yrs	10-yrs	25-yrs	50-yrs	100-yrs
Pre-development (L/sec)	0.52	25.22	31.57	36.12	46.77	48.38	51.62
Post-development (L/sec)	0.84	49.53	60.72	69.47	88.92	89.51	94.22

Table 2B: Runoff Coefficient and Flows Summary (Parcel B – Phase 1)

Land-use	Run-off Co-efficient	2-yrs	5-yrs	10-yrs	25-yrs	50-yrs	100-yrs
Pre-development (L/sec)	0.34	20.08	25.14	28.76	37.24	38.52	41.10
Post-development (L/sec)	0.83	59.88	73.41	83.98	107.50	108.21	113.90

Table 2C: Runoff Coefficient and Flows Summary (Parcel B – Phase 2)

Land-use	Run-off Co-efficient	2-yrs	5-yrs	10-yrs	25-yrs	50-yrs	100-yrs
Pre-development (L/sec)	0.29	21.31	26.68	30.52	39.53	40.88	43.62
Post-development (L/sec)	0.82	73.58	90.20	103.20	132.10	132.98	139.97

Note: Calculation of run-off co-efficient and flows calculated based on the preliminary concept plan (Dwg A 1.0)

7.2 Orifice Control:

Discharge form storm events from 2 year up to 100 years proposed to be restricted by installing orifice pipes. Orifice sizing calculations are presented in Appendix C and summarized in Table 3. Comparison controlled flow through orifice and allowable flow limit presented in Table 3.

Table 3: Controlled Flow through Orifice

Drainage Area	Orifice Pipe Size (mm)	Allowable Discharge (L/sec)			Controlled Discharge (L/sec)		
		2-yrs	5-yrs	100-yrs	2-yrs	5-yrs	100-yrs
PARCEL A	88	25.22	31.57	51.62	25.08	27.72	32.36
PARCEL B (PHASE -1)	78	20.08	25.14	41.10	19.74	21.81	25.45
PARCEL B (PHASE -2)	TBD	21.31	26.68	43.62	*To be design during Phase-2 Development*		

7.3 On-site Detention Storage:

Require detention storage caused by flow restriction calculated for 2, 5, 10, 25, 50 and 100 years rainfall events and presented in Appendix C. Available detention storage calculated and attached in Appendix C. Detention Storage calculation summarized in Table 4.

Table 4: Detention Storage Summary

Drainage Area	Maximum Detention Storage Required (m^3)			Available Storage (m^3)
	2-yrs	5-yrs	100-yrs	
PARCEL –A	14.77	20.92	53.05	56.59
PARCEL-B (PHASE -1)	26.69	37.51	91.71	95.87
PARCEL-B (PHASE -2)	*To be designed during Phase – 2 development*			

7.2 Minor Storm Sewer System:

Designing the storm sewers to makes sure the capacity to transportation of the runoff of only a 5-year storm event to the municipal drain. The post-development drainage areas for the site are shown on Drawing DR-102 in the Appendix A.

Detailed breakdown of the land use and the runoff coefficients during post-development conditions are given in Drawing DR-102. The calculations for the sizing of the pipes for channelling the surface water flow from a 5-year storm event system are presented in Design Sheet (Appendix C).

7.3 Major Drainage System:

The overland flow will not impact the proposed developed site since the grading of the site ensures storm flows greater than 100 years will be able to flow overland through the site without any impact to King Road East (Refer: Drawing C1).

8.0 Water Quality Control Plan

8.1 Oil and Grit Separator

To substantially improve the water quality of the water leaving the site, an oil/grit separating device proposed that be installed for water quality treatment. The suggested unit for the area of the site and the level of treatment desired will be in accordance with the attached "Hydroworks Sizing Summary". Owner's manual and details also attached in Appendix F. Sizing of Oil and Grit separator summarized in Table 5.

Table 5: TSS Removal Design Summary

Development Area	Proposed Model	Flow Capture (%)	TSS Removal (%)
Parcel A	Hydrostorm HS6	99	83
Parcel B – Phase 1	Hydrostorm HS6	99	84
Parcel B –Phase 2	*To be designed during Phase 2 development*		

9.0 Erosion and Sediment Control

During the construction period, total sediment loadings are much greater than for pre-development and post-development conditions. Also, with site regarding, water borne sediment quantities will increase. As a consequence, sediment control will be required during the construction phase.

Sediment control could be effectively implemented by the following procedures that are recommended to minimize the transportation of sediments out of the property, especially during construction:

1. Filter bags shall be attached to hoses where pumping is carried out from excavations and the filter bags shall be maintained on a regular basis;
2. During the construction period, a mud mat shall be provided at the entrance into and the exit from the area under construction, to minimize sediment transportation from the site to the municipal roads;
3. Limit extent of exposed excavation;
4. Installation of a silt fence to prevent sediment from entering the existing conveyance system;
5. Provide sediment traps to existing catch basins;
6. Scheduling construction during times when there is no danger of flooding.

10.0 Summary

- To control post-development runoff to pre-development runoff up to 100-year rainfall event, quantity controls are required which are provided through orifice control.
- To ensure water quality a Stormceptor (HS6) is recommended for the site.
- Overland flow route through the site ensures that major overland flows are safely carried through the site.
- Erosion control such as installation of temporary silt fence, mud matt & rock check dams are recommended to minimize off-site sediment transport.

We trust you will find this submission complete and in order. Should you have any questions, please contact the undersigned.

Respectfully submitted.

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PROVINCE OF ONTARIO

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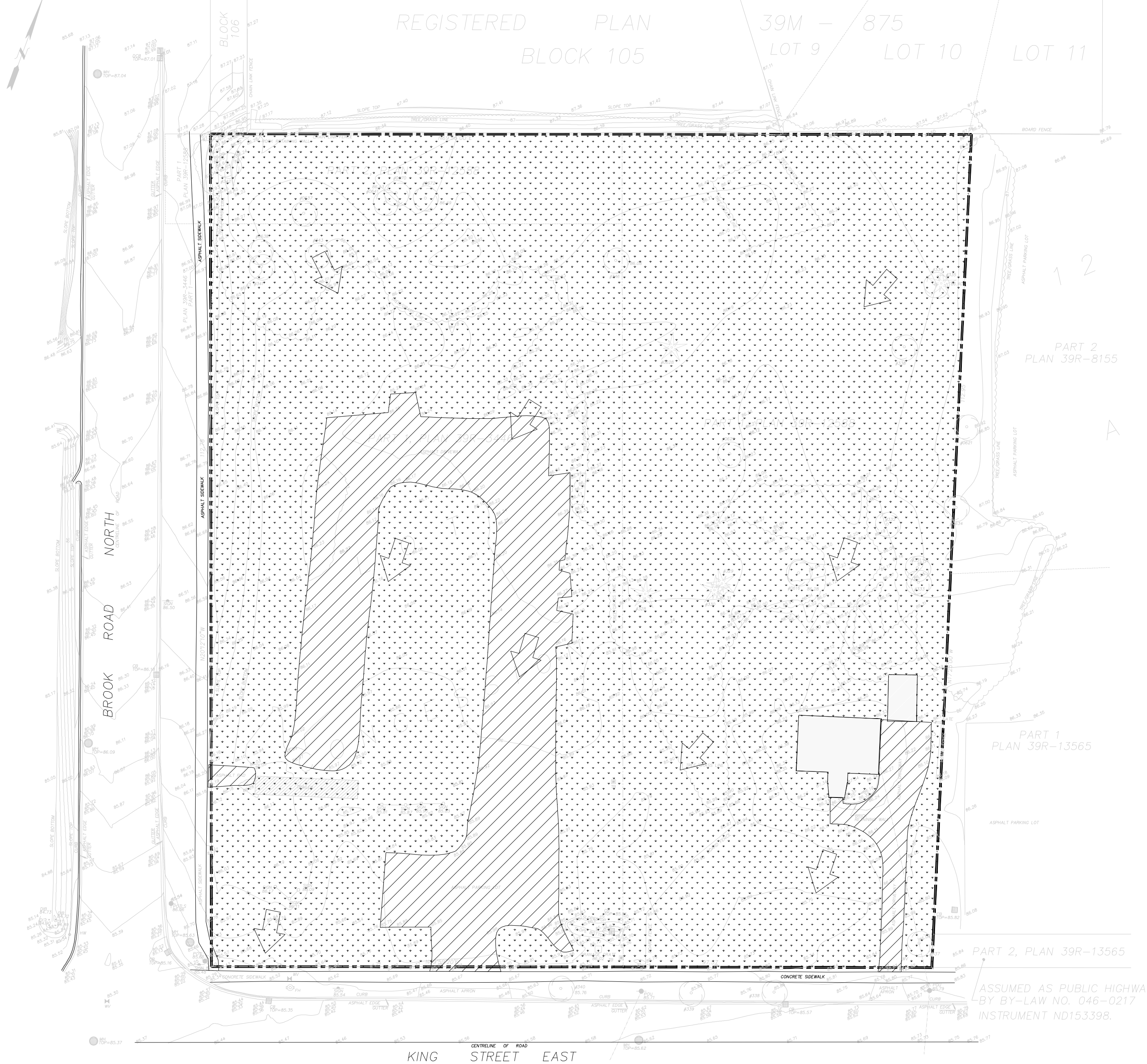
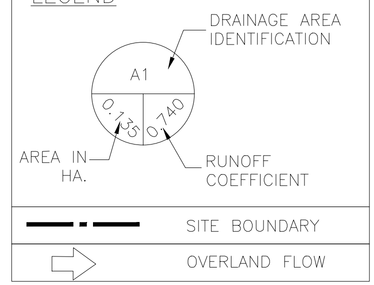
Appendix A
Figures



PRE-DEVELOPMENT LAND USE TABLE

LAND COVER	HATCH	AREA (SQ.M.)	RUNOFF CO-EFFICCIENT
ROOF		113.50	0.95
LANDSCAPING		9544.06	0.25
CONCRETE/ ASPHALT		1663.02	0.95

LEGEND



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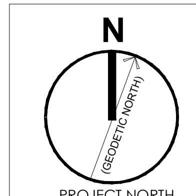
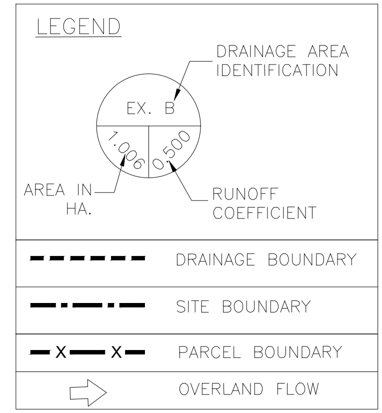
PROJECT:
COMMERCIAL DEVELOPMENT 428 AND 432 KING STREET EAST, COBOURG, ON

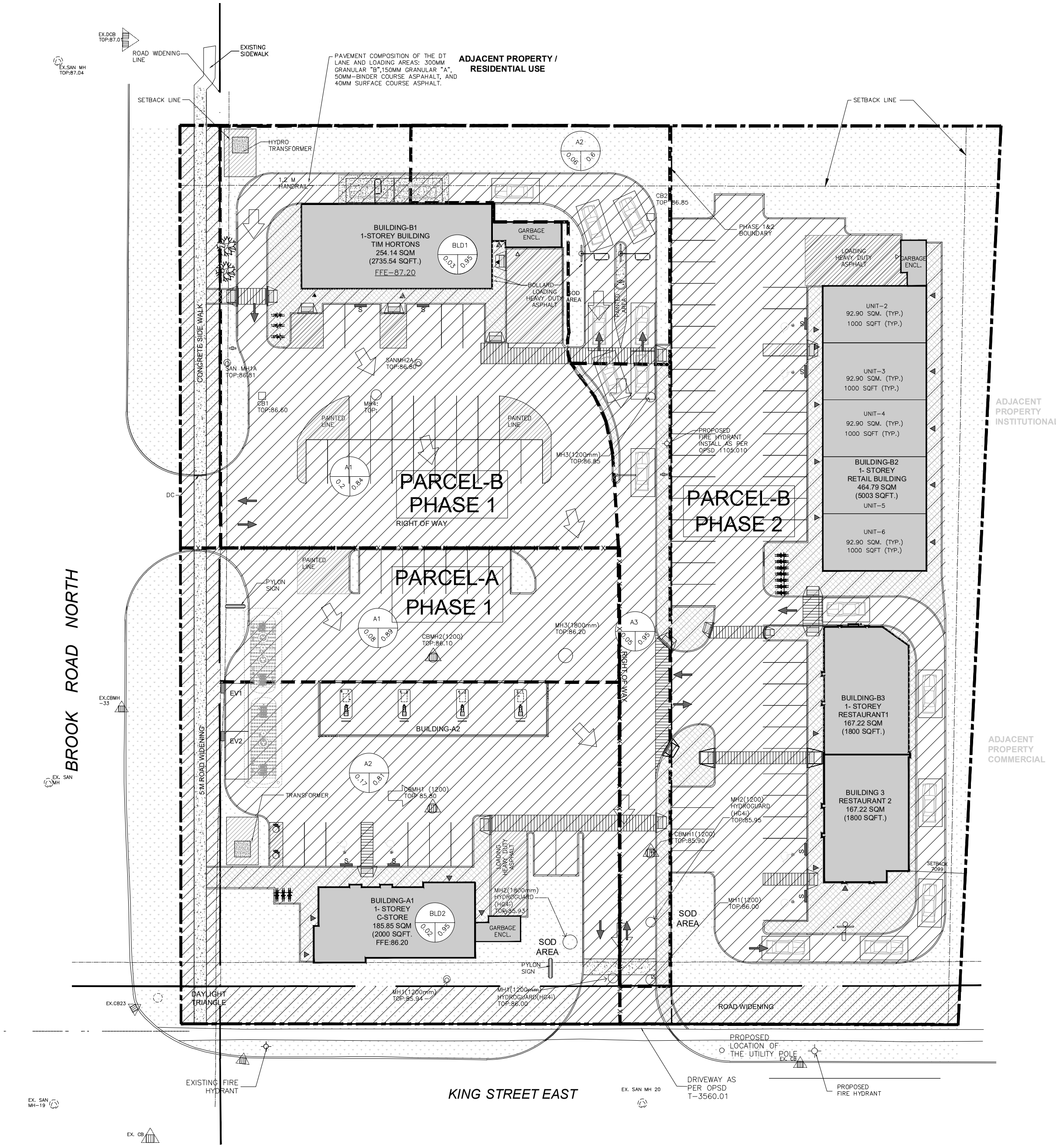
DRAWING TITLE:
PRE-DEVELOPMENT SITE DRAINAGE PLAN

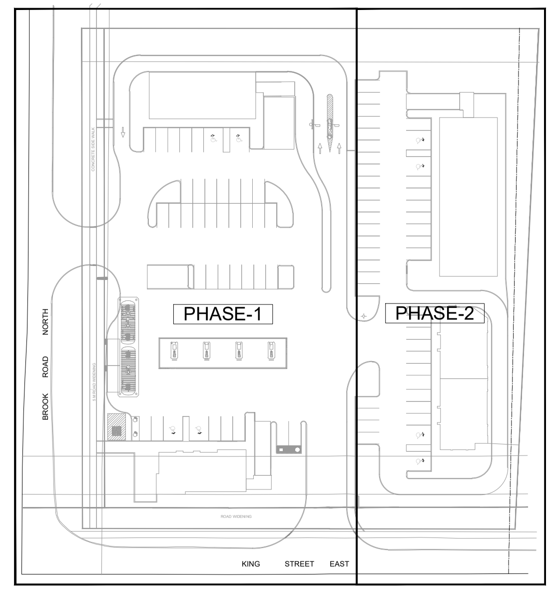
DRAWN BY: AZ	DATE: 21 OCTOBER 2019
CHECKED BY: AZ	SCALE: NTS
PROJECT NO.: 19-43	DRAWING NO.: DR-101



LAND COVER	HATCH	AREA (SQ.M.)	RUNOFF CO-EFFICCIENT
ROOF		1265.89	0.95
LANDSCAPING		2014.67	0.25
CONCRETE/ ASPHALT		7038.42	0.95







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PROJECT:

COMMERCIAL DEVELOPMENT 428 AND 432 KING STREET EAST, COBOURG, ON

DRAWING TITLE:

POST-DEVELOPMENT SITE DRAINAGE PLAN

DRAWN BY: AZ	DATE: 21 OCTOBER 2019
CHECKED BY: AZ	SCALE: NTS
PROJECT NO.:	DRAWING NO.:
19-43	**DR-102**

N

(GEODETIC NORTH)

PROJECT NORTH

Appendix B
Flow Analysis

Calculation Sheet 1A

(PARCEL A)

n Architecture Inc

Project:	Commercial Development
Address:	428-432 King Street East-ParcelA
Town/Township/City	Town of Cobourg, ON
Project No.	n1943
Proposed Development Area (m^2)	2751.82
Date:	3/9/2020

PRE-DEVELOPMENT RUNOFF COFFICENT

AREA TYPE	AREA (M^2)	RUNOFF COEFFICIENT "C"	AREA x C
ASPHALT	1060.0	0.95	1007.00
BUILDING ROOF	0.0	0.95	0.00
LANDSCAPED AREA	1691.8	0.25	422.96
		ΣAREA X C	1429.96
		WEIGHTED AVERAGE "C"	**0.52**
		AREA "A" (Hectares)	0.2752

Rainfall intensity:

$$I = \frac{a}{(b + T_d)}$$

I = Rainfall Intensity (mm/hr)
a = coefficient
b = coefficient

T_d=Time of concentration(hr) 0.25

Design Flow:

$$Q = 0.002778CIA$$

Where:

Q= volume of runoff (m^3/second)
C = Runoff coefficient
A = contributing draingae area (hectares)
I= rainfall intensity (milimeters/hour)
I= Average rainfall intensity (milimeters/hour)

Return Period (Years)	2 -Years	5-Years	10 -Years	25 -Years	50 -Years	100-Years
a	1778.0	2464.0	2819.0	3886.0	4750.0	5588.0
b	13.0	16.0	16.0	18.0	24.0	28.0
T_d (mins)	15.00	15.00	15.00	15.00	15.00	15.00
i (mm/hr)	63.50	79.48	90.94	117.76	121.79	129.95
C	0.52	0.52	0.52	0.52	0.52	0.52
Q (m^3/sec)	0.03	0.03	0.04	0.05	0.05	0.05
Q (l/sec)	25.22	31.57	36.12	46.77	48.38	51.62

Rainfall intensity formulas (beyond Clarigton) as per Ganaraska Region Conservation Authority, Dec 2014

Calculation Sheet 2A

(PARCEL-A)

n Architecture Inc

Project:	Commercial Development
Address:	428-432 King Street East-ParcelA
Town/Township/City	Town of Cobourg, ON
Project No.	n1943
Proposed Development Area (m^2)	2751.82
Date:	3/9/2020

POST DEVELOPMENT RUNOFF COFFICENT

AREA TYPE	AREA (M^2)	RUNOFF COEFFICIENT "C"	AREA x C
ASPHALT/CONC.	2126.47	0.95	2020.15
LANDSCAPED AREA	439.50	0.25	109.88
BUILDING	185.85	0.95	176.56
		ΣAREA X C	2306.58
		WEIGHTED AVERAGE "C"	**0.84**
		AREA "A" (Hectares)	0.2752

Rainfall intensity:

$$I = \frac{a}{(b + T_d)}$$

I = Rainfall Intensity (mm/hr)

a = coefficient

b = coefficient

T_d=Time of concentration(hr) 0.25

Design Flow:

$$Q = 0.002778CIA$$

Where:

Q= volume of runoff (m^3/second)

C = Runoff coefficient

A = contributing draingae area (hectares)

I= rainfall intensity (milimeters/hour)

I= Average rainfall intensity (milimeters/hour)

Return Period (Years)	2 -Years	5-Years	10 -Years	25 -Years	50 -Years	100-Years
A	1778.0	2464.0	2819.0	3886.0	4750.0	5588.0
B	13.0	16.0	16.0	18.0	24.0	28.0
t (mins)	10.00	10.00	10.00	10.00	10.00	10.00
I (mm/hr)	77.30	94.77	108.42	138.79	139.71	147.05
C	0.84	0.84	0.84	0.84	0.84	0.84
Q (m^3/sec)	0.05	0.06	0.07	0.09	0.09	0.09
Q (l/sec)	49.53	60.72	69.47	88.92	89.51	94.22

Rainfall intensity formulas (beyond Clarigton) as per Ganaraska Region Conservation Authority, Dec 2014

Calculation Sheet 1B1

(PARCEL-B PHASE -1)

n Architecture inc

Project:	**Commercial Development**
Address:	**428-432 King Street East-ParcelB**
Town/Township/City	**Town of Cobourg, ON**
Project No.	**n1943**
Proposed Development Area (m^2)	**3370**
Date:	**3/9/2020**

PRE-DEVELOPMENT RUNOFF COFFICENT

AREA TYPE	AREA (M^2)	RUNOFF COEFFICIENT "C"	AREA x C
ASPHALT	423.000	0.95	401.85
BUILDING ROOF	0.000	0.95	0.00
LANDSCAPED AREA	2947.000	0.25	736.75
		ΣAREA X C	1138.60
		WEIGHTED AVERAGE "C"	**0.34**
		AREA "A" (Hectares)	0.3370

Rainfall intensity:

$$I = \frac{a}{(b + T_d)}$$

Where:

I = Rainfall Intensity (mm/hr)
a = coefficient
b = coefficient
T_d=Time of concentration(hr) 0.25

Design Flow:

$$Q = 0.002778CIA$$

Where:

Q= volume of runoff (m^3/second)
C = Runoff coefficient
A = contributing draingae area (hectares)
I= rainfall intensity (milimeters/hour)

Return Period (Years)	2 -Years	5-Years	10 -Years	25 -Years	50 -Years	100-Years
a	1778.0	2464.0	2819.0	3886.0	4750.0	5588.0
b	13.0	16.0	16.0	18.0	24.0	28.0
t (mins)	15.00	15.00	15.00	15.00	15.00	15.00
i (mm/hr)	63.50	79.48	90.94	117.76	121.79	129.95
Modified C	0.34	0.34	0.34	0.34	0.34	0.34
Q (m^3/sec)	0.02	0.03	0.03	0.04	0.04	0.04
Q (l/sec)	20.08	25.14	28.76	37.24	38.52	41.10

Rainfall intensity formulas (beyond Clarigton) as per Ganaraska Region Conservation Authority, Dec 2014

Calculation Sheet 2B1

(PARCEL-B PHASE-1)

Project:	**Commercial Development**
Address:	**428-432 King Street East-ParcelB**
Town/Township/City	**Town of Cobourg, ON**
Project No.	**n1943**
Proposed Development Area (m^2)	**3370**
Date:	**3/9/2020**

POST DEVELOPMENT RUNOFF COFFICENT

AREA TYPE	AREA (M^2)	RUNOFF COEFFICIENT "C"	AREA x C
ASPHALT/CONC.	2525.800	0.95	2399.51
LANDSCAPED AREA	590.000	0.25	147.50
BUILDING	254.140	0.95	241.43
		ΣAREA X C	2788.44
		WEIGHTED AVERAGE "C"	**0.83**
		AREA "A" (Hectares)	0.3370

Rainfall intensity:

$$I = \frac{a}{(b + T_d)}$$

Where:

I = Rainfall Intensity (mm/hr)

a = coefficient

b = coefficient

T_d=Time of concentration(hr) 0.25

Design Flow:

$$Q = 0.002778CIA$$

Where:

Q= volume of runoff (m^3/second)

C = Runoff coefficient

A = contributing draingae area (hectares)

I= rainfall intensity (milimeters/hour)

Return Period (Years)	2 -Years	5-Years	10 -Years	25 -Years	50 -Years	100-Years
a	1778.0	2464.0	2819.0	3886.0	4750.0	5588.0
b	13.0	16.0	16.0	18.0	24.0	28.0
t (mins)	10.00	10.00	10.00	10.00	10.00	10.00
I (mm/hr)	77.30	94.77	108.42	138.79	139.71	147.05
Modified C	0.83	0.83	0.83	0.83	0.83	0.83
Q (m^3/sec)	0.06	0.07	0.08	0.11	0.11	0.11
Q (l/sec)	59.88	73.41	83.98	107.50	108.21	113.90

Rainfall intensity formulas (beyond Clarigton) as per Ganaraska Region Conservation Authority, Dec 2014

Calculation Sheet 1B2

(PARCEL -B PHASE-2)

n Architecture inc

Project:	Gas Station
Address:	428-432 King Street East-ParcelB
Town/Township/City	Township of Cobourg, ON
Project No.	n1943
Proposed Development Area (m^2)	3370
Date:	3/9/2020

PRE-DEVELOPMENT RUNOFF COFFICENT

AREA TYPE	AREA (M^2)	RUNOFF COEFFICIENT "C"	AREA x C
ASPHALT	200.000	0.95	190.00
BUILDING ROOF	27.690	0.95	26.31
LANDSCAPED AREA	3968.310	0.25	992.08
		ΣAREA X C	1208.38
		WEIGHTED AVERAGE "C"	**0.29**
		AREA "A" (Hectares)	0.4196

Rainfall intensity:

$$I = \frac{a}{(b + T_d)}$$

Where:

I = Rainfall Intensity (mm/hr)
a = coefficient
b = coefficient
T_d=Time of concentration(hr) 0.25

Design Flow:

$$Q = 0.002778CIA$$

Where:

Q= volume of runoff (m^3/second)
C = Runoff coefficient
A = contributing draingae area (hectares)
I= rainfall intensity (milimeters/hour)

Return Period (Years)	2 -Years	5-Years	10 -Years	25 -Years	50 -Years	100-Years
a	1778.0	2464.0	2819.0	3886.0	4750.0	5588.0
b	13.0	16.0	16.0	18.0	24.0	28.0
t (mins)	15.00	15.00	15.00	15.00	15.00	15.00
i (mm/hr)	63.50	79.48	90.94	117.76	121.79	129.95
Modified C	0.29	0.29	0.29	0.29	0.29	0.29
Q (m^3/sec)	0.02	0.03	0.03	0.04	0.04	0.04
Q (l/sec)	21.31	26.68	30.52	39.53	40.88	43.62

Rainfall intensity formulas (beyond Clarigton) as per Ganaraska Region Conservation Authority, Dec 2014

Calculation Sheet 2B2

(Parcel B -Phase 2)

n Architecture Inc

Project:	**Gas Station**
Address:	**428-432 King Street East-Parcel B**
Town/Township/City	**Township of Cobourg, ON**
Project No.	**n1943**
Proposed Development Area (m^2)	**3370**
Date:	**3/10/2020**

POST DEVELOPMENT RUNOFF COFFICENT

AREA TYPE	AREA (M^2)	RUNOFF COEFFICIENT "C"	AREA x C
ASPHALT/CONC.	2277.560	0.95	2163.68
LANDSCAPED AREA	799.440	0.25	199.86
BUILDING	1119.000	0.95	1063.05
		ΣAREA X C	3426.59
		WEIGHTED AVERAGE "C"	**0.82**
		AREA "A" (Hectares)	0.4196

Rainfall intensity:

$$I = \frac{a}{(b + T_d)}$$

Where:

I = Rainfall Intensity (mm/hr)

a = coefficient

b = coefficient

T_d=Time of concentration(hr) 0.25

Design Flow:

$$Q = 0.002778CIA$$

Where:

Q= volume of runoff (m^3/second)

C = Runoff coefficient

A = contributing draingae area (hectares)

I= rainfall intensity (milimeters/hour)

Return Period (Years)	2 -Years	5-Years	10 -Years	25 -Years	50 -Years	100-Years
a	1778.0	2464.0	2819.0	3886.0	4750.0	5588.0
b	13.0	16.0	16.0	18.0	24.0	28.0
t (mins)	10.00	10.00	10.00	10.00	10.00	10.00
I (mm/hr)	77.30	94.77	108.42	138.79	139.71	147.05
Modified C	0.82	0.82	0.82	0.82	0.82	0.82
Q (m^3/sec)	0.07	0.09	0.10	0.13	0.13	0.14
Q (l/sec)	73.58	90.20	103.20	132.10	132.98	139.97

Rainfall intensity formulas (beyond Clarigton) as per Ganaraska Region Conservation Authority, Dec 2014

Appendix C

Orifice Sizing
Detention Storage Analysis

n Architecture inc

Table 1A

Orifice Sizing Calculations

(PARCEL -A)

Project:	**Commercial Development**
Address:	**428-432 King Street East-Parcel A**
Town/Township/City	**Town of Cobourg, ON**
Project No.	**n1943**
Proposed Development Area (m^2)	**6814.59**
Date:	**3/9/2020**

Orifice Location	MH1	
Orifice Type	Eccentric Reducer Pipe	
Invert Elevation	83.600	m
Min. Ground Elevation	85.900	m
Orifice Center Elevation	83.644	
Diameter of Orifce Pipe	88	mm
Area of Orifice (A)	0.00607904	m^2
Coefficient of Discharge (C_d)	0.8	
Gravitational Constant	9.81	

Orifice Flow Equation:

$$Q = C_d A_o \sqrt{(2gH)}$$

Where:

Q = Flow (m3/sec)

A_o = Orifice area (m2)

g = Gravitational Constant

H = Center line head (m)

C_d = coefficient of discharge, dimensionless, typically between 0.6 and 0.85, depending on the orifice geometry

	2 years	5 years	10 years	25 years	50 years	100 years
Ponding Depth (m)	-0.900	-0.600	-0.350	-0.200	-0.050	0.000
Water Elevation	85.00	85.30	85.55	85.70	85.85	85.90
Upstearm Head (m)	1.356	1.656	1.906	2.056	2.206	2.256
Total Discharge (L/sec)	**25.08**	**27.72**	**29.74**	**30.89**	**31.99**	**32.36**
Discharge Velocity (m/sec)	4.13	4.56	4.89	5.08	5.26	5.32
Pre-developmet Peak Flow (L/sec)	**25.22**	**31.57**	**36.12**	**46.77**	**48.38**	**51.62**
Uncontrolled Flow (L/sec)	0.00	0.00	0.00	0.00	0.00	0.00
Allowable Peak Flow (l/sec)	**25.22**	**31.57**	**36.12**	**46.77**	**48.38**	**51.62**
Detention Storage Required (m^3)	**14.77**	**20.92**	**25.67**	**41.56**	**45.23**	**53.05**
Total Available Storage (m^3)	**56.59**	**56.59**	**56.59**	**56.59**	**56.59**	**56.59**

n Architectura Inc

Table 1B-1

Orifice Sizing Calculations

(PARCEL- B-PHASE 1)

Project:	**Commercial Development**
Address:	**428-432 King Street East-Parcel B**
Town/Township/City	**Town of Cobourg, ON**
Project No.	**n1943**
Proposed Development Area (m^2)	**6814.59**
Date:	**3/9/2020**

Orifice Location	MH1	
Orifice Type	Eccentric Reducer Pipe	
Invert Elevation	83.600	m
Min. Ground Elevation	85.900	m
Orifice Center Elevation	83.639	
Diameter of Orifce Pipe	78	mm
Area of Orifice (A)	0.00477594	m^2
Coefficient of Discharge (C_d)	0.8	
Gravitational Constant	9.81	

Orifice Flow Equation:

$$Q = C_d A_o \sqrt{(2gH)}$$

Where:

Q = Flow (m3/sec)

A_o = Orifice area (m2)

g = Gravitational Constant

H = Center line head (m)

C_d = coefficient of discharge, dimensionless, typically between 0.6 and 0.85, depending on the orifice geometry

	2 years	5 years	10 years	25 years	50 years	100 years
Ponding Depth (m)	-0.900	-0.600	-0.350	-0.200	-0.050	0.000
Water Elevation	85.00	85.30	85.55	85.70	85.85	85.90
Upstearm Head (m)	1.361	1.661	1.911	2.061	2.211	2.261
Total Discharge (L/sec)	**19.74**	**21.81**	**23.40**	**24.30**	**25.16**	**25.45**
Discharge Velocity (m/sec)	4.13	4.57	4.90	5.09	5.27	5.33
Pre-developmet Peak Flow (L/sec)	**20.08**	**25.14**	**28.76**	**37.24**	**38.52**	**41.10**

Detention Storage Required (m^3)	**26.69**	**37.51**	**44.98**	**44.98**	**78.11**	**91.71**
Total Available Storage	**92.87**	**92.87**	**92.87**	**92.87**	**92.87**	**92.87**

On-Site Storage Calculator

Town of Cobourg, ON

Project: **Commercial Development**

Project No.: **n1943**

Date: **10-Mar-20**

n Architecture Inc

Table 2A - 2 Years Storage (PARCEL A)

Equation of IDF:

Comp. Runoff Coeff.R = 0.84

A = 0.28 ha

Q *release* = 0.025 m^3/s

25.08 L/s

$$i = \frac{A}{(t+B)^C}$$

I = Rainfall Intensity (mm/hr)

T = Time of Concentration (hr)

a= 1778

b= 13

Storage Required (m^3) 14.77

t_d (min)	i_2 (mm/hr)	Q_2 (m^3/s)	Q_{stored} (m^3/s)	Peak Volume (m^3)	
10	77.30	0.050	0.024	14.667	
11	74.08	0.047	0.022	14.772	***
12	71.12	0.046	0.020	14.748	
13	68.38	0.044	0.019	14.610	
14	65.85	0.042	0.017	14.371	
15	63.50	0.041	0.016	14.041	
16	61.31	0.039	0.014	13.630	
17	59.27	0.038	0.013	13.146	
18	57.35	0.037	0.012	12.597	
19	55.56	0.036	0.011	11.988	
20	53.88	0.035	0.009	11.324	
21	52.29	0.034	0.008	10.611	
22	50.80	0.033	0.007	9.852	
23	49.39	0.032	0.007	9.053	
24	48.05	0.031	0.006	8.215	
25	46.79	0.030	0.005	7.342	
26	45.59	0.029	0.004	6.436	
27	44.45	0.028	0.003	5.501	
28	43.37	0.028	0.003	4.537	
29	42.33	0.027	0.002	3.548	
30	41.35	0.026	0.001	2.535	
31	40.41	0.026	0.001	1.500	
32	39.51	0.025	0.000	0.443	

On-Site Storage Calculator

Town of Cobourg, ON

Project: **Commercial Development**
Project No.: **n1943**
Date: **10-Mar-20**

n Architecture Inc

Table 2B - 5 Years Storage (PARCEL A)

Equation of IDF:

Comp. Runoff Coeff.R = 0.84
A = 0.28 ha
$Q_{release}$ = 0.028 m^3/s
27.72 L/s

$$i = \frac{A}{(t+B)^C}$$

I = Rainfall Intensity (mm/hr)
T = Time of Concentration (hr)
a= 2464
b= 16

Storage Required (m^3) 20.92

t_d (min)	i_5 (mm/hr)	Q_5 (m^3/s)	Q_{stored} (m^3/s)	Peak Volume (m^3)	
10	94.77	0.061	0.033	19.800	
11	91.26	0.058	0.031	20.295	
12	88.00	0.056	0.029	20.637	
13	84.97	0.054	0.027	20.840	
14	82.13	0.053	0.025	20.919	***
15	79.48	0.051	0.023	20.885	
16	77.00	0.049	0.022	20.750	
17	74.67	0.048	0.020	20.522	
18	72.47	0.046	0.019	20.209	
19	70.40	0.045	0.017	19.820	
20	68.44	0.044	0.016	19.359	
21	66.59	0.043	0.015	18.834	
22	64.84	0.042	0.014	18.249	
23	63.18	0.040	0.013	17.608	
24	61.60	0.039	0.012	16.916	
25	60.10	0.039	0.011	16.177	
26	58.67	0.038	0.010	15.394	
27	57.30	0.037	0.009	14.570	
28	56.00	0.036	0.008	13.708	
29	54.76	0.035	0.007	12.810	
30	53.57	0.034	0.007	11.879	
31	52.43	0.034	0.006	10.917	
32	51.33	0.033	0.005	9.925	
33	50.29	0.032	0.004	8.906	
34	49.28	0.032	0.004	7.862	
35	48.31	0.031	0.003	6.793	
36	47.38	0.030	0.003	5.701	
37	46.49	0.030	0.002	4.588	
38	45.63	0.029	0.002	3.454	
39	44.80	0.029	0.001	2.301	
40	44.00	0.028	0.000	1.130	

On-Site Storage Calculator

Town of Cobourg, ON

Project: Commercial Development

Project No.: n1943

Date: 10-Mar-20

n Architecture Inc

Table 2C - 10 Years Storage (PARCEL A)

Comp. Runoff Coeff.R = 0.84

A = 0.28 ha

Q *release* = 0.030 m^3/s

29.74 L/s

Equation of IDF:

$$i = \frac{A}{(t+B)^C}$$

I = Rainfall Intensity (mm/hr)

T = Time of Concentration (hr)

a= 2819

b= 16

Storage Required (m^3) 25.67

t_d (min)	i_{10} (mm/hr)	Q_{10} (m^3/s)	Q_{stored} (m^3/s)	Peak Volume (m^3)	
10	108.42	0.069	0.040	23.837	
11	104.41	0.067	0.037	24.523	
12	100.68	0.065	0.035	25.032	
13	97.21	0.062	0.033	25.383	
14	93.97	0.060	0.030	25.592	
15	90.94	0.058	0.029	25.672	***
16	88.09	0.056	0.027	25.635	
17	85.42	0.055	0.025	25.493	
18	82.91	0.053	0.023	25.254	
19	80.54	0.052	0.022	24.927	
20	78.31	0.050	0.020	24.518	
21	76.19	0.049	0.019	24.036	
22	74.18	0.048	0.018	23.485	
23	72.28	0.046	0.017	22.870	
24	70.48	0.045	0.015	22.197	
25	68.76	0.044	0.014	21.470	
26	67.12	0.043	0.013	20.693	
27	65.56	0.042	0.012	19.869	
28	64.07	0.041	0.011	19.001	
29	62.64	0.040	0.010	18.092	
30	61.28	0.039	0.010	17.145	
31	59.98	0.038	0.009	16.163	
32	58.73	0.038	0.008	15.147	
33	57.53	0.037	0.007	14.100	
34	56.38	0.036	0.006	13.023	
35	55.27	0.035	0.006	11.919	
36	54.21	0.035	0.005	10.788	
37	53.19	0.034	0.004	9.633	
38	52.20	0.033	0.004	8.454	
39	51.25	0.033	0.003	7.254	
40	50.34	0.032	0.003	6.033	
41	49.46	0.032	0.002	4.791	
42	48.60	0.031	0.001	3.531	
43	47.78	0.031	0.001	2.254	
44	46.98	0.030	0.000	0.959	

On-Site Storage Calculator

Town of Cobourg, ON

Project: **Commercial Development**

Project No.: **n1943**

Date: **10-Mar-20**

n Architecture Inc

Table 2D - 25 Years Storage (PARCEL A)

Comp. Runoff Coeff.R = 0.84

A = 0.28 ha

$Q_{release}$ = 0.031 m^3/s

30.89 L/s

Equation of IDF:

$$i = \frac{A}{(t+B)^C}$$

I = Rainfall Intensity (mm/hr)

T = Time of Concentration (hr)

a= 3886

b= 18

Storage Required (m^3) 41.56

t_d (min)	i_{25} (mm/hr)	Q_{25} (m^3/s)	Q_{stored} (m^3/s)	Peak Volume (m^3)	
10	138.79	0.089	0.058	34.821	
11	134.00	0.086	0.055	36.279	
12	129.53	0.083	0.052	37.517	
13	125.35	0.080	0.049	38.555	
14	121.44	0.078	0.047	39.412	
15	117.76	0.075	0.045	40.105	
16	114.29	0.073	0.042	40.649	
17	111.03	0.071	0.040	41.055	
18	107.94	0.069	0.038	41.336	
19	105.03	0.067	0.036	41.501	
20	102.26	0.066	0.035	41.561	***
21	99.64	0.064	0.033	41.522	
22	97.15	0.062	0.031	41.392	
23	94.78	0.061	0.030	41.179	
24	92.52	0.059	0.028	40.887	
25	90.37	0.058	0.027	40.523	
26	88.32	0.057	0.026	40.091	
27	86.36	0.055	0.024	39.596	
28	84.48	0.054	0.023	39.041	
29	82.68	0.053	0.022	38.432	
30	80.96	0.052	0.021	37.770	
31	79.31	0.051	0.020	37.060	
32	77.72	0.050	0.019	36.305	
33	76.20	0.049	0.018	35.506	
34	74.73	0.048	0.017	34.667	
35	73.32	0.047	0.016	33.789	
36	71.96	0.046	0.015	32.875	
37	70.65	0.045	0.014	31.928	
38	69.39	0.044	0.014	30.947	
39	68.18	0.044	0.013	29.937	
40	67.00	0.043	0.012	28.897	
41	65.86	0.042	0.011	27.829	
42	64.77	0.041	0.011	26.736	
43	63.70	0.041	0.010	25.617	
44	62.68	0.040	0.009	24.475	
45	61.68	0.040	0.009	23.310	
46	60.72	0.039	0.008	22.124	
47	59.78	0.038	0.007	20.917	

On-Site Storage Calculator

Town of Cobourg, ON

Project: **Commercial Developme**

Project No.: **n1943**

Date: **10-Mar-20**

n Architecture Inc

Table 2E - 50 Years Storage (PARCEL A)

Equation of IDF:

Comp. Runoff Coeff.R = 0.84

A = 0.28 ha

Q release = 0.032 m^3/s

31.99 L/s

$$i = \frac{A}{(t+B)^C}$$

I = Rainfall Intensity (mm/hr)

T = Time of Concentration (hr)

a= 4750

b= 24

Storage Required (m^3) 45.23

t_d (min)	i_{50} (mm/hr)	Q_{50} (m^3/s)	Q_{stored} (m^3/s)	Peak Volume (m^3)	
10	139.71	0.090	0.058	34.510	
11	135.71	0.087	0.055	36.273	
12	131.94	0.085	0.053	37.832	
13	128.38	0.082	0.050	39.202	
14	125.00	0.080	0.048	40.400	
15	121.79	0.078	0.046	41.437	
16	118.75	0.076	0.044	42.327	
17	115.85	0.074	0.042	43.079	
18	113.10	0.072	0.040	43.705	
19	110.47	0.071	0.039	44.212	
20	107.95	0.069	0.037	44.608	
21	105.56	0.068	0.036	44.902	
22	103.26	0.066	0.034	45.100	
23	101.06	0.065	0.033	45.207	
24	98.96	0.063	0.031	45.230	***
25	96.94	0.062	0.030	45.173	
26	95.00	0.061	0.029	45.043	
27	93.14	0.060	0.028	44.841	
28	91.35	0.059	0.027	44.574	
29	89.62	0.057	0.025	44.245	
30	87.96	0.056	0.024	43.856	
31	86.36	0.055	0.023	43.412	
32	84.82	0.054	0.022	42.916	
33	83.33	0.053	0.021	42.369	
34	81.90	0.052	0.020	41.775	
35	80.51	0.052	0.020	41.136	
36	79.17	0.051	0.019	40.454	
37	77.87	0.050	0.018	39.732	
38	76.61	0.049	0.017	38.971	
39	75.40	0.048	0.016	38.173	
40	74.22	0.048	0.016	37.340	
41	73.08	0.047	0.015	36.474	
42	71.97	0.046	0.014	35.576	
43	70.90	0.045	0.013	34.648	
44	69.85	0.045	0.013	33.690	
45	68.84	0.044	0.012	32.704	
46	67.86	0.043	0.011	31.692	
47	66.90	0.043	0.011	30.654	

On-Site Storage Calculator

Town of Cobourg, ON

Project: **Commercial Development**

Project No.: **n1943**

Date: **10-Mar-20**

n Architecture Inc

Table 2F - 100 Years Storage (PARCEL A)

Equation of IDF:

Comp. Runoff Coeff.R = 0.84

A = 0.28 ha

$Q_{release}$ = 0.032 m^3/s

32.36 L/s

$$i = \frac{A}{(t+B)^C}$$

I = Rainfall Intensity (mm/hr)

T = Time of Concentration (hr)

a= 5588

b= 28

Storage Required (m^3) 53.05

t_d (min)	i_{100} (mm/hr)	Q_{100} (m^3/s)	Q_{stored} (m^3/s)	Peak Volume (m^3)	
10	147.05	0.094	0.062	37.118	
11	143.28	0.092	0.059	39.236	
12	139.70	0.090	0.057	41.150	
13	136.29	0.087	0.055	42.876	
14	133.05	0.085	0.053	44.428	
15	129.95	0.083	0.051	45.817	
16	127.00	0.081	0.049	47.055	
17	124.18	0.080	0.047	48.152	
18	121.48	0.078	0.045	49.116	
19	118.89	0.076	0.044	49.957	
20	116.42	0.075	0.042	50.682	
21	114.04	0.073	0.041	51.298	
22	111.76	0.072	0.039	51.812	
23	109.57	0.070	0.038	52.229	
24	107.46	0.069	0.036	52.556	
25	105.43	0.068	0.035	52.797	
26	103.48	0.066	0.034	52.957	
27	101.60	0.065	0.033	53.041	
28	99.79	0.064	0.032	53.053	***
29	98.04	0.063	0.030	52.996	
30	96.34	0.062	0.029	52.874	
31	94.71	0.061	0.028	52.691	
32	93.13	0.060	0.027	52.448	
33	91.61	0.059	0.026	52.150	
34	90.13	0.058	0.025	51.800	
35	88.70	0.057	0.024	51.398	
36	87.31	0.056	0.024	50.949	
37	85.97	0.055	0.023	50.453	
38	84.67	0.054	0.022	49.914	
39	83.40	0.053	0.021	49.333	
40	82.18	0.053	0.020	48.712	
41	80.99	0.052	0.020	48.053	
42	79.83	0.051	0.019	47.357	
43	78.70	0.050	0.018	46.625	
44	77.61	0.050	0.017	45.861	
45	76.55	0.049	0.017	45.064	
46	75.51	0.048	0.016	44.236	
47	74.51	0.048	0.015	43.378	

On-Site Storage Calculator

Town of Cobourg, ON

Project: **Commercial Development**

Project No.: **n1943**

Date: **10-Mar-20**

n Architecture Inc

Table 2AB1 - 2 Years Storage (PARCEL - B, PHASE - 1)

Equation of IDF:

$$i = \frac{A}{(t+B)^C}$$

Comp. Runoff Coeff.R = 0.83

A = 0.34 ha

$Q_{release}$ = 0.020 m^3/s

19.74 L/s

I = Rainfall Intensity (mm/hr)

T = Time of Concentration (hr)

a= 1778

b= 13

Storage Required (m^3) 26.69

t_d (min)	i_2 (mm/hr)	Q_2 (m^3/s)	Q_{stored} (m^3/s)	Peak Volume (m^3)	
10	77.30	0.060	0.040	24.080	
11	74.08	0.057	0.038	24.842	
12	71.12	0.055	0.035	25.447	
13	68.38	0.053	0.033	25.915	
14	65.85	0.051	0.031	26.261	
15	63.50	0.049	0.029	26.497	
16	61.31	0.047	0.028	26.636	
17	59.27	0.046	0.026	26.686	***
18	57.35	0.044	0.025	26.656	
19	55.56	0.043	0.023	26.554	
20	53.88	0.042	0.022	26.387	
21	52.29	0.041	0.021	26.160	
22	50.80	0.039	0.020	25.878	
23	49.39	0.038	0.019	25.546	
24	48.05	0.037	0.017	25.168	
25	46.79	0.036	0.016	24.747	
26	45.59	0.035	0.016	24.287	
27	44.45	0.034	0.015	23.791	
28	43.37	0.034	0.014	23.262	
29	42.33	0.033	0.013	22.701	
30	41.35	0.032	0.012	22.111	
31	40.41	0.031	0.012	21.494	
32	39.51	0.031	0.011	20.852	
33	38.65	0.030	0.010	20.186	
34	37.83	0.029	0.010	19.498	
35	37.04	0.029	0.009	18.790	
36	36.29	0.028	0.008	18.062	
37	35.56	0.028	0.008	17.316	
38	34.86	0.027	0.007	16.553	
39	34.19	0.026	0.007	15.773	
40	33.55	0.026	0.006	14.978	
41	32.93	0.026	0.006	14.169	
42	32.33	0.025	0.005	13.346	
43	31.75	0.025	0.005	12.510	
44	31.19	0.024	0.004	11.662	
45	30.66	0.024	0.004	10.802	
46	30.14	0.023	0.004	9.932	
47	29.63	0.023	0.003	9.050	
48	29.15	0.023	0.003	8.159	
49	28.68	0.022	0.002	7.259	
50	28.22	0.022	0.002	6.349	
51	27.78	0.022	0.002	5.431	
52	27.35	0.021	0.001	4.505	

On-Site Storage Calculator

Town of Cobourg, ON

Project: **Commercial Developme**

Project No.: **n1943**

Date: **10-Mar-20**

n Architecture Inc

Table 2BB1 - 5 Years Storage (PARCEL - B, PHASE - 1)

Equation of IDF:

$$i = \frac{A}{(t+B)^C}$$

Comp. Runoff Coeff.R = 0.83

A = 0.34 ha

Q release = 0.022 m^3/s

21.81 L/s

I = Rainfall Intensity (mm/hr)

T = Time of Concentration (hr)

a= 2464

b= 16

Storage Required (m^3) 37.51

t_d (min)	i_5 (mm/hr)	Q_5 (m^3/s)	Q_{stored} (m^3/s)	Peak Volume (m^3)	
10	94.77	0.073	0.052	30.956	
11	91.26	0.071	0.049	32.258	
12	88.00	0.068	0.046	33.372	
13	84.97	0.066	0.044	34.320	
14	82.13	0.064	0.042	35.117	
15	79.48	0.062	0.040	35.779	
16	77.00	0.060	0.038	36.317	
17	74.67	0.058	0.036	36.743	
18	72.47	0.056	0.034	37.068	
19	70.40	0.055	0.033	37.299	
20	68.44	0.053	0.031	37.444	
21	66.59	0.052	0.030	37.511	***
22	64.84	0.050	0.028	37.505	
23	63.18	0.049	0.027	37.433	
24	61.60	0.048	0.026	37.299	
25	60.10	0.047	0.025	37.107	
26	58.67	0.045	0.024	36.863	
27	57.30	0.044	0.023	36.568	
28	56.00	0.043	0.022	36.228	
29	54.76	0.042	0.021	35.845	
30	53.57	0.041	0.020	35.421	
31	52.43	0.041	0.019	34.960	
32	51.33	0.040	0.018	34.464	
33	50.29	0.039	0.017	33.934	
34	49.28	0.038	0.016	33.373	
35	48.31	0.037	0.016	32.783	
36	47.38	0.037	0.015	32.165	
37	46.49	0.036	0.014	31.521	
38	45.63	0.035	0.014	30.853	
39	44.80	0.035	0.013	30.161	
40	44.00	0.034	0.012	29.447	
41	43.23	0.033	0.012	28.712	
42	42.48	0.033	0.011	27.958	
43	41.76	0.032	0.011	27.185	
44	41.07	0.032	0.010	26.393	
45	40.39	0.031	0.009	25.585	
46	39.74	0.031	0.009	24.761	
47	39.11	0.030	0.008	23.922	
48	38.50	0.030	0.008	23.067	
49	37.91	0.029	0.008	22.199	
50	37.33	0.029	0.007	21.317	
51	36.78	0.028	0.007	20.423	
52	36.24	0.028	0.006	19.517	

On-Site Storage Calculator

Town of Cobourg, ON

Project: **Commercial Developme**

Project No.: **n1943**

Date: **10-Mar-20**

n Architecture Inc

Table 2CB1 - 10 Years Storage (PARCEL - B, PHASE - 1)

Equation of IDF:

$$i = \frac{A}{(t+B)^C}$$

Comp. Runoff Coeff.R = 0.83

A = 0.34 ha

Q release = 0.023 m^3/s

23.40 L/s

I = Rainfall Intensity (mm/hr)

T = Time of Concentration (hr)

a= 2819

b= 16

Storage Required (m^3) 44.98

t_d (min)	i_{10} (mm/hr)	Q_{10} (m^3/s)	Q_{stored} (m^3/s)	Peak Volume (m^3)	
10	108.42	0.084	0.061	36.351	
11	104.41	0.081	0.057	37.934	
12	100.68	0.078	0.055	39.303	
13	97.21	0.075	0.052	40.480	
14	93.97	0.073	0.049	41.486	
15	90.94	0.070	0.047	42.336	
16	88.09	0.068	0.045	43.046	
17	85.42	0.066	0.043	43.627	
18	82.91	0.064	0.041	44.091	
19	80.54	0.062	0.039	44.449	
20	78.31	0.061	0.037	44.709	
21	76.19	0.059	0.036	44.879	
22	74.18	0.057	0.034	44.966	
23	72.28	0.056	0.033	44.977	***
24	70.48	0.055	0.031	44.917	
25	68.76	0.053	0.030	44.791	
26	67.12	0.052	0.029	44.605	
27	65.56	0.051	0.027	44.362	
28	64.07	0.050	0.026	44.066	
29	62.64	0.049	0.025	43.721	
30	61.28	0.047	0.024	43.330	
31	59.98	0.046	0.023	42.896	
32	58.73	0.045	0.022	42.421	
33	57.53	0.045	0.021	41.909	
34	56.38	0.044	0.020	41.361	
35	55.27	0.043	0.019	40.779	
36	54.21	0.042	0.019	40.166	
37	53.19	0.041	0.018	39.522	
38	52.20	0.040	0.017	38.851	
39	51.25	0.040	0.016	38.153	
40	50.34	0.039	0.016	37.430	
41	49.46	0.038	0.015	36.683	
42	48.60	0.038	0.014	35.913	
43	47.78	0.037	0.014	35.122	
44	46.98	0.036	0.013	34.311	
45	46.21	0.036	0.012	33.480	
46	45.47	0.035	0.012	32.630	
47	44.75	0.035	0.011	31.763	

On-Site Storage Calculator

Town of Cobourg, ON

Project: **Commercial Developme**

Project No.: **n1943**

Date: **10-Mar-20**

n Architecture Inc

Table 2DB1 - 25 Years Storage (PARCEL - B, PHASE - 1)

Comp. Runoff Coeff.R = 0.83

A = 0.34 ha

Q *release* = 0.024 m^3/s

24.30 L/s

Equation of IDF:

$$i = \frac{A}{(t+B)^C}$$

I = Rainfall Intensity (mm/hr)

T = Time of Concentration (hr)

a= 3886

b= 18

Storage Required (m^3) 0.83

t_d (min)	i_{25} (mm/hr)	Q_{25} (m^3/s)	Q_{stored} (m^3/s)	Peak Volume (m^3)	
10	138.79	0.107	0.083	49.922	
11	134.00	0.104	0.079	52.467	
12	129.53	0.100	0.076	54.746	
13	125.35	0.097	0.073	56.784	
14	121.44	0.094	0.070	58.603	
15	117.76	0.091	0.067	60.224	
16	114.29	0.089	0.064	61.663	
17	111.03	0.086	0.062	62.937	
18	107.94	0.084	0.059	64.059	
19	105.03	0.081	0.057	65.042	
20	102.26	0.079	0.055	65.896	
21	99.64	0.077	0.053	66.632	
22	97.15	0.075	0.051	67.258	
23	94.78	0.073	0.049	67.782	
24	92.52	0.072	0.047	68.213	
25	90.37	0.070	0.046	68.555	
26	88.32	0.068	0.044	68.815	
27	86.36	0.067	0.043	68.999	
28	84.48	0.065	0.041	69.112	
29	82.68	0.064	0.040	69.158	***
30	80.96	0.063	0.038	69.141	
31	79.31	0.061	0.037	69.065	
32	77.72	0.060	0.036	68.934	
33	76.20	0.059	0.035	68.751	
34	74.73	0.058	0.034	68.519	
35	73.32	0.057	0.032	68.241	
36	71.96	0.056	0.031	67.919	
37	70.65	0.055	0.030	67.556	
38	69.39	0.054	0.029	67.154	
39	68.18	0.053	0.029	66.714	
40	67.00	0.052	0.028	66.240	
41	65.86	0.051	0.027	65.732	
42	64.77	0.050	0.026	65.192	
43	63.70	0.049	0.025	64.623	
44	62.68	0.049	0.024	64.025	
45	61.68	0.048	0.023	63.399	
46	60.72	0.047	0.023	62.748	
47	59.78	0.046	0.022	62.071	

On-Site Storage Calculator

Town of Cobourg, ON

Project: **Commercial Developme**

Project No.: **n1943**

Date: **10-Mar-20**

n Architecture Inc

Table 2EB1 - 50 Years Storage (PARCEL - B, PHASE - 1)

Equation of IDF:

Comp. Runoff Coeff.R = 0.83

A = 0.34 ha

$Q_{release}$ = 0.025 m^3/s

25.16 L/s

$$i = \frac{A}{(t+B)^C}$$

I = Rainfall Intensity (mm/hr)

T = Time of Concentration (hr)

a= 4750

b= 24

Storage Required (m^3) 78.11

t_d (min)	i_{50} (mm/hr)	Q_{50} (m^3/s)	Q_{stored} (m^3/s)	Peak Volume (m^3)	
10	139.71	0.108	0.083	49.828	
11	135.71	0.105	0.080	52.770	
12	131.94	0.102	0.077	55.465	
13	128.38	0.099	0.074	57.933	
14	125.00	0.097	0.072	60.191	
15	121.79	0.094	0.069	62.256	
16	118.75	0.092	0.067	64.143	
17	115.85	0.090	0.065	65.863	
18	113.10	0.088	0.062	67.430	
19	110.47	0.086	0.060	68.854	
20	107.95	0.084	0.058	70.144	
21	105.56	0.082	0.057	71.310	
22	103.26	0.080	0.055	72.359	
23	101.06	0.078	0.053	73.300	
24	98.96	0.077	0.051	74.139	
25	96.94	0.075	0.050	74.881	
26	95.00	0.074	0.048	75.534	
27	93.14	0.072	0.047	76.102	
28	91.35	0.071	0.046	76.590	
29	89.62	0.069	0.044	77.002	
30	87.96	0.068	0.043	77.343	
31	86.36	0.067	0.042	77.617	
32	84.82	0.066	0.041	77.828	
33	83.33	0.065	0.039	77.977	
34	81.90	0.063	0.038	78.070	
35	80.51	0.062	0.037	78.108	***
36	79.17	0.061	0.036	78.095	
37	77.87	0.060	0.035	78.033	
38	76.61	0.059	0.034	77.924	
39	75.40	0.058	0.033	77.770	
40	74.22	0.057	0.032	77.574	
41	73.08	0.057	0.031	77.338	
42	71.97	0.056	0.031	77.063	
43	70.90	0.055	0.030	76.751	
44	69.85	0.054	0.029	76.404	
45	68.84	0.053	0.028	76.024	
46	67.86	0.053	0.027	75.611	
47	66.90	0.052	0.027	75.167	

On-Site Storage Calculator

Town of Cobourg, ON

Project: **Commercial Developme**

Project No.: **n1943**

Date: **10-Mar-20**

n Architecture Inc

Table 2FB1 - 100 Years Storage (PARCEL - B, PHASE - 1)

Equation of IDF:

Comp. Runoff Coeff.R = 0.83

A = 0.34 ha

$Q_{release}$ = 0.025 m^3/s

25.45 L/s

$$I = \frac{a}{(b + T_d)}$$

I = Rainfall Intensity (mm/hr)

T = Time of Concentration (hr)

a= 5588

b= 28

Storage Required (m^3) 91.71

t_d (min)	i_{100} (mm/hr)	Q_{100} (m^3/s)	Q_{stored} (m^3/s)	Peak Volume (m^3)	
10	147.05	0.114	0.088	53.073	
11	143.28	0.111	0.086	56.452	
12	139.70	0.108	0.083	59.587	
13	136.29	0.106	0.080	62.494	
14	133.05	0.103	0.078	65.190	
15	129.95	0.101	0.075	67.689	
16	127.00	0.098	0.073	70.005	
17	124.18	0.096	0.071	72.151	
18	121.48	0.094	0.069	74.137	
19	118.89	0.092	0.067	75.974	
20	116.42	0.090	0.065	77.670	
21	114.04	0.088	0.063	79.235	
22	111.76	0.087	0.061	80.676	
23	109.57	0.085	0.059	82.000	
24	107.46	0.083	0.058	83.215	
25	105.43	0.082	0.056	84.327	
26	103.48	0.080	0.055	85.341	
27	101.60	0.079	0.053	86.262	
28	99.79	0.077	0.052	87.096	
29	98.04	0.076	0.050	87.848	
30	96.34	0.075	0.049	88.520	
31	94.71	0.073	0.048	89.118	
32	93.13	0.072	0.047	89.645	
33	91.61	0.071	0.046	90.105	
34	90.13	0.070	0.044	90.501	
35	88.70	0.069	0.043	90.836	
36	87.31	0.068	0.042	91.113	
37	85.97	0.067	0.041	91.334	
38	84.67	0.066	0.040	91.502	
39	83.40	0.065	0.039	91.619	
40	82.18	0.064	0.038	91.688	
41	80.99	0.063	0.037	91.711	***
42	79.83	0.062	0.036	91.690	
43	78.70	0.061	0.036	91.626	
44	77.61	0.060	0.035	91.522	
45	76.55	0.059	0.034	91.378	
46	75.51	0.058	0.033	91.198	
47	74.51	0.058	0.032	90.981	

On-Site Avaiable Storage Calculator

Town of Cobourg, ON

Table 3A- Avilable Storage (PARCEL A)

Project:	**Commercial Development**
Address:	**428-432 King Street East-Parcel A**
Project No.:	**n1943**
Date:	**10-Mar-20**

MH/CATCH BASIN

Description	Length/Dia. (m)	Width (m)	HWL Elevation	85.95 Height (m)	Volume (m^3)
CBMH1	1.2		84.81	1.14	1.29
CBMH2	1.2		84.47	1.48	1.67
MH3	1.8		84.37	1.58	4.02
TOTAL					6.98

PIPES

FROM MH	TO MH	Length (m)		DIA (mm)	Volume (m^3)
CBMH1	PIPE	16.7		300	1.17
STM PLUG	PIPE	3.5		300	0.25
STM PLUG	PIPE	10.0		300	0.70
CBMH2	MH3	15.0		600	4.38
MH2	MH1	5.5		300	0.39
MH3	MH2	35.0		900	22.95
TOTAL					29.85

PONDING

Ponding Location	Lowest Point Elv.	Ponding Depth (m)	Ponding Area (m^2)	Ponding Volume (m^3)
CBMH1	85.8	0.15	226.0	11.3
TOTAL				11.3

ROOF TOP

Location	Area(m^2)	VOL. (m^3)
BLDG.4	185.85	8.47

TOTAL VOLUME: (m^3) **56.59**

On-Site Avaiable Storage Calculat

Town of Cobourg, ON

Table 3B-1- Avilable Storage

(PARCEL -B PHASE - 1)

n Architecture Inc

Project:	**Commercial Development**
Address:	**428-432 King Street East-Parcel B**
Project No.:	**n1943**
Date:	**10-Mar-20**

MH/CATCH BASIN — **HWL** **85.90**

Description	Length/Dia. (m)	Width (m)	Elevation	Height (m)	Volume (m^3)
CB1	0.6	0.6	84.75	1.15	0.41
CB2	0.6	0.6	84.66	1.24	0.45
MH4	1.2		84.66	1.24	1.40
MH3	1.2		84.53	1.37	1.55
MH2	1.2		84.18	1.72	1.95
CBMH1	1.2		84.23	1.67	1.89
MH1	1.2		84.08	1.82	2.06
TOTAL					9.70

PIPES

FROM MH	TO MH	Length (m)		DIA (mm)	Volume (m^3)
Tank	MH3	2.5		300	0.18
CB2	MH3	22.5		300	1.58
STM PLUG	MH4	14.0		300	0.98
CB1	MH4	13.0		300	0.91
MH3	CBMH1	56.5		300	3.97
CBMH1	MH2	7.5		300	0.53
MH2	MH1	6.0		300	0.42
TOTAL					8.58

STORMWATER DETENTION TANK

Manufacturer	MODEL	Width (m)	Length (m)	Volume (m^3)
Stormtech	CHAMBERMAXX	3.39	30.48	63.0
TOTAL				63.0

ROOFTOP DETENTION

Location	Area(m^2)	VOL. (m^3)
BLDG.4	254.14	11.58

TOTAL VOLUME:	(m^3)	**92.87**

Appendix D

Storm Drainage Design Sheet

N Architecture Inc.

PREPARED BY: A.Z

DATE PREPARED 10-Mar-20

Engineering Department
Storm Drainage Design Chart
For Circular Drains Flowing Full
428-432 King Street East-Parcel A
Town of Cobourg, ON

Td (start): 10.00 min

IDF CURVE	
Constants	**5 -yrs**
a	2464.0
b	16.0

$$I = \frac{a}{(b + T_d)}$$

Catchments							td (min)	Hydrology		Hyraulics						Comments
				R		ACC.		Rainfall	Peak	STORM SEWER DESIGN INFORMATION					TIME	
Catchment ID	Total Area (m^2)	Captured By	Outlet to	runoff Coeffi.	A x R	A x R		I5	5-yrs	size (mm)	slope (%)	length (m)	Q full (m^3/s)	V full (m/s)	SECT. (min)	
Canopy	187.00	STM Plug	Pipe	0.95	0.02	0.02	10.00	94.77	0.005	300	1.00	3.5	0.097	1.368	0.04	
A1	818	CBMH2	MH3	0.89	0.07	0.07	10.00	94.77	0.019	600	0.50	15.0	0.434	1.535	0.16	
BLDG A1	185.85	STM Plug	CBMH1	0.95	0.02	0.02	10.00	94.77	0.005	300	1.00	10.0	0.097	1.368	0.12	
A2	1358.00	CBMH1	Pipe	0.81	0.11	0.11	10.12	94.33	0.029	300	0.50	16.7	0.068	0.967	0.29	
Conveyance		MH3	MH2		0.00	0.22	10.41	93.30	0.057	900	0.50	35.0	1.280	2.012	0.29	
Conveyance		MH2	MH1		0.00	0.22	10.70	92.29	0.056	300	0.50	5.5	0.068	0.967	0.09	

N Architecture Inc.

PREPARED BY: A.Z

DATE PREPARED 10-Mar-20

td (start): 10.00 min

Engineering Department
Storm Drainage Design Chart
For Circular Drains Flowing Full
428-432 King Street East-Parcel B
Town of Cobourg, ON

IDF CURVE	
Constants	**2 -yrs**
a	1778.0
b	13.0

$$I = \frac{a}{(b+T_d)}$$

Catchments							td	Hydrology		Hyraulics						Comments
				R		**ACC.**		**Rainfall**	**Peak**	**STORM SEWER DESIGN INFORMATION**					**TIME**	
Catchment ID	**Total Area (m^2)**	**Captured By**	**Outlet to**	runoff Coeffi.	**A x R**	A x R	**(min)**	**I_2**	**2-yrs**	size (mm)	slope (%)	length (m)	Q full (m^3/s)	V full (m/s)	SECT. (min)	
A1	1959.5	CB1	MH4	0.84	0.17	0.17	10.00	77.30	0.036	300	0.50	13.0	0.068	0.967	0.22	
BLD-B1	254.14	STM PLUG	MH4	0.95	0.02	0.02	10.00	77.30	0.036	300	1.00	14.0	0.097	0.967	0.22	
Conveyance		MH4	TANK			0.19	10.22	76.56	0.005	300	1.00	1.0	0.097	1.368	0.24	
A2	628.00	CB2	MH3	0.60	0.04	0.04	10.00	77.30	0.040	300	0.50	22.5	0.068	0.967	0.03	
Conveyance		Tank	MH3			0.19	10.47	75.77	0.005	300	0.50	2.5	0.068	1.368	0.24	
Conveyance		MH3	CBMH1			0.23	10.71	75.00	0.008	300	0.50	56.5	0.068	0.967	0.39	
A3	528.00	CBMH1	MH2(OGS)	0.95	0.05	0.28	11.09	73.79	0.047	300	0.50	7.5	0.068	0.967	0.97	
Conveyance		MH2	MH1		0.00	0.28	12.07	70.93	0.057	300	0.50	6.0	0.068	0.967	0.13	
Conveyance		MH1	Ex. Pipe		0.00	0.28	12.20	70.56	0.000	150	2.00	10.0	0.022	1.219	0.14	

Appendix E

Stormwater Chambers

User Inputs

Chamber Model	DC-780
Outlet Control Structure	Yes (Outlet)
Project Name	Dynamic Drive
Engineer	Abu Sayed Ziauddin
Project Location	Toronto, ON
Project Date	01/31/2020
Measurement Type	Metric
Required Storage Volume	61 cubic meters
Stone Porosity	40%
Stone Foundation Depth	229 mm.
Stone Above Chambers	152 mm.
Average Cover Over Chambers	460 mm.
Design Constraint	Width
Design Constraint Dimension	4 meters

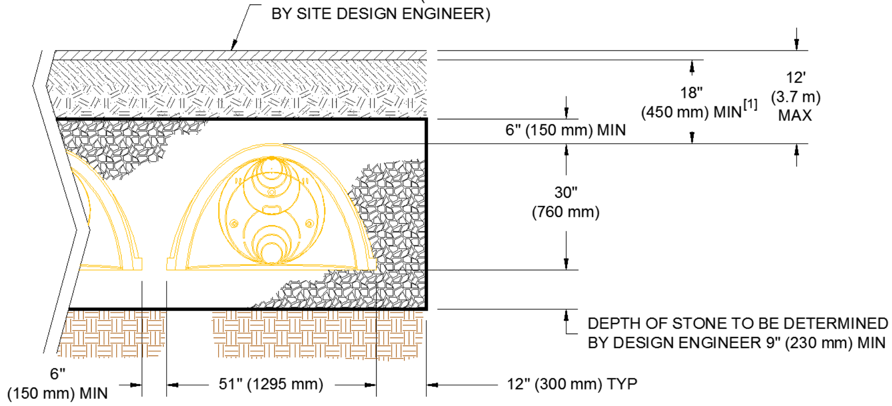
Results

System Volume and Bed Size

Installed Storage Volume	63 cubic meters
Storage Volume Per Chamber	2.21 cubic meters
Number Of Chambers Required	23 each
Number Of End Caps Required	4 each
Rows/Chambers	1 row(s) of 12 chamber(s)
Leftover Rows/Chambers	1 row(s) of 11 chamber(s)
Maximum Length	28.23 meters
Maximum Width	3.54 meters
Approx. Bed Size Required	98 square meters

System Components

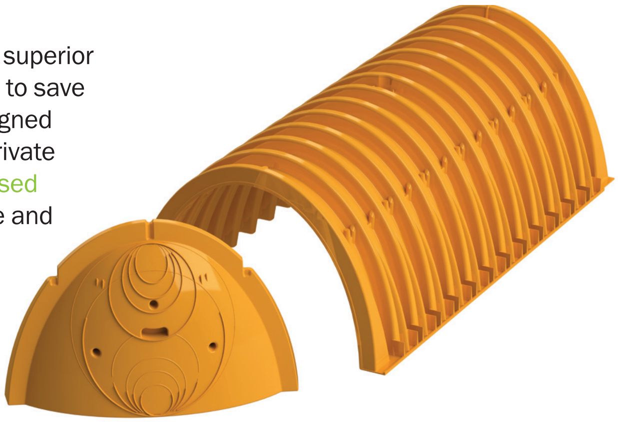
Amount Of Stone Required	82 cubic meters
Volume Of Excavation (Not Including Fill)	112 cubic meters
Non-woven Filter Fabric Required	266 square meters
Length Of Isolator Row	26.52 meters
Woven Isolator Row Fabric	78 square meters



*TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 24" (600 mm).

STORMTECH DC-780 CHAMBER

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots, thus maximizing land usage for private (commercial) and public applications. StormTech chambers can also be used in conjunction with Green Infrastructure, thus enhancing the performance and extending the service life of these practices.



- 12' (3.6 m) Deep Cover Applications
- Designed in accordance with ASTM F 2787 and produced to meet the ASTM 2418 product standard.
- AASHTO safety factors provided for AASHTO Design Truck (H20 and deep cover conditions.)

STORMTECH DC-780 CHAMBER
(not to scale)

Nominal Chamber Specifications

Size (L x W x H)
85.4" x 51.0" x 30.0"
2,170 mm x 1,295 mm x 762 mm

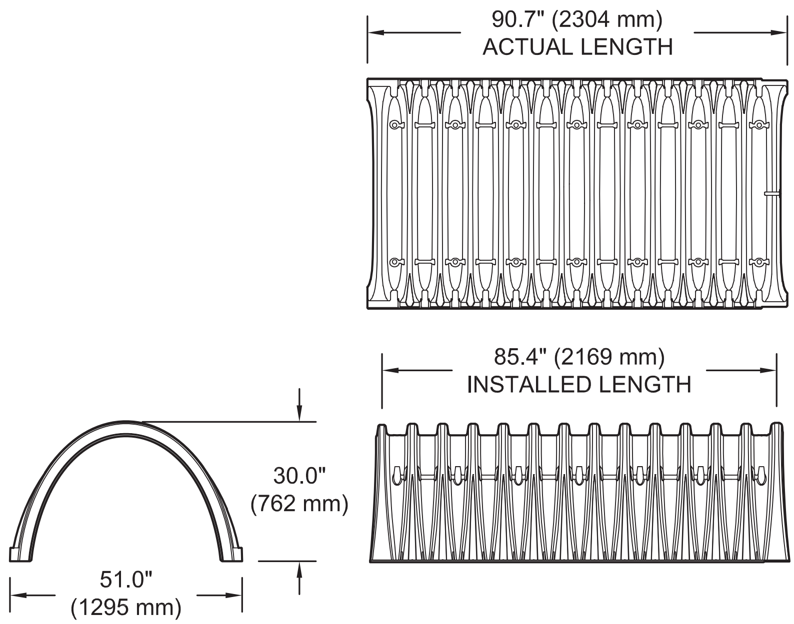
Chamber Storage
46.2 ft³ (1.30 m³)

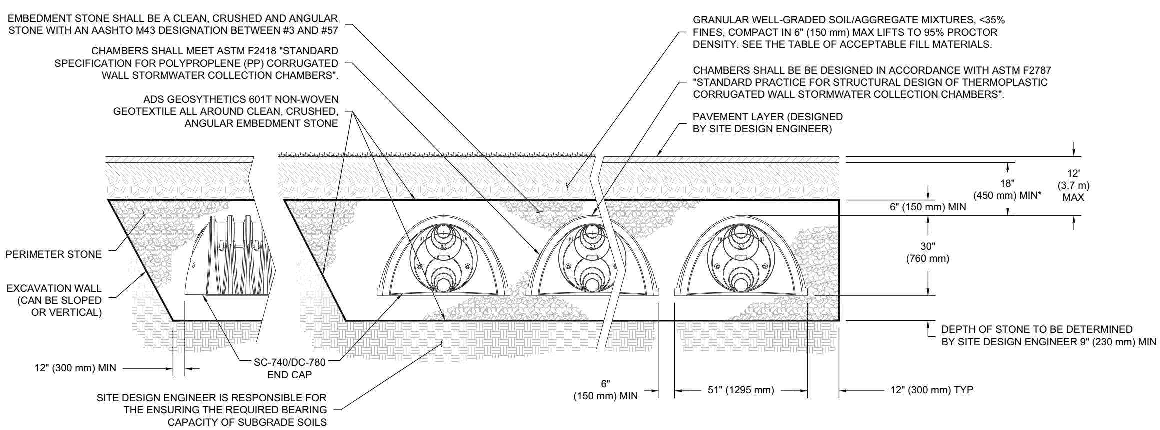
Min. Installed Storage*
78.4 ft³ (2.20 m³)

Weight
80.0 lbs (36.3 kg)

Shipping
24 chambers/pallet
60 end caps/pallet
12 pallets/truck

*Assumes 9" (230 mm) stone below, 6" (150 mm) row spacing and 40% stone porosity.





*MINIMUM COVER TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 24" (600 mm).

DC-780 CUMULATIVE STORAGE VOLUMES PER CHAMBER

Assumes 40% Stone Porosity. Calculations are Based Upon a 9" (230 mm) Stone Base Under Chambers.

Depth of Water in System Inches (mm)		Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
45 (1,143)	↑ Stone Cover	46.27 (1.310)	78.47 (2.222)
44 (1,118)	Stone Cover	46.27 (1.310)	77.34 (2.190)
43 (1,092)	Stone Cover	46.27 (1.310)	76.21 (2.158)
42 (1,067)	Stone Cover	46.27 (1.310)	75.09 (2.126)
41 (1,041)	Stone Cover	46.27 (1.310)	73.96 (2.094)
40 (1,016)	Stone Cover ↓	46.27 (1.310)	72.83 (2.062)
39 (991)		46.27 (1.310)	71.71 (2.030)
38 (965)		46.21 (1.309)	70.54 (1.998)
37 (940)		46.04 (1.304)	69.32 (1.963)
36 (914)		45.76 (1.296)	68.02 (1.926)
35 (889)		45.15 (1.278)	66.53 (1.884)
34 (864)		44.34 (1.255)	64.91 (1.838)
33 (838)		43.38 (1.228)	63.21 (1.790)
32 (813)		42.29 (1.198)	61.43 (1.740)
31 (787)		41.11 (1.164)	59.59 (1.688)
30 (762)		39.83 (1.128)	57.70 (1.634)
29 (737)		38.47 (1.089)	55.76 (1.579)
28 (711)		37.01 (1.048)	53.76 (1.522)
27 (686)		35.49 (1.005)	51.72 (1.464)
26 (660)		33.90 (0.960)	49.63 (1.405)
25 (635)		32.24 (0.913)	47.52 (1.346)
24 (610)		30.54 (0.865)	45.36 (1.285)
23 (584)		28.77 (0.815)	43.18 (1.223)
22 (559)		26.96 (0.763)	40.97 (1.160)
21 (533)		25.10 (0.711)	38.72 (1.096)
20 (508)		23.19 (0.657)	36.45 (1.032)
19 (483)		21.25 (0.602)	34.16 (0.967)
18 (457)		19.26 (0.545)	31.84 (0.902)
17 (432)		17.24 (0.488)	29.50 (0.835)
16 (406)		15.19 (0.430)	27.14 (0.769)
15 (381)		13.10 (0.371)	24.76 (0.701)
14 (356)		10.98 (0.311)	22.36 (0.633)
13 (330)		8.83 (0.250)	19.95 (0.565)
12 (305)		6.66 (0.189)	17.52 (0.496)
11 (279)		4.46 (0.126)	15.07 (0.427)
10 (254)		2.24 (0.064)	12.61 (0.357)
9 (229)	↑ Stone Foundation	0 (0)	10.14 (0.287)
8 (203)	Stone Foundation	0 (0)	9.01 (0.255)
7 (178)	Stone Foundation	0 (0)	7.89 (0.223)
6 (152)	Stone Foundation	0 (0)	6.76 (0.191)
5 (127)	Stone Foundation	0 (0)	5.63 (0.160)
4 (102)	Stone Foundation	0 (0)	4.51 (0.128)
3 (76)	Stone Foundation	0 (0)	3.38 (0.096)
2 (51)	Stone Foundation	0 (0)	2.25 (0.064)
1 (25)	Stone Foundation ↓	0 (0)	1.13 (0.032)

Note: Add 1.13 ft³ (0.032 m³) of Storage for Each Additional Inch (25 mm) of Stone Foundation.

STORAGE VOLUME PER CHAMBER FT³ (M³)

	Bare Chamber Storage ft³ (m³)	Chamber and Stone Foundation Depth in. (mm)		
		9" (230 mm)	12" (300 mm)	18" (450 mm)
DC-780 Chamber	78.4 (2.2)	78.4 (2.2)	81.8 (2.3)	88.6 (2.5)

Note: Assumes 40% porosity for the stone, the bare chamber volume, 6" (150 mm) of stone above, and 6" (150 mm) row spacing.

AMOUNT OF STONE PER CHAMBER

ENGLISH TONS (yds3)	Stone Foundation Depth		
	9"	12"	18"
DC-780 Chamber	4.2 (3.0)	4.7 (3.3)	5.6 (3.9)
METRIC KILOGRAMS (m³)	230 mm	300 mm	450 mm
DC-780 Chamber	3,810 (2.3)	4,264 (2.5)	5,080 (3.0)

Note: Assumes 9" (150 mm) of stone above, and between chambers.

VOLUME EXCAVATION PER CHAMBER YD³ (M³)

	Stone Foundation Depth		
	9" (230 mm)	12" (300 mm)	18" (450 mm)
DC-780 Chamber	5.9 (4.5)	6.3 (4.8)	6.9 (5.3)

Note: Assumes 6" (150 mm) separation between chamber rows and 18" (450 mm) of cover. The volume of excavation will vary as depth of cover increases.

Working on a project?
Visit us at www.stormtech.com
and utilize the StormTech Design Tool

For more information on the StormTech DC-780 Chamber and other ADS products, please contact our Customer Service Representatives at 1-800-821-6710

*THE MOST **ADVANCED** NAME IN WATER MANAGEMENT SOLUTIONS™*

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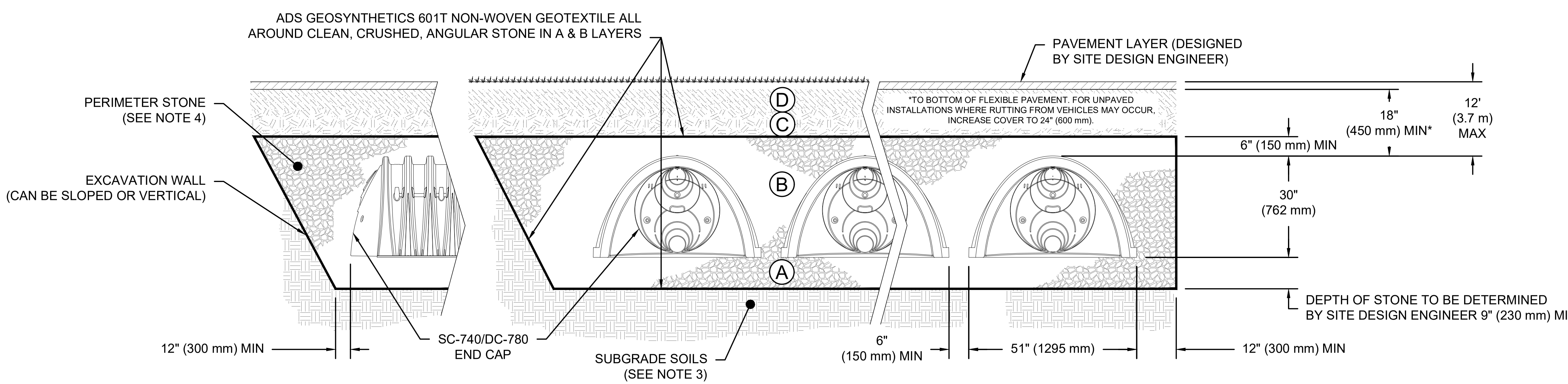
ACCEPTABLE FILL MATERIALS: STORMTECH DC-780 CHAMBER SYSTEMS

MATERIAL LOCATION		DESCRIPTION	AASHTO MATERIAL CLASSIFICATIONS	COMPACTION / DENSITY REQUIREMENT
D	**FINAL FILL:** FILL MATERIAL FOR LAYER 'D' STARTS FROM THE TOP OF THE 'C' LAYER TO THE BOTTOM OF FLEXIBLE PAVEMENT OR UNPAVED FINISHED GRADE ABOVE. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'D' LAYER	ANY SOIL/ROCK MATERIALS, NATIVE SOILS, OR PER ENGINEER'S PLANS. CHECK PLANS FOR PAVEMENT SUBGRADE REQUIREMENTS.	N/A	PREPARE PER SITE DESIGN ENGINEER'S PLANS. PAVED INSTALLATIONS MAY HAVE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS.
C	**INITIAL FILL:** FILL MATERIAL FOR LAYER 'C' STARTS FROM THE TOP OF THE EMBEDMENT STONE ('B' LAYER) TO 18" (450 mm) ABOVE THE TOP OF THE CHAMBER. NOTE THAT PAVEMENT SUBBASE MAY BE A PART OF THE 'C' LAYER.	GRANULAR WELL-GRADED SOIL/AGGREGATE MIXTURES, <35% FINES OR PROCESSED AGGREGATE. MOST PAVEMENT SUBBASE MATERIALS CAN BE USED IN LIEU OF THIS LAYER.	AASHTO M145[1] A-1, A-2-4, A-3 OR AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10	BEGIN COMPACTIONS AFTER 12" (300 mm) OF MATERIAL OVER THE CHAMBERS IS REACHED. COMPACT ADDITIONAL LAYERS IN 6" (150 mm) MAX LIFTS TO A MIN. 95% PROCTOR DENSITY FOR WELL GRADED MATERIAL AND 95% RELATIVE DENSITY FOR PROCESSED AGGREGATE MATERIALS. ROLLER GROSS VEHICLE WEIGHT NOT TO EXCEED 12,000 lbs (53 kN). DYNAMIC FORCE NOT TO EXCEED 20,000 lbs (89 kN).
B	**EMBEDMENT STONE:** FILL SURROUNDING THE CHAMBERS FROM THE FOUNDATION STONE ('A' LAYER) TO THE 'C' LAYER ABOVE.	CLEAN, CRUSHED, ANGULAR STONE	AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57	NO COMPACTION REQUIRED.
A	**FOUNDATION STONE:** FILL BELOW CHAMBERS FROM THE SUBGRADE UP TO THE FOOT (BOTTOM) OF THE CHAMBER.	CLEAN, CRUSHED, ANGULAR STONE	AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57	PLATE COMPACT OR ROLL TO ACHIEVE A FLAT SURFACE.[2,3]

PLEASE NOTE:
1. THE LISTED AASHTO DESIGNATIONS ARE FOR GRADATIONS ONLY. THE STONE MUST ALSO BE CLEAN, CRUSHED, ANGULAR. FOR EXAMPLE, A SPECIFICATION FOR #4 STONE WOULD STATE: "CLEAN, CRUSHED, ANGULAR NO. 4 (AASHTO M43) STONE".
2. STORMTECH COMPACTION REQUIREMENTS ARE MET FOR 'A' LOCATION MATERIALS WHEN PLACED AND COMPACTED IN 9" (230 mm) (MAX) LIFTS USING TWO FULL COVERAGES WITH A VIBRATORY COMPACTOR.
3. WHERE INFILTRATION SURFACES MAY BE COMPROMISED BY COMPACTION, FOR STANDARD DESIGN LOAD CONDITIONS, A FLAT SURFACE MAY BE ACHIEVED BY RAKING OR DRAGGING WITHOUT COMPACTION EQUIPMENT. FOR SPECIAL LOAD DESIGNS, CONTACT STORMTECH FOR COMPACTION REQUIREMENTS.
4. ONCE LAYER 'C' IS PLACED, ANY SOIL/MATERIAL CAN BE PLACED IN LAYER 'D' UP TO THE FINISHED GRADE. MOST PAVEMENT SUBBASE SOILS CAN BE USED TO REPLACE THE MATERIAL REQUIREMENTS OF LAYER 'C' OR 'D' AT THE SITE DESIGN ENGINEER'S DISCRETION.



NOTES:

1. CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F2418-16a, "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
2. DC-780 CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
3. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR ASSESSING THE BEARING RESISTANCE (ALLOWABLE BEARING CAPACITY) OF THE SUBGRADE SOILS AND THE DEPTH OF FOUNDATION STONE WITH CONSIDERATION FOR THE RANGE OF EXPECTED SOIL MOISTURE CONDITIONS.
4. PERIMETER STONE MUST BE EXTENDED HORIZONTALLY TO THE EXCAVATION WALL FOR BOTH VERTICAL AND SLOPED EXCAVATION WALLS.
5. REQUIREMENTS FOR HANDLING AND INSTALLATION:
   - TO MAINTAIN THE WIDTH OF CHAMBERS DURING SHIPPING AND HANDLING, CHAMBERS SHALL HAVE INTEGRAL, INTERLOCKING STACKING LUGS.
   - TO ENSURE A SECURE JOINT DURING INSTALLATION AND BACKFILL, THE HEIGHT OF THE CHAMBER JOINT SHALL NOT BE LESS THAN 2".
   - TO ENSURE THE INTEGRITY OF THE ARCH SHAPE DURING INSTALLATION, a) THE ARCH STIFFNESS CONSTANT AS DEFINED IN SECTION 6.2.8 OF ASTM F2418 SHALL BE GREATER THAN OR EQUAL TO 550 LBS/IN/IN. AND b) TO RESIST CHAMBER DEFORMATION DURING INSTALLATION AT ELEVATED TEMPERATURES (ABOVE 73° F / 23° C), CHAMBERS SHALL BE PRODUCED FROM REFLECTIVE GOLD OR YELLOW COLORS.

DC-780
STANDARD CROSS SECTION

DATE: 05-10-19 | DRAWN: KR
PROJECT #: | CHECKED: KR

DATE	DRWN	CHKD	DESCRIPTION

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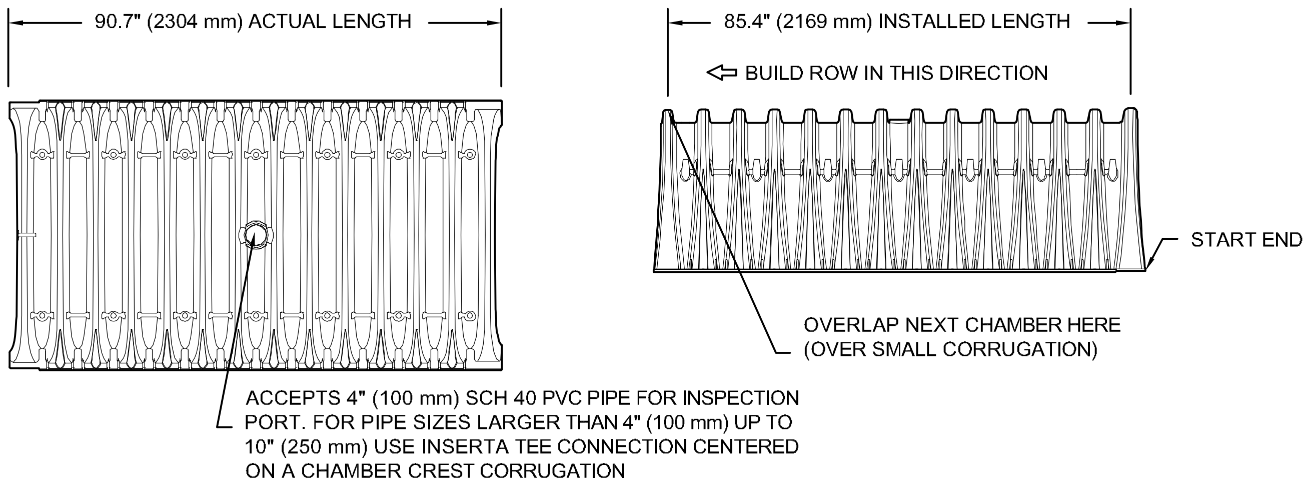
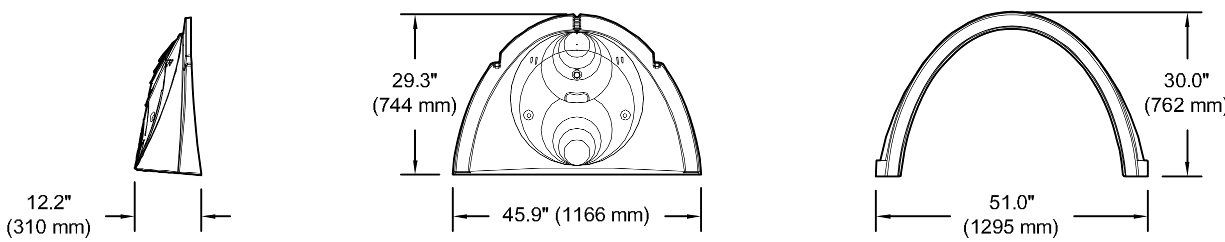
SHEET 1 OF 1

DC-780 TECHNICAL SPECIFICATION

NTS

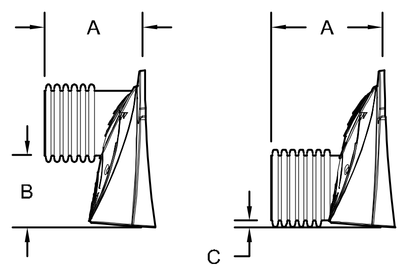




NOMINAL CHAMBER SPECIFICATIONS

SIZE (W X H X INSTALLED LENGTH)	51.0" X 30.0" X 85.4"	(1295 mm X 762 mm X 2169 mm)
CHAMBER STORAGE	46.2 CUBIC FEET	(1.30 m³)
MINIMUM INSTALLED STORAGE*	78.4 CUBIC FEET	(2.20 m³)
WEIGHT	75.0 lbs.	(33.6 kg)

*ASSUMES 6" (152 mm) STONE ABOVE, 9" (229 mm) BELOW, AND 6" (152 mm) BETWEEN CHAMBERS



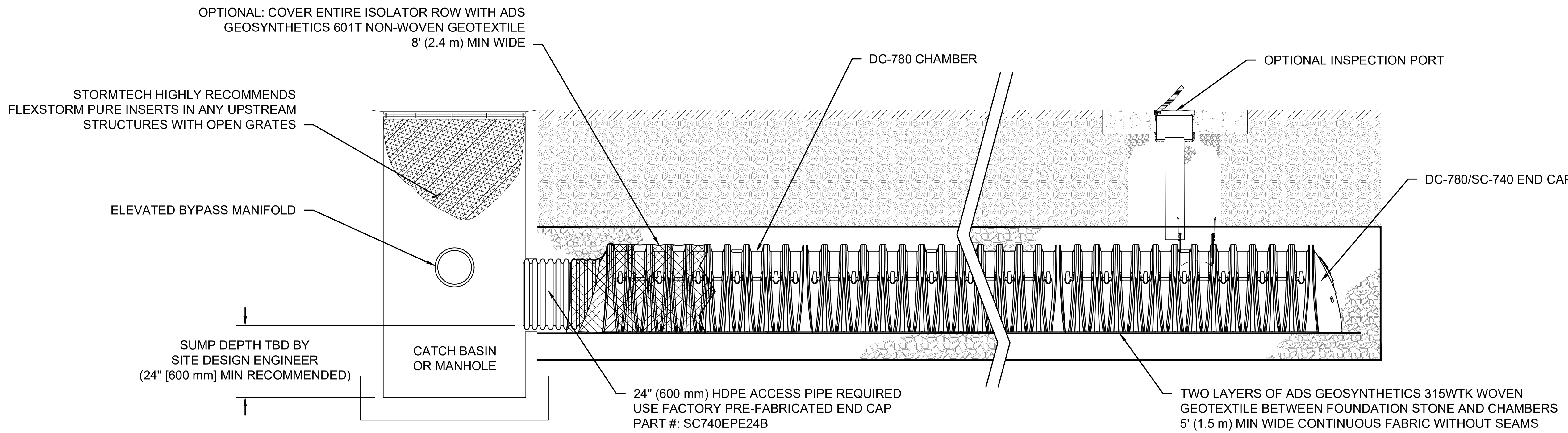
STUBS AT BOTTOM OF END CAP FOR PART NUMBERS ENDING WITH "B"
STUBS AT TOP OF END CAP FOR PART NUMBERS ENDING WITH "T"

PART #	STUB	A	B	C
SC740EPE06T / SC740EPE06TPC	6" (150 mm)	10.9" (277 mm)	18.5" (470 mm)	---
SC740EPE06B / SC740EPE06BPC			---	0.5" (13 mm)
SC740EPE08T / SC740EPE08TPC	8" (200 mm)	12.2" (310 mm)	16.5" (419 mm)	---
SC740EPE08B / SC740EPE08BPC			---	0.6" (15 mm)
SC740EPE10T / SC740EPE10TPC	10" (250 mm)	13.4" (340 mm)	14.5" (368 mm)	---
SC740EPE10B / SC740EPE10BPC			---	0.7" (18 mm)
SC740EPE12T / SC740EPE12TPC	12" (300 mm)	14.7" (373 mm)	12.5" (318 mm)	---
SC740EPE12B / SC740EPE12BPC			---	1.2" (30 mm)
SC740EPE15T / SC740EPE15TPC	15" (375 mm)	18.4" (467 mm)	9.0" (229 mm)	---
SC740EPE15B / SC740EPE15BPC			---	1.3" (33 mm)
SC740EPE18T/ SC740EPE18TPC	18" (450 mm)	19.7" (500 mm)	5.0" (127 mm)	---
SC740EPE18B / SC740EPE18BPC			---	1.6" (41 mm)
SC740EPE24B*	24" (600 mm)	18.5" (470 mm)	---	0.1" (3 mm)

ALL STUBS, EXCEPT FOR THE SC740EPE24B ARE PLACED AT BOTTOM OF END CAP SUCH THAT THE OUTSIDE DIAMETER OF THE STUB IS FLUSH WITH THE BOTTOM OF THE END CAP. FOR ADDITIONAL INFORMATION CONTACT STORMTECH AT 1-888-892-2694.

* FOR THE SC740EPE24B THE 24" (600 mm) STUB LIES BELOW THE BOTTOM OF THE END CAP APPROXIMATELY 1.75" (44 mm). BACKFILL MATERIAL SHOULD BE REMOVED FROM BELOW THE N-12 STUB SO THAT THE FITTING SITS LEVEL.

NOTE: ALL DIMENSIONS ARE NOMINAL



DC-780 ISOLATOR ROW DETAIL
NTS

INSPECTION & MAINTENANCE

STEP 1) INSPECT ISOLATOR ROW FOR SEDIMENT
- A. INSPECTION PORTS (IF PRESENT)
  - A.1. REMOVE/OPEN LID ON NYLOPLAST INLINE DRAIN
  - A.2. REMOVE AND CLEAN FLEXSTORM FILTER IF INSTALLED
  - A.3. USING A FLASHLIGHT AND STADIA ROD, MEASURE DEPTH OF SEDIMENT AND RECORD ON MAINTENANCE LOG
  - A.4. LOWER A CAMERA INTO ISOLATOR ROW FOR VISUAL INSPECTION OF SEDIMENT LEVELS (OPTIONAL)
  - A.5. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.
- B. ALL ISOLATOR ROWS
  - B.1. REMOVE COVER FROM STRUCTURE AT UPSTREAM END OF ISOLATOR ROW
  - B.2. USING A FLASHLIGHT, INSPECT DOWN THE ISOLATOR ROW THROUGH OUTLET PIPE
    - i) MIRRORS ON POLES OR CAMERAS MAY BE USED TO AVOID A CONFINED SPACE ENTRY
    - ii) FOLLOW OSHA REGULATIONS FOR CONFINED SPACE ENTRY IF ENTERING MANHOLE
  - B.3. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.

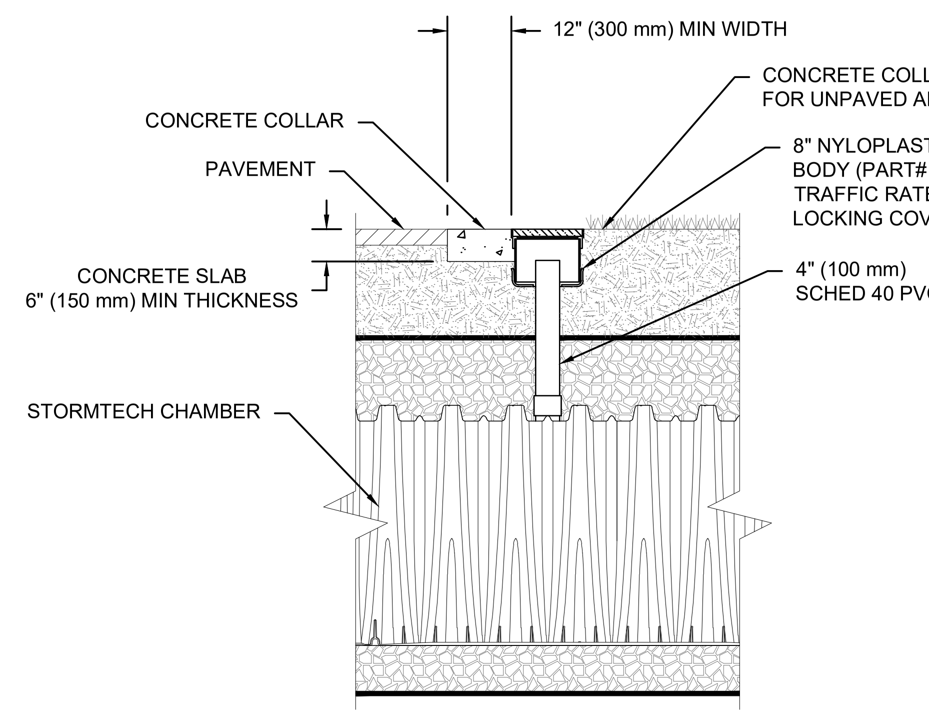
STEP 2) CLEAN OUT ISOLATOR ROW USING THE JETVAC PROCESS
- A. A FIXED CULVERT CLEANING NOZZLE WITH REAR FACING SPREAD OF 45" (1.1 m) OR MORE IS PREFERRED
- B. APPLY MULTIPLE PASSES OF JETVAC UNTIL BACKFLUSH WATER IS CLEAN
- C. VACUUM STRUCTURE SUMP AS REQUIRED

STEP 3) REPLACE ALL COVERS, GRATES, FILTERS, AND LIDS; RECORD OBSERVATIONS AND ACTIONS.

STEP 4) INSPECT AND CLEAN BASINS AND MANHOLES UPSTREAM OF THE STORMTECH SYSTEM.

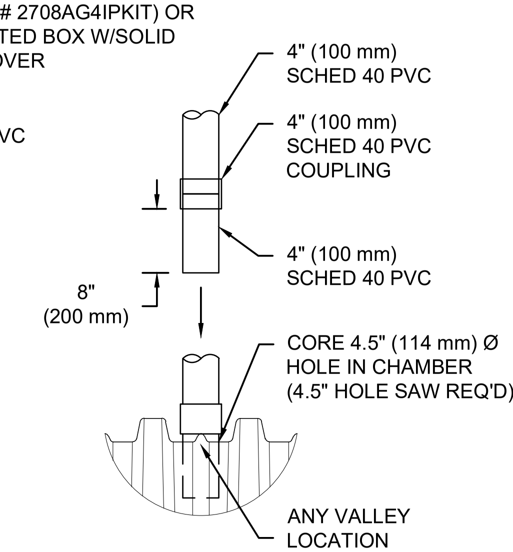
NOTES

1. INSPECT EVERY 6 MONTHS DURING THE FIRST YEAR OF OPERATION. ADJUST THE INSPECTION INTERVAL BASED ON PREVIOUS OBSERVATIONS OF SEDIMENT ACCUMULATION AND HIGH WATER ELEVATIONS.
2. CONDUCT JETTING AND VACTORING ANNUALLY OR WHEN INSPECTION SHOWS THAT MAINTENANCE IS NECESSARY.



NOTES:
1. INSPECTION PORTS MAY BE CONNECTED THROUGH ANY CHAMBER CORRUGATION VALLEY.
2. ALL SCHEDULE 40 FITTINGS TO BE SOLVENT CEMENTED (4" PVC NOT PROVIDED BY ADS).

4" PVC INSPECTION PORT DETAIL
NTS



CONNECTION DETAIL
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DATE	DRWN	CHKD	DESCRIPTION

DC-780
ISOLATOR ROW DETAILS
DATE: 05-10-19 DRAWN: KR
PROJECT #: CHECKED: KR

SHEET 1 OF 1

StormTech®
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An ADS company

Isolator® Row O&M Manual

THE MOST **ADVANCED** NAME IN WATER MANAGEMENT SOLUTIONS™

THE ISOLATOR® ROW

INTRODUCTION
An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The StormTech Isolator Row is a patented technique to inexpensively enhance Total Suspended Solids (TSS) removal and provide easy access for inspection and maintenance.

THE ISOLATOR ROW
The Isolator Row is a row of StormTech chambers, either SC-160LP, SC-310, SC-310-3, SC-740, DC-780, MC-3500 or MC-4500 models, that is surrounded with filter fabric and connected to a closely located manhole for easy access. The fabric-wrapped chambers provide for settling and filtration of sediment as storm water rises in the Isolator Row and ultimately passes through the filter fabric. The open bottom chambers and perforated sidewalls (SC-310, SC- 310-3 and SC-740 models) allow storm water to flow both vertically and horizontally out of the chambers. Sediments are captured in the Isolator Row protecting the storage areas of the adjacent stone and chambers from sediment accumulation.

Two different fabrics are used for the Isolator Row. A woven geotextile fabric is placed between the stone and the Isolator Row chambers. The tough geotextile provides a media for storm water filtration and provides a durable surface for maintenance operations. It is also designed to prevent scour of the underlying stone and remain intact during high pressure jetting. A non-woven fabric is placed over the chambers to provide a filter media for flows passing through the perforations in the sidewall of the chamber. The non-woven fabric is not required over the DC-780, MC-3500 or MC-4500 models as these chambers do not have perforated side walls.

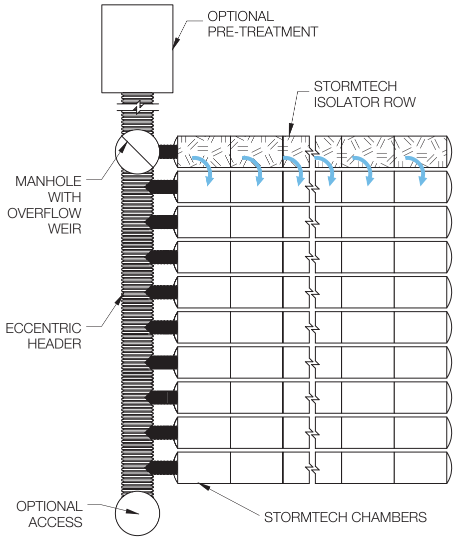
The Isolator Row is typically designed to capture the "first flush" and offers the versatility to be sized on a volume basis or flow rate basis. An upstream manhole not only provides access to the Isolator Row but typically includes a high flow weir such that storm water flowrates or volumes that exceed the capacity of the Isolator Row overtop the over flow weir and discharge through a manifold to the other chambers.

The Isolator Row may also be part of a treatment train. By treating storm water prior to entry into the chamber system, the service life can be extended and pollutants such as hydrocarbons can be captured. Pre-treatment best management practices can be as simple as deep sump catch basins, oil-water separators or can be innovative storm water treatment devices. The design of the treatment train and selection of pretreatment devices by the design engineer is often driven by regulatory requirements. Whether pretreatment is used or not, the Isolator Row is recommended by StormTech as an effective means to minimize maintenance requirements and maintenance costs.

Note: See the StormTech Design Manual for detailed information on designing inlets for a StormTech system, including the Isolator Row.

Looking down the Isolator Row from the manhole opening, woven geotextile is shown between the chamber and stone base.

StormTech Isolator Row with Overflow Spillway (not to scale)



ISOLATOR ROW INSPECTION/MAINTENANCE

INSPECTION

The frequency of inspection and maintenance varies by location. A routine inspection schedule needs to be established for each individual location based upon site specific variables. The type of land use (i.e. industrial, commercial, residential), anticipated pollutant load, percent imperviousness, climate, etc. all play a critical role in determining the actual frequency of inspection and maintenance practices.

At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

The Isolator Row incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.

If upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 3 inches throughout the length of the Isolator Row, clean-out should be performed.

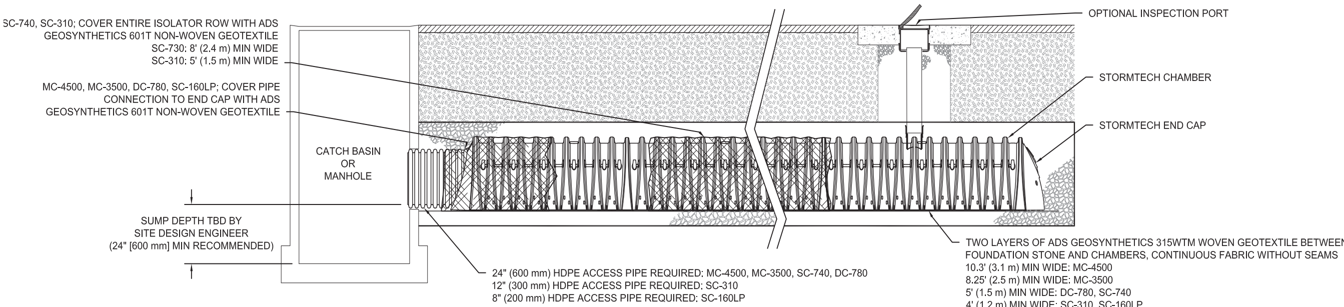
MAINTENANCE

The Isolator Row was designed to reduce the cost of periodic maintenance. By “isolating” sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the row for cleanout. If entry into the manhole is required, please follow local and OSHA rules for a confined space entries.

Maintenance is accomplished with the JetVac process. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/JetVac combination vehicles. Selection of an appropriate JetVac nozzle will improve maintenance efficiency. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45” are best. Most JetVac reels have 400 feet of hose allowing maintenance of an Isolator Row up to 50 chambers long. **The JetVac process shall only be performed on StormTech Isolator Rows that have AASHTO class 1 woven geotextile (as specified by StormTech) over their angular base stone.**

StormTech Isolator Row (not to scale)

Note: Non-woven fabric is only required over the inlet pipe connection into the end cap for DC-780, MC-3500 and MC-4500 chamber models and is not required over the entire Isolator Row.



ISOLATOR ROW STEP BY STEP MAINTENANCE PROCEDURES

STEP 1
Inspect Isolator Row for sediment.

A) Inspection ports (if present)
  i. Remove lid from floor box frame
  ii. Remove cap from inspection riser
  iii. Using a flashlight and stadia rod,measure depth of sediment and record results on maintenance log.
  iv. If sediment is at or above 3 inch depth, proceed to Step 2. If not, proceed to Step 3.

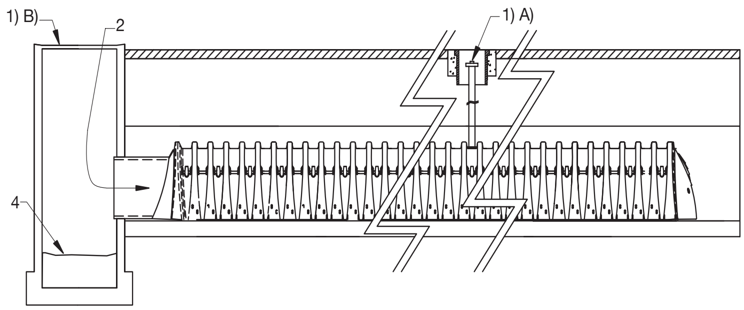
B) All Isolator Rows
  i. Remove cover from manhole at upstream end of Isolator Row
  ii. Using a flashlight, inspect down Isolator Row through outlet pipe
    1. Mirrors on poles or cameras may be used to avoid a confined space entry
    2. Follow OSHA regulations for confined space entry if entering manhole
  iii. If sediment is at or above the lower row of sidewall holes (approximately 3 inches), proceed to Step 2. If not, proceed to Step 3.

STEP 2
Clean out Isolator Row using the JetVac process.

A) A fixed floor cleaning nozzle with rear facing nozzle spread of 45 inches or more is preferable
B) Apply multiple passes of JetVac until backflush water is clean
C) Vacuum manhole sump as required

STEP 3
Replace all caps, lids and covers, record observations and actions.

STEP 4
Inspect & clean catch basins and manholes upstream of the StormTech system.



SAMPLE MAINTENANCE LOG

Date	Stadia Rod Readings: Fixed point to chamber bottom (1)	Stadia Rod Readings: Fixed point to top of sediment (2)	Sediment Depth (1)–(2)	Observations/Actions	Inspector
3/15/11	6.3 ft	none		New installation. Fixed point is CI frame at grade	DJM
9/24/11		6.2	0.1 ft	Some grit felt	SM
6/20/13		5.8	0.5 ft	Mucky feel, debris visible in manhole and in Isolator Row, maintenance due	NV
7/7/13	6.3 ft		0	System jetted and vacuumed	DJM

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An ADS company

SC-310/SC-740/DC-780

StormTech Construction Guide

REQUIRED MATERIALS AND EQUIPMENT LIST
- Acceptable fill materials per Table 1
- Woven and non-woven geotextiles
- StormTech solid end caps and pre-cored end caps
- StormTech chambers
- StormTech manifolds and fittings

IMPORTANT NOTES:

A. This installation guide provides the minimum requirements for proper installation of chambers. Non-adherence to this guide may result in damage to chambers during installation. Replacement of damaged chambers during or after backfilling is costly and very time consuming. It is recommended that all installers are familiar with this guide, and that the contractor inspects the chambers for distortion, damage and joint integrity as work progresses.

B. Use of a dozer to push embedment stone between the rows of chambers may cause damage to chambers and is not an acceptable backfill method. Any chambers damaged by using the “dump and push” method are not covered under the StormTech standard warranty.

C. Care should be taken in the handling of chambers and end caps. Avoid dropping, prying or excessive force on chambers during removal from pallet and initial placement.

Requirements for System Installation


Excavate bed and prepare subgrade per engineer’s plans.

Place non-woven geotextile over prepared soils and up excavation walls. Install underdrains if required.


Place clean, crushed, angular stone foundation 6” (150 mm) min. Compact to achieve a flat surface.

Manifold, Scour Fabric and Chamber Assembly

Install manifolds and lay out woven scour geotextile at inlet rows [min. 12.5 ft (3.8 m)] at each inlet end cap. Place a continuous piece (no seams, double layer) along entire length of Isolator® Row(s).

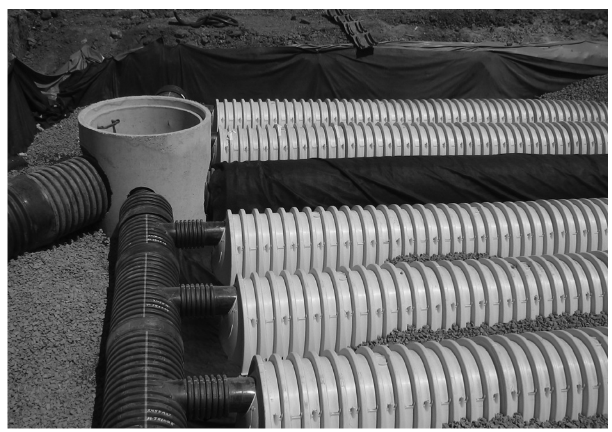
Align the first chamber and end cap of each row with inlet pipes. Contractor may choose to postpone stone placement around end chambers and leave ends of rows open for easy inspection of chambers during the backfill process.

Continue installing chambers by overlapping chamber end corrugations. Chamber joints are labeled “Lower Joint – Overlap Here” and “Build this direction – Upper Joint” Be sure that the chamber placement does not exceed the reach of the construction equipment used to place the stone. Maintain minimum 6” (150 mm) spacing between rows.

Attaching the End Caps

Lift the end of the chamber a few inches off the ground. With the curved face of the end cap facing outward, place the end cap into the chamber’s end corrugation.

Prefabricated End Caps



24” (600 mm) inlets are the maximum size that can fit into a SC-740/DC-780 end cap and must be prefabricated with a 24” (600 mm) pipe stub. SC-310 chambers with a 12” (300 mm) inlet pipe must use a prefabricated end cap with a 12” (300 mm) pipe stub.

Isolator Row

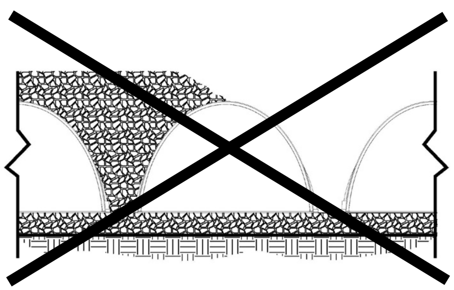
Place two continuous layers of ADS Woven fabric between the foundation stone and the isolator row chambers, making sure the fabric lays flat and extends the entire width of the chamber feet. Drape a strip of ADS non-woven geotextile over the row of chambers (not required over DC-780). This is the same type of non-woven geotextile used as a separation layer around the angular stone of the StormTech system.

Initial Anchoring of Chambers – Embedment Stone

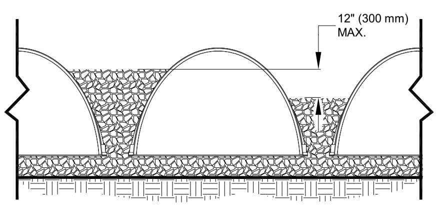
Initial embedment shall be spotted along the centerline of the chamber evenly anchoring the lower portion of the chamber. This is best accomplished with a stone conveyor or excavator reaching along the row.

No equipment shall be operated on the bed at this stage of the installation. Excavators must be located off the bed. Dump trucks shall not dump stone directly on to the bed. Dozers or loaders are not allowed on the bed at this time.

Backfill of Chambers – Embedment Stone

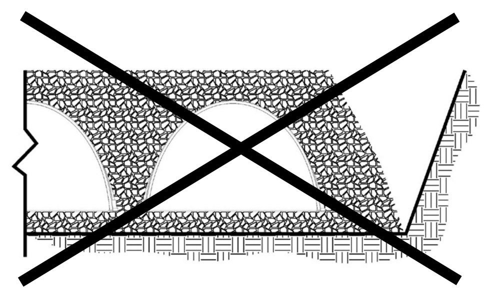


UNEVEN BACKFILL

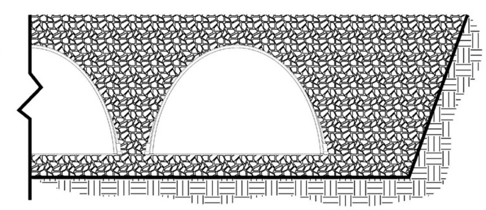


EVEN BACKFILL

Backfill chambers evenly. Stone column height should never differ by more than 12” (300 mm) between adjacent chamber rows or between chamber rows and perimeter.



PERIMETER NOT BACKFILLED



PERIMETER FULLY BACKFILLED

Perimeter stone must be brought up evenly with chamber rows. Perimeter must be fully backfilled, with stone extended horizontally to the excavation wall.

Backfill - Embedment Stone & Cover Stone

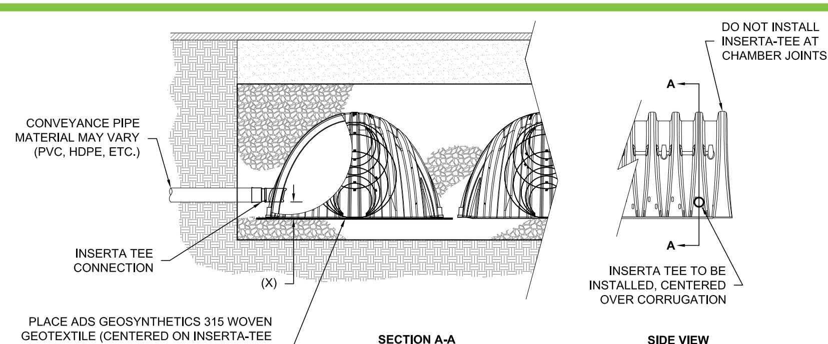
Continue evenly backfilling between rows and around perimeter until embedment stone reaches tops of chambers. Perimeter stone must extend horizontally to the excavation wall for both straight or sloped sidewalls. **Only after chambers have been backfilled to top of chamber and with a minimum 6" (150 mm) of cover stone on top of chambers can small dozers be used over the chambers for backfilling remaining cover stone.**

Small dozers and skid loaders may be used to finish grading stone backfill in accordance with ground pressure limits in Table 2. They must push material parallel to rows only. Never push perpendicular to rows. StormTech recommends that the contractor inspect chambers before placing final backfill. Any chambers damaged by construction shall be removed and replaced.

Final Backfill of Chambers – Fill Material

Install non-woven geotextile over stone. Geotextile must overlap 24" (600 mm) min. where edges meet. Compact each lift of backfill as specified in the site design engineer's drawings. Roller travel parallel with rows.

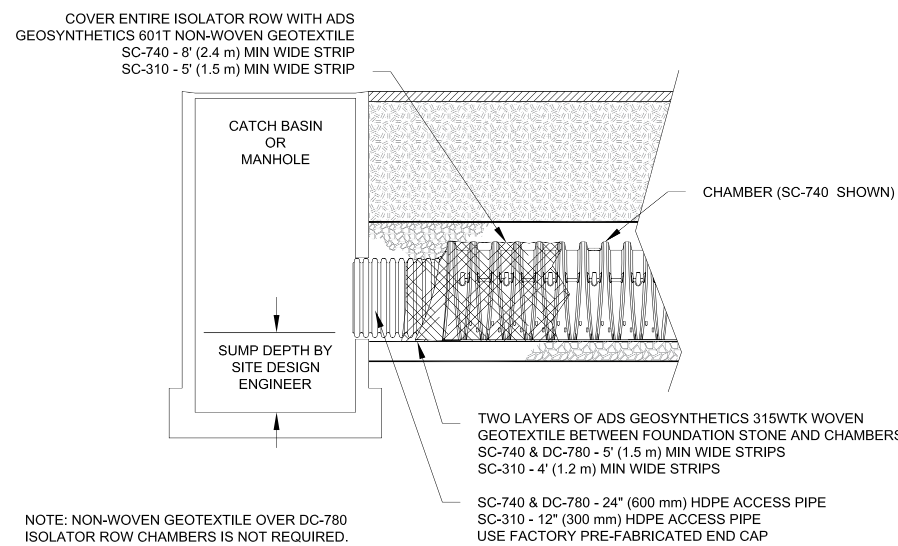
Inserta Tee Detail



CHAMBER	MAX DIAMETER OF INSERTA TEE	HEIGHT FROM BASE OF CHAMBER (X)
SC-310	6" (150 mm)	4" (100 mm)
SC-740	10" (250 mm)	4" (100 mm)
DC-780	10" (250 mm)	4" (100 mm)
MC-3500	12" (300 mm)	6" (150 mm)
MC-4500	12" (300 mm)	8" (200 mm)
INSERTA TEE FITTINGS AVAILABLE FOR SDR 26, SDR 35, SCH 40 IPS GASKETED & SOLVENT WELD, N-12, HP STORM, C-900 OR DUCTILE IRON		

NOTE:
PART NUMBERS WILL VARY BASED ON INLET PIPE MATERIALS. CONTACT STORMTECH FOR MORE INFORMATION.

StormTech Isolator Row Detail



NOTE: NON-WOVEN GEOTEXTILE OVER DC-780 ISOLATOR ROW CHAMBERS IS NOT REQUIRED.

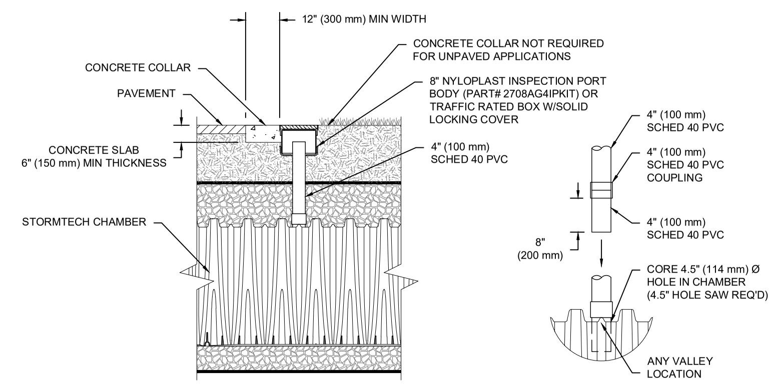
Table 1- Acceptable Fill Materials

Material Location	Description	AASHTO M43 Designation[1]	Compaction/Density Requirement
Ⓓ **Final Fill:** Fill Material for layer 'D' starts from the top of the 'C' layer to the bottom of flexible pavement or unpaved finished grade above. Note that the pavement subbase may be part of the 'D' layer.	Any soil/rock materials, native soils or per engineer's plans. Check plans for pavement subgrade requirements.	N/A	Prepare per site design engineer's plans. Paved installations may have stringent material and preparation requirements.
Ⓒ **Initial Fill:** Fill Material for layer 'C' starts from the top of the embedment stone ('B' layer) to 18" (450 mm) above the top of the chamber. Note that pavement subbase may be part of the 'C' layer.	Granular well-graded soil/ aggregate mixtures, <35% fines or processed aggregate. Most pavement subbase materials can be used in lieu of this layer.	AASHTO M45 A-1, A-2-4, A-3 or AASHTO M431 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10	Begin compaction after min. 12" (300 mm) of material over the chambers is reached. Compact additional layers in 6" (150 mm) max. lifts to a min. 95% Proctor density for well-graded material and 95% relative density for processed aggregate materials. Roller gross vehicle weight not to exceed 12,000 lbs (53 kN). Dynamic force not to exceed 20,000 lbs (89 kN)
Ⓑ **Embedment Stone:** Embedment Stone surrounding chambers from the foundation stone to the 'C' layer above.	Clean, crushed, angular stone	AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57	No compaction required.
Ⓐ **Foundation Stone:** Foundation Stone below the chambers from the subgrade up to the foot (bottom) of the chamber.	Clean, crushed, angular stone,	AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57	Place and compact in 6" (150 mm) lifts using two full coverages with a vibratory compactor.[2,3]

PLEASE NOTE:

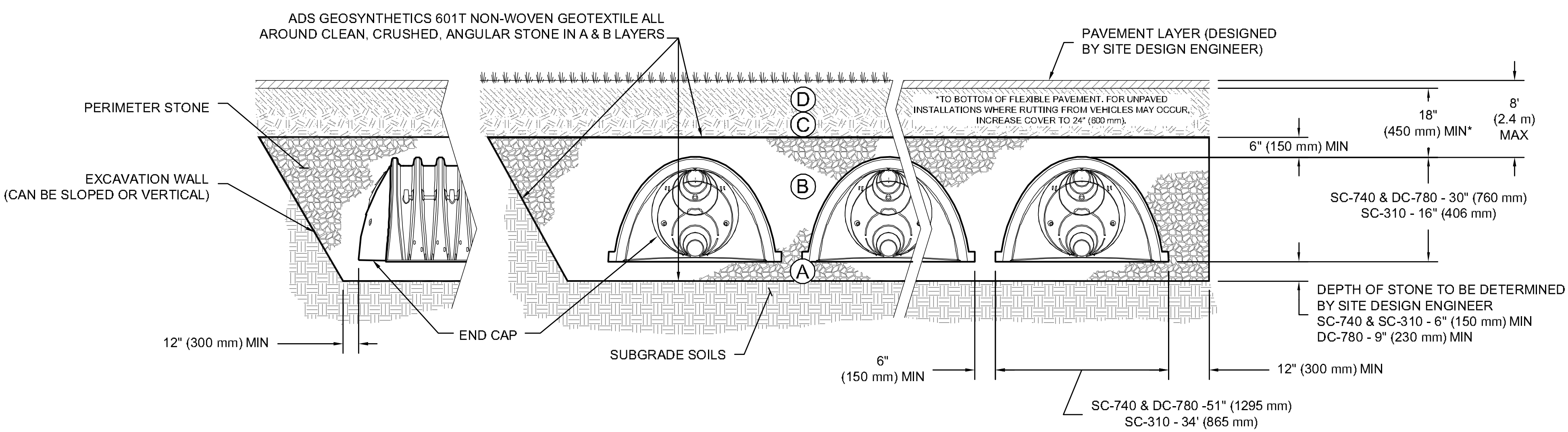
1. ***The listed AASHTO designations are for gradations only. The stone must also be clean, crushed, angular. For example, a specification for #4 stone would state: "clean, crushed, angular no. 4 (AASHTO M43) stone".***
2. ***StormTech compaction requirements are met for 'A' location materials when placed and compacted in 6" (150 mm) (max) lifts using two full coverages with a vibratory compactor.***
3. ***Where infiltration surfaces may be comprised by compaction, for standard installations and standard design load conditions, a flat surface may be achieved by raking or dragging without compaction equipment. For special load designs, contact StormTech for compaction requirements.***

Figure 1- Inspection Port Detail



NOTES:
1. INSPECTION PORTS MAY BE CONNECTED THROUGH ANY CHAMBER CORRUGATION VALLEY.
2. ALL SCHEDULE 40 FITTINGS TO BE SOLVENT CEMENTED (4" PVC NOT PROVIDED BY ADS).

Figure 2 - Fill Material Locations



NOTES:

1. ***36" (900 mm) of stabilized cover materials over the chambers is required for full dump truck travel and dumping.***
2. ***During paving operations, dump truck axle loads on 18" (450 mm) of cover may be necessary. Precautions should be taken to avoid rutting of the road base layer, to ensure that compaction requirements have been met, and that a minimum of 18" (450 mm) of cover exists over the chambers. Contact StormTech for additional guidance on allowable axle loads during paving.***
3. ***Ground pressure for track dozers is the vehicle operating weight divided by total ground contact area for both tracks. Excavators will exert higher ground pressures based on loaded bucket weight and boom extension.***
4. ***Mini-excavators (< 8,000lbs/3,628 kg) can be used with at least 12" (300 mm) of stone over the chambers and are limited by the maximum ground pressures in Table 2 based on a full bucket at maximum boom extension.***
5. ***Storage of materials such as construction materials, equipment, spoils, etc. should not be located over the StormTech system. The use of equipment over the StormTech system not covered in Table 2 (ex. soil mixing equipment, cranes, etc) is limited. Please contact StormTech for more information.***
6. ***Allowable track loads based on vehicle travel only. Excavators shall not operate on chamber beds until the total backfill reaches 3 feet (900 mm) over the entire bed.***

Table 2 - Maximum Allowable Construction Vehicle Loads[5]

Material Location	Fill Depth over Chambers in. [mm]	Maximum Allowable Wheel Loads		Maximum Allowable Track Loads[6]		Maximum Allowable Roller Loads
		Max Axle Load for Trucks lbs [kN]	Max Wheel Load for Loaders lbs [kN]	Track Width in. [mm]	Max Ground Pressure psf [kPa]	Max Drum Weight or Dynamic Force lbs [kN]
(D) Final Fill Material	36" [900] Compacted	32,000 [142]	16,000 [71]	12" [305] 18" [457] 24" [610] 30" [762] 36" [914]	3420 [164] 2350 [113] 1850 [89] 1510 [72] 1310 [63]	38,000 [169]
(C) Initial Fill Material	24" [600] Compacted	32,000 [142]	16,000 [71]	12" [305] 18" [457] 24" [610] 30" [762] 36" [914]	2480 [119] 1770 [85] 1430 [68] 1210 [58] 1070 [51]	20,000 [89]
	24" [600] Loose/Dumped	32,000 [142]	16,000 [71]	12" [305] 18" [457] 24" [610] 30" [762] 36" [914]	2245 [107] 1625 [78] 1325 [63] 1135 [54] 1010 [48]	20,000 [89] Roller gross vehicle weight not to exceed 12,000 lbs. [53 kN]
	18" [450]	32,000 [142]	16,000 [71]	12" [305] 18" [457] 24" [610] 30" [762] 36" [914]	2010 [96] 1480 [71] 1220 [58] 1060 [51] 950 [45]	20,000 [89] Roller gross vehicle weight not to exceed 12,000 lbs. [53 kN]
(B) Embedment Stone	12" [300]	16,000 [71]	NOT ALLOWED	12" [305] 18" [457] 24" [610] 30" [762] 36" [914]	1540 [74] 1190 [57] 1010 [48] 910 [43] 840 [40]	20,000 [89] Roller gross vehicle weight not to exceed 12,000 lbs. [53 kN]
	6" [150]	8,000 [35]	NOT ALLOWED	12" [305] 18" [457] 24" [610] 30" [762] 36" [914]	1070 [51] 900 [43] 800 [38] 760 [36] 720 [34]	NOT ALLOWED

Table 3 - Placement Methods and Descriptions

Material Location	Placement Methods/ Restrictions	Wheel Load Restrictions	Track Load Restrictions	Roller Load Restrictions
		See Table 2 for Maximum Construction Loads		
(D) Final Fill Material	A variety of placement methods may be used. All construction loads must not exceed the maximum limits in Table 2.	36" (900 mm) minimum cover required for dump trucks to dump over chambers.	Dozers to push parallel to rows until 36" (900mm) compacted cover is reached.[4]	Roller travel parallel to rows only until 36" (900 mm) compacted cover is reached.
(C) Initial Fill Material	Excavator positioned off bed recommended. Small excavator allowed over chambers. Small dozer allowed.	Asphalt can be dumped into paver when compacted pavement subbase reaches 18" (450 mm) above top of chambers.	Small LGP track dozers & skid loaders allowed to grade cover stone with at least 6" (150 mm) stone under tracks at all times. Equipment must push parallel to rows at all times.	Use dynamic force of roller only after compacted fill depth reaches 12" (300 mm) over chambers. Roller travel parallel to chamber rows only.
(B) Embedment Stone	No equipment allowed on bare chambers. Use excavator or stone conveyor positioned off bed or on foundation stone to evenly fill around all chambers to at least the top of chambers.	No wheel loads allowed. Material must be placed outside the limits of the chamber bed.	No tracked equipment is allowed on chambers until a min. 6" (150 mm) cover stone is in place.	No rollers allowed.
(A) Foundation Stone	No StormTech restrictions. Contractor responsible for any conditions or requirements by others relative to subgrade bearing capacity, dewatering or protection of subgrade.			

17.0 Standard Limited Warranty

STANDARD LIMITED WARRANTY OF STORMTECH LLC ("STORMTECH"): PRODUCTS

(A) This Limited Warranty applies solely to the StormTech chambers and end plates manufactured by StormTech and sold to the original purchaser (the "Purchaser"). The chambers and end plates are collectively referred to as the "Products."

(B) The structural integrity of the Products, when installed strictly in accordance with StormTech's written installation instructions at the time of installation, are warranted to the Purchaser against defective materials and workmanship for one (1) year from the date of purchase. Should a defect appear in the Limited Warranty period, the Purchaser shall provide StormTech with written notice of the alleged defect at StormTech's corporate headquarters within ten (10) days of the discovery of the defect. The notice shall describe the alleged defect in reasonable detail. StormTech agrees to supply replacements for those Products determined by StormTech to be defective and covered by this Limited Warranty. The supply of replacement products is the sole remedy of the Purchaser for breaches of this Limited Warranty. StormTech's liability specifically excludes the cost of removal and/or installation of the Products.

(C) **THIS LIMITED WARRANTY IS EXCLUSIVE. THERE ARE NO OTHER WARRANTIES WITH RESPECT TO THE PRODUCTS, INCLUDING NO IMPLIED WARRANTIES OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.**

(D) This Limited Warranty only applies to the Products when the Products are installed in a single layer. **UNDER NO CIRCUMSTANCES, SHALL THE PRODUCTS BE INSTALLED IN A MULTI-LAYER CONFIGURATION.**

(E) No representative of StormTech has the authority to change this Limited Warranty in any manner or to extend this Limited Warranty. This Limited Warranty does not apply to any person other than to the Purchaser.

(F) Under no circumstances shall StormTech be liable to the Purchaser or to any third party for product liability claims; claims arising from the design, shipment, or installation of the Products, or the cost of other goods or services related to the purchase and installation of the Products. For this Limited Warranty to apply, the Products must be installed in accordance with all site conditions required by state and local codes; all other applicable laws; and StormTech's written installation instructions.

(G) **THE LIMITED WARRANTY DOES NOT EXTEND TO INCIDENTAL, CONSEQUENTIAL, SPECIAL OR INDIRECT DAMAGES. STORMTECH SHALL NOT BE LIABLE FOR PENALTIES OR LIQUIDATED DAMAGES, INCLUDING LOSS OF PRODUCTION AND PROFITS; LABOR AND MATERIALS; OVERHEAD COSTS; OR OTHER LOSS OR EXPENSE INCURRED BY THE PURCHASER OR ANY THIRD PARTY. SPECIFICALLY EXCLUDED FROM LIMITED WARRANTY COVERAGE ARE DAMAGE TO THE PRODUCTS ARISING FROM ORDINARY WEAR AND TEAR; ALTERATION, ACCIDENT, MISUSE, ABUSE OR NEGLECT; THE PRODUCTS BEING SUBJECTED TO VEHICLE TRAFFIC OR OTHER CONDITIONS WHICH ARE NOT PERMITTED BY STORMTECH'S WRITTEN SPECIFICATIONS OR INSTALLATION INSTRUCTIONS; FAILURE TO MAINTAIN THE MINIMUM GROUND COVERS SET FORTH IN THE INSTALLATION INSTRUCTIONS; THE PLACEMENT OF IMPROPER MATERIALS INTO THE PRODUCTS; FAILURE OF THE PRODUCTS DUE TO IMPROPER SITING OR IMPROPER SIZING; OR ANY OTHER EVENT NOT CAUSED BY STORMTECH. A PRODUCT ALSO IS EXCLUDED FROM LIMITED WARRANTY COVERAGE IF SUCH PRODUCT IS USED IN A PROJECT OR SYSTEM IN WHICH ANY GEOTEXTILE PRODUCTS OTHER THAN THOSE PROVIDED BY ADVANCED DRAINAGE SYSTEMS ARE USED. THIS LIMITED WARRANTY REPRESENTS STORMTECH'S SOLE LIABILITY TO THE PURCHASER FOR CLAIMS RELATED TO THE PRODUCTS, WHETHER THE CLAIM IS BASED UPON CONTRACT, TORT, OR OTHER LEGAL THEORY.**

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ADS GEOSYNTHETICS 0601T NONWOVEN GEOTEXTILE

Scope

This specification describes ADS Geosynthetics 6.0 oz (0601T) nonwoven geotextile.

Filter Fabric Requirements

ADS Geosynthetics 6.0 oz (0601T) is a needle-punched nonwoven geotextile made of 100% polypropylene staple fibers, which are formed into a random network for dimensional stability. ADS Geosynthetics 6.0 oz (0601T) resists ultraviolet deterioration, rotting, biological degradation, naturally encountered basics and acids. Polypropylene is stable within a pH range of 2 to 13. ADS Geosynthetics 6.0 oz (0601T) conforms to the physical property values listed below:

Filter Fabric Properties

PROPERTY	TEST METHOD	UNIT	M.A.R.V. (Minimum Average Roll Value)
Weight (Typical)	ASTM D 5261	oz/yd^2 (g/m^2)	6.0 (203)
Grab Tensile	ASTM D 4632	lbs (kN)	160 (0.711)
Grab Elongation	ASTM D 4632	%	50
Trapezoid Tear Strength	ASTM D 4533	lbs (kN)	60 (0.267)
CBR Puncture Resistance	ASTM D 6241	lbs (kN)	410 (1.82)
Permittivity*	ASTM D 4491	sec^{-1}	1.5
Water Flow*	ASTM D 4491	gpm/ft^2 ($l/min/m^2$)	110 (4480)
AOS*	ASTM D 4751	US Sieve (mm)	70 (0.212)
UV Resistance	ASTM D 4355	%/hrs	70/500

PACKAGING	
Roll Dimensions (W x L) – ft	12.5 x 360 / 15 x 300
Square Yards Per Roll	500
Estimated Roll Weight – lbs	195

* At the time of manufacturing. Handling may change these properties.

ADS GEOSYNTHETICS 315W WOVEN GEOTEXTILE

Scope
This specification describes ADS Geosynthetics 315W woven geotextile.

Filter Fabric Requirements
ADS Geosynthetics 315W is manufactured using high tenacity polypropylene yarns that are woven to form a dimensionally stable network, which allows the yarns to maintain their relative position. ADS Geosynthetics 315W resists ultraviolet deterioration, rotting and biological degradation and is inert to commonly encountered soil chemicals. ADS Geosynthetics 315W conforms to the physical property values listed below:

Filter Fabric Properties

PROPERTY	TEST METHOD	ENGLISH M.A.R.V. (Minimum Average Roll Value)	METRIC M.A.R.V. (Minimum Average Roll Value)
Tensile Strength (Grab)	ASTM D-4632	315 lbs	1400 N
Elongation	ASTM D-4632	15%	15%
CBR Puncture	ASTM D-6241	900 lbs	4005 N
Puncture	ASTM D-4833	150 lbs	667 N
Mullen Burst	ASTM D-3786	600 psi	4134 kPa
Trapezoidal Tear	ASTM D-4533	120 lbs	533 N
UV Resistance (at 500 hrs)	ASTM D-4355	70%	70%
Apparent Opening Size (AOS)*	ASTM D-4751	40 US Std. Sieve	0.425 mm
Permittivity	ASTM D-4491	.05 sec^{-1}	.05 sec^{-1}
Water Flow Rate	ASTM D-4491	4 gpm/ft^2	163 $l/min/m^2$
Roll Sizes		12.5' x 360' 15.0' x 300' 17.5' x 258'	3.81 m x 109.8 m 4.57 m x 91.5 m 5.33 m x 78.6 m

*Maximum average roll value.

Appendix F

Oil and Grit Separator

Hydroworks Sizing Summary

Cobourg Gas
Parcel A

03-10-2020

Recommended Size: HS 6

A HydroStorm HS 6 is recommended to provide 80 % annual TSS removal based on a drainage area of 0.2752 (ha) with an imperviousness of 84 % and Peterborough, Ontario rainfall for the ETV Canada particle size distribution.

The recommended HydroStorm HS 6 treats 99 % of the annual runoff and provides 83 % annual TSS removal for the Peterborough rainfall records and ETV Canada particle size distribution.

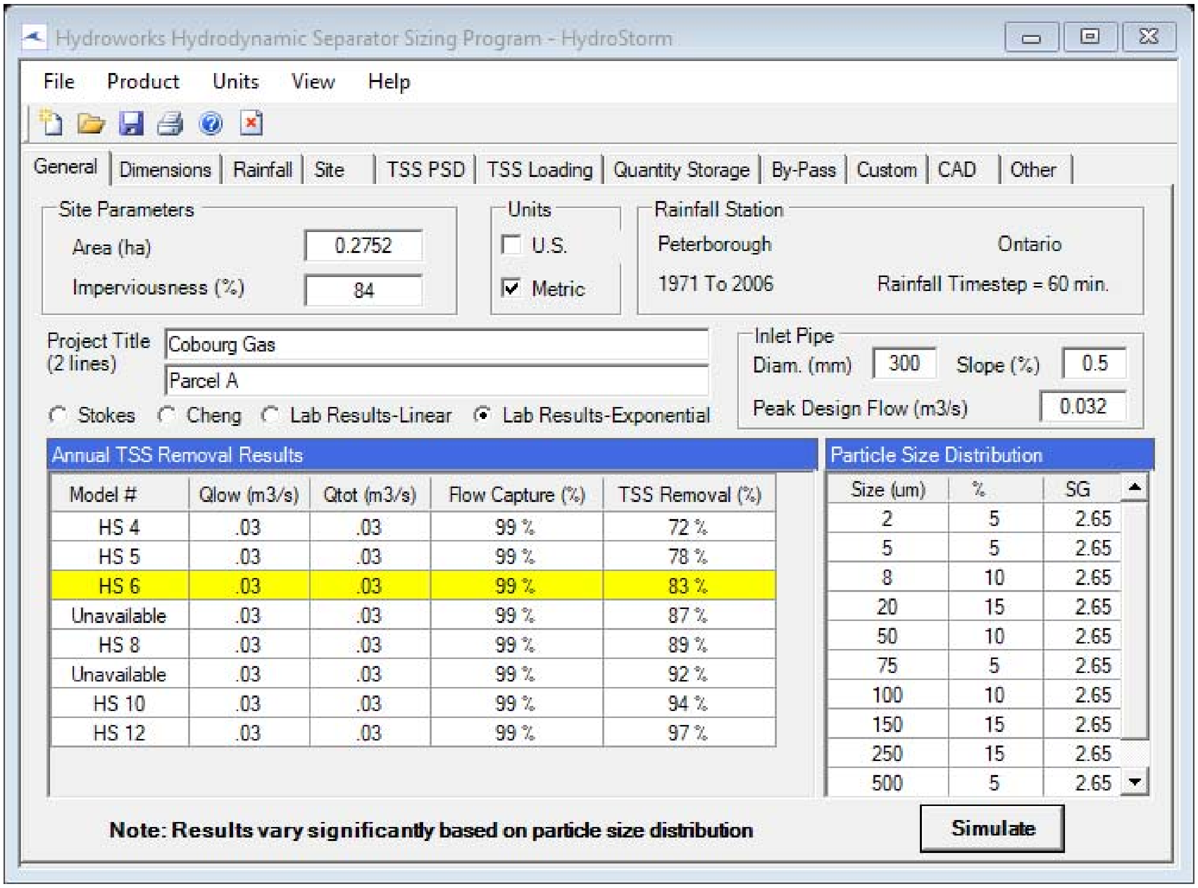
The HydroStorm has a headloss coefficient (K) of 1.04. The given peak flow Of .032 (m3/s) Is less than the full pipe flow Of .07 (m3/s) indicating free flow In the pipe during the peak flow assuming no tailwater condition. Partial pipe flow was assumed For the headloss calculations. The normal depth Is greater than the critical dpeth For the peak flow And 300 (mm) pipe diameter And .5 % slope given. Normal depth was assumed For the headloss calculations. The headloss was calculated To be 47 (mm) based On a flow depth Of 145 (mm) .

This summary report provides the main parameters that were used for sizing. These parameters are shown on the summary tables and graphs provided in this report.

If you have any questions regarding this sizing summary please do not hesitate to contact Hydroworks at 888-290-7900 or email us at support@hydroworks.com.

The sizing program is for sizing purposes only and does not address any site specific parameters such as hydraulic gradeline, tailwater submergence, groundwater, soils bearing capacity, etc. Headloss calculations are not a hydraulic gradeline calculation since this requires a starting water level and an analysis of the entire system downstream of the HydroStorm . Design liability is only valid for lawsuits brought within the United States where Hydroworks has its corporate headquarters.

TSS Removal Sizing Summary



Hydroworks Hydrodynamic Separator Sizing Program - HydroStorm

File Product Units View Help

General | Dimensions | Rainfall | Site | TSS PSD | TSS Loading | Quantity Storage | By-Pass | Custom | CAD | Other

Site Parameters
Area (ha) 0.2752
Imperviousness (%) 84

Units
U.S.
☑ Metric

Rainfall Station
Peterborough Ontario
1971 To 2006 Rainfall Timestep = 60 min.

Project Title (2 lines) Cobourg Gas
Parcel A

Inlet Pipe
Diam. (mm) 300 Slope (%) 0.5
Peak Design Flow (m3/s) 0.032

Stokes ○ Cheng ○ Lab Results-Linear ◉ Lab Results-Exponential

Annual TSS Removal Results

Model #	Qlow (m3/s)	Qtot (m3/s)	Flow Capture (%)	TSS Removal (%)
HS 4	.03	.03	99 %	72 %
HS 5	.03	.03	99 %	78 %
HS 6	.03	.03	99 %	83 %
Unavailable	.03	.03	99 %	87 %
HS 8	.03	.03	99 %	89 %
Unavailable	.03	.03	99 %	92 %
HS 10	.03	.03	99 %	94 %
HS 12	.03	.03	99 %	97 %

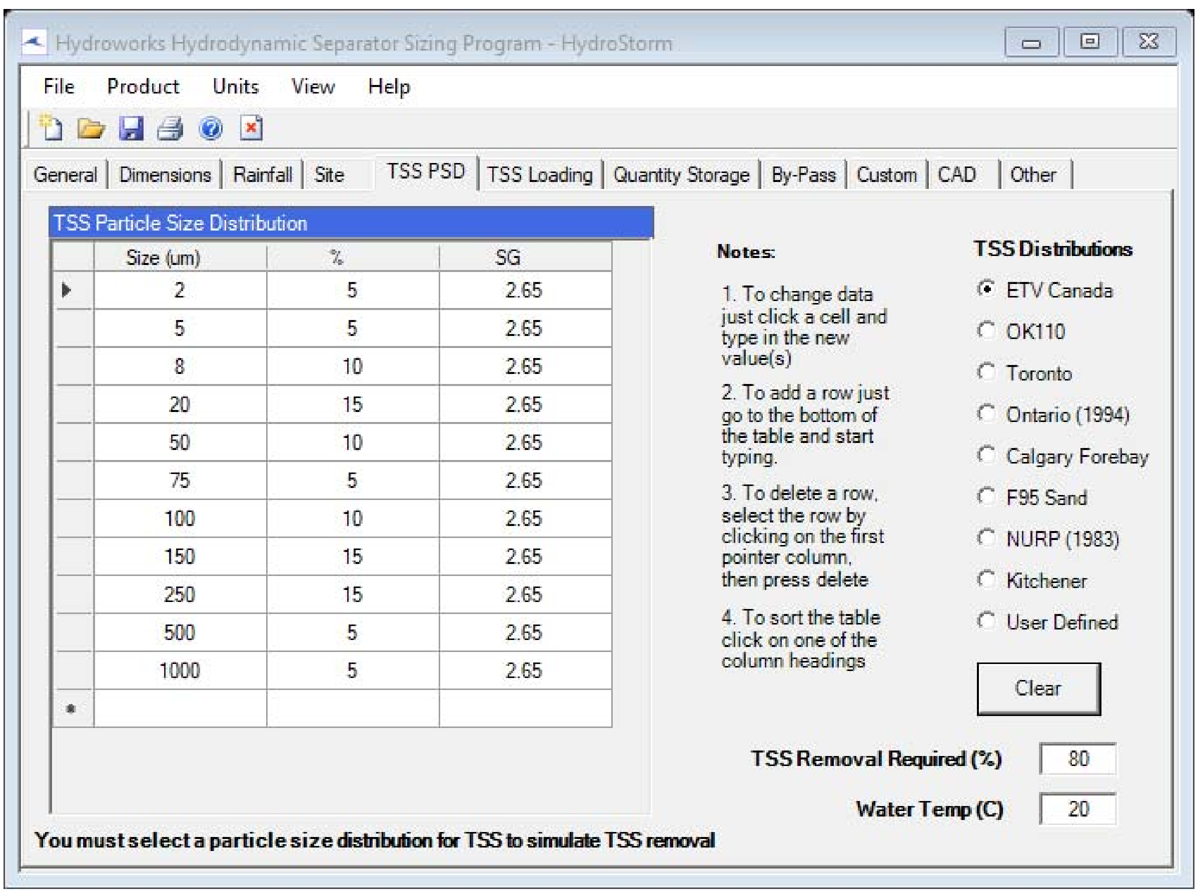
Particle Size Distribution

Size (um)	%	SG
2	5	2.65
5	5	2.65
8	10	2.65
20	15	2.65
50	10	2.65
75	5	2.65
100	10	2.65
150	15	2.65
250	15	2.65
500	5	2.65

Note: Results vary significantly based on particle size distribution

Simulate

TSS Particle Size Distribution



Hydroworks Hydrodynamic Separator Sizing Program - HydroStorm

File Product Units View Help

General | Dimensions | Rainfall | Site | TSS PSD | TSS Loading | Quantity Storage | By-Pass | Custom | CAD | Other

TSS Particle Size Distribution

Size (um)	%	SG
2	5	2.65
5	5	2.65
8	10	2.65
20	15	2.65
50	10	2.65
75	5	2.65
100	10	2.65
150	15	2.65
250	15	2.65
500	5	2.65
1000	5	2.65

Notes:

1. To change data just click a cell and type in the new value(s)
2. To add a row just go to the bottom of the table and start typing.
3. To delete a row, select the row by clicking on the first pointer column, then press delete
4. To sort the table click on one of the column headings

TSS Distributions

◉ ETV Canada
○ OK110
○ Toronto
○ Ontario (1994)
○ Calgary Forebay
○ F95 Sand
○ NURP (1983)
○ Kitchener
○ User Defined

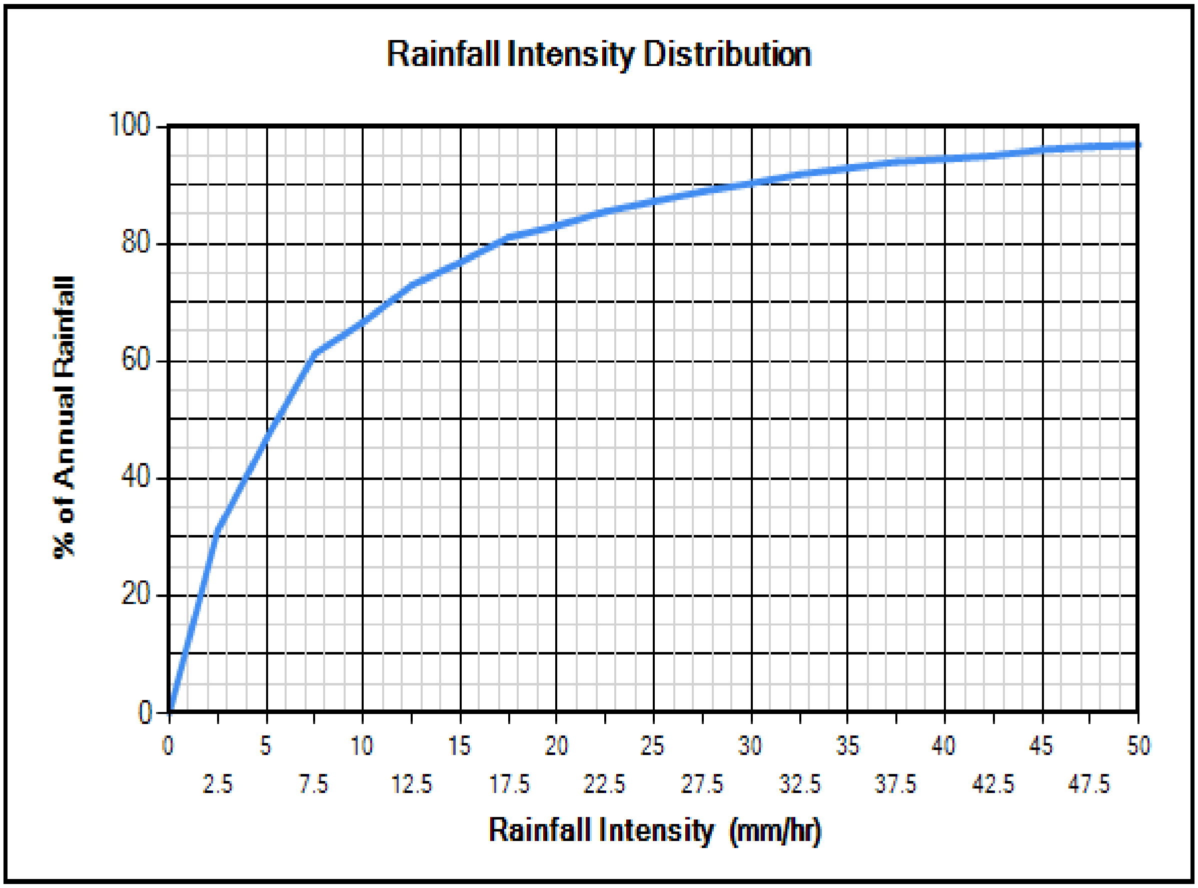
Clear

TSS Removal Required (%) 80

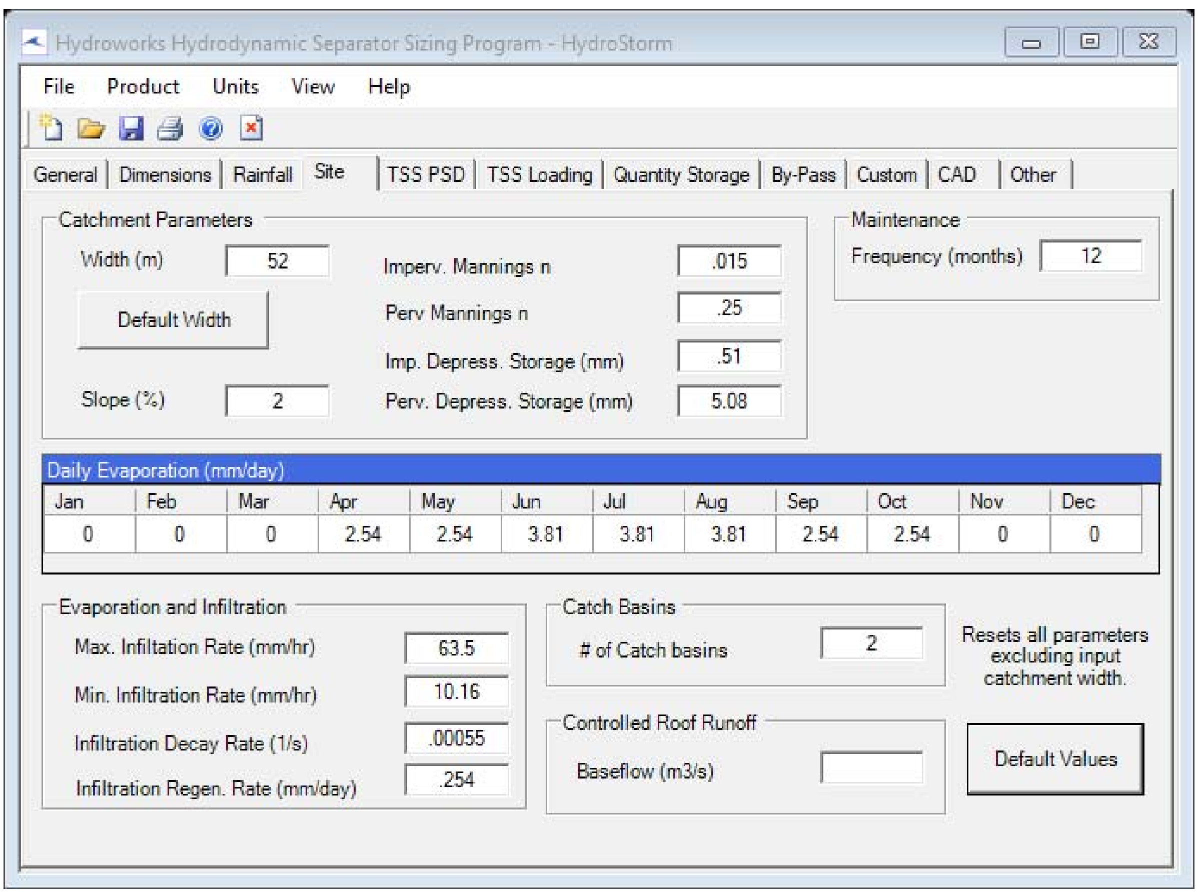
Water Temp (C) 20

You must select a particle size distribution for TSS to simulate TSS removal

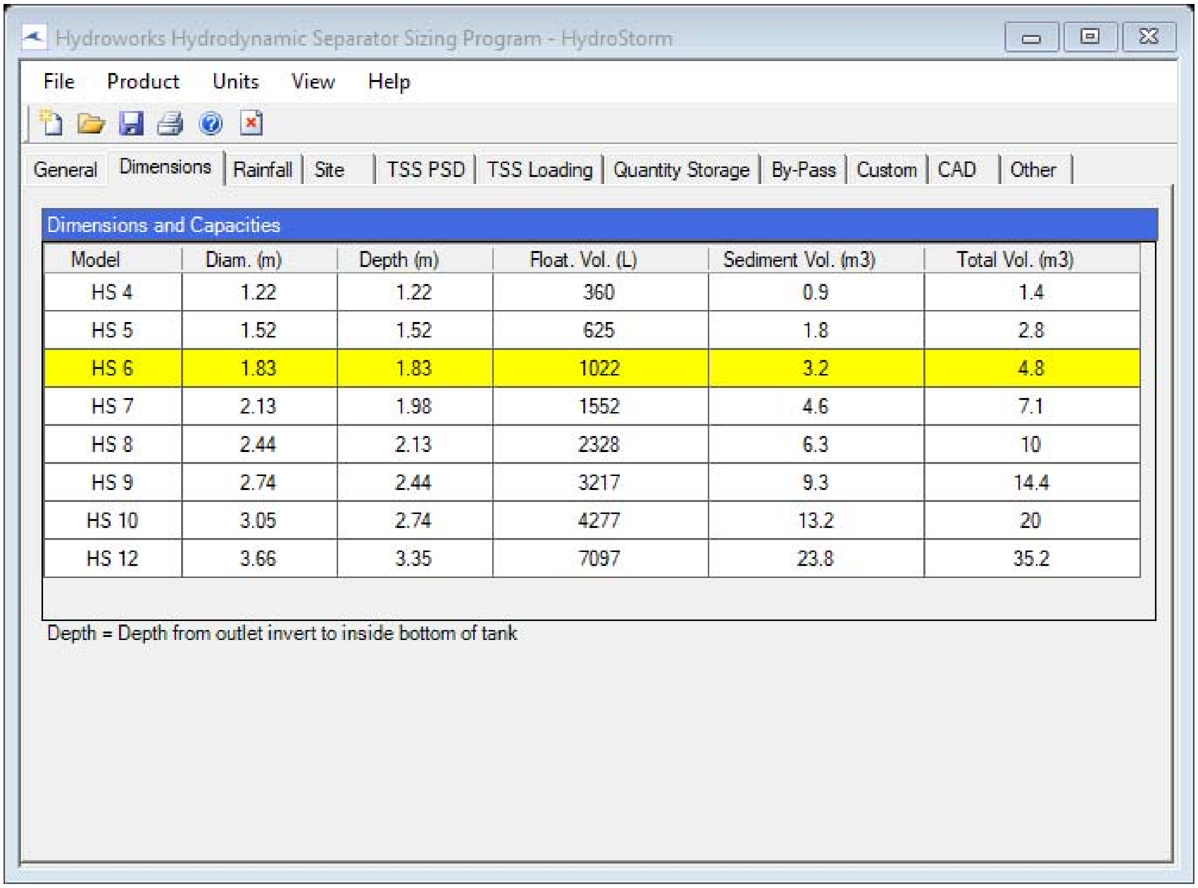
Rainfall Station - Peterborough, Ontario(1971 To 2006)



Site Physical Characteristics



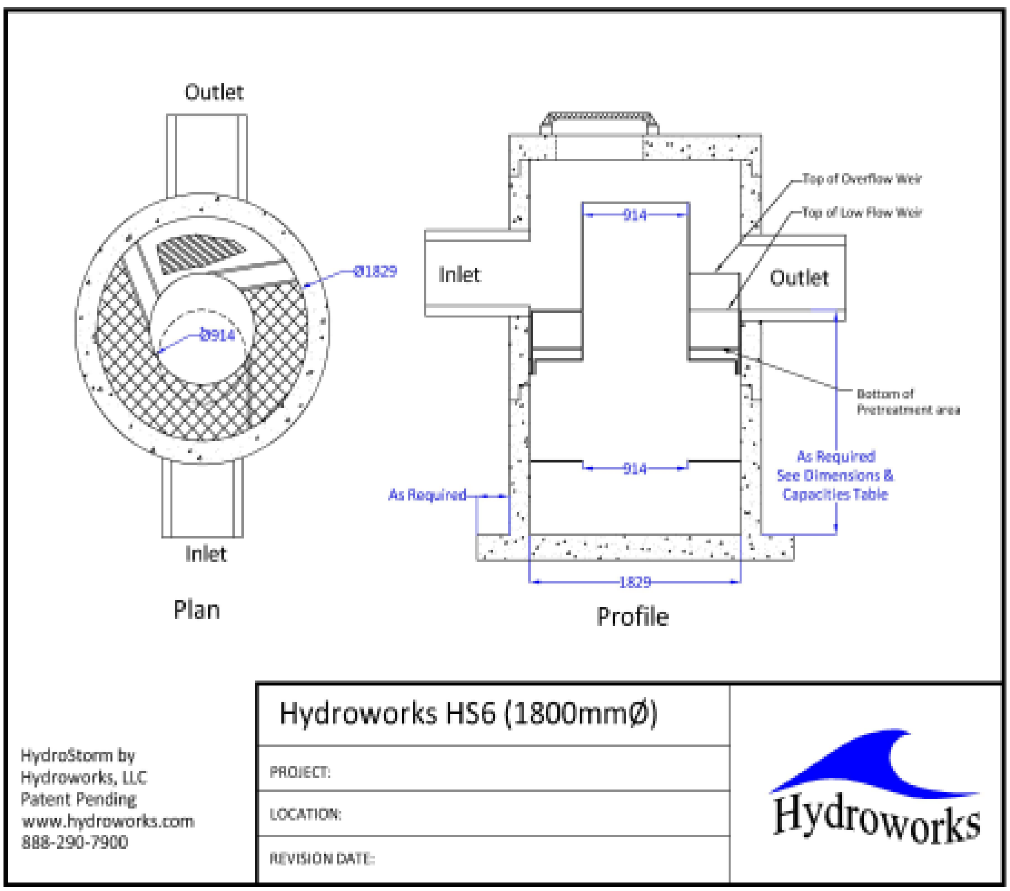
Dimensions And Capacities



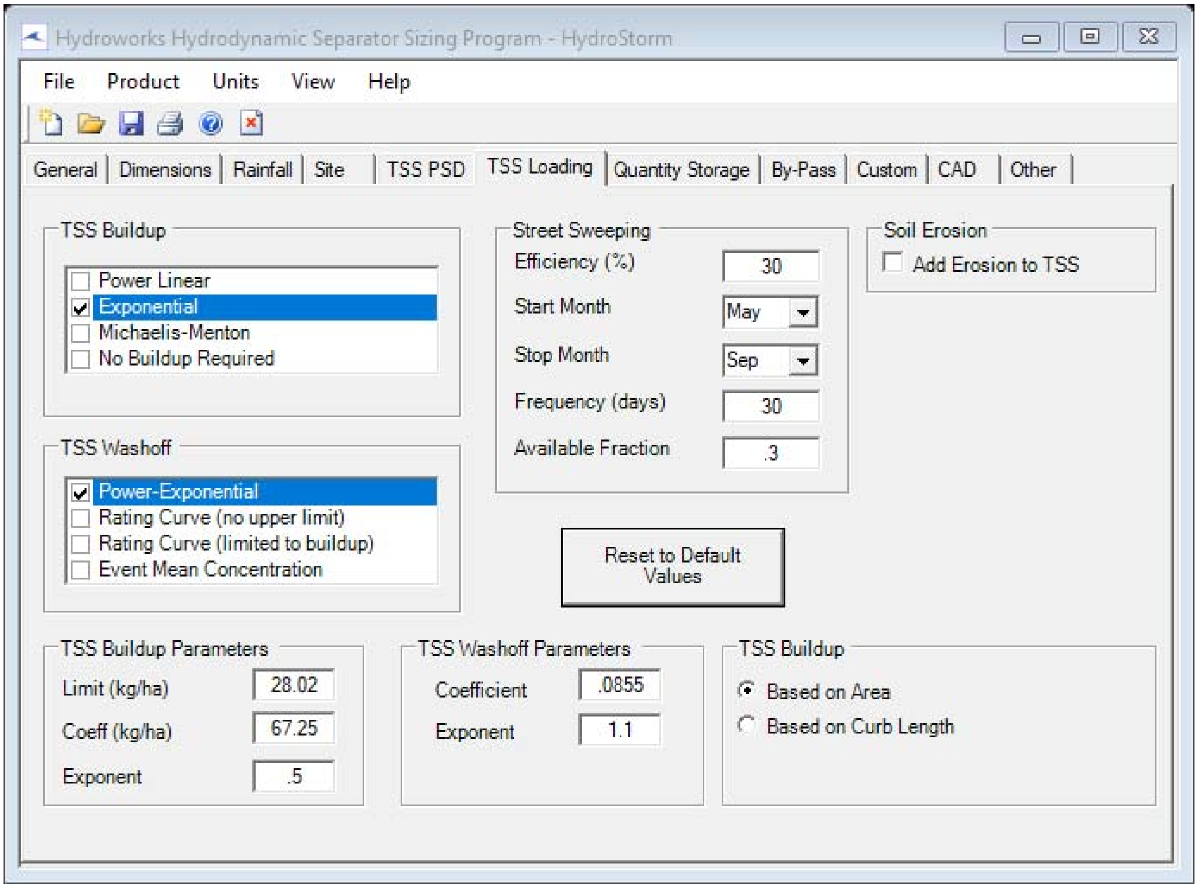
Model	Diam. (m)	Depth (m)	Float. Vol. (L)	Sediment Vol. (m3)	Total Vol. (m3)
HS 4	1.22	1.22	360	0.9	1.4
HS 5	1.52	1.52	625	1.8	2.8
HS 6	1.83	1.83	1022	3.2	4.8
HS 7	2.13	1.98	1552	4.6	7.1
HS 8	2.44	2.13	2328	6.3	10
HS 9	2.74	2.44	3217	9.3	14.4
HS 10	3.05	2.74	4277	13.2	20
HS 12	3.66	3.35	7097	23.8	35.2

Depth = Depth from outlet invert to inside bottom of tank

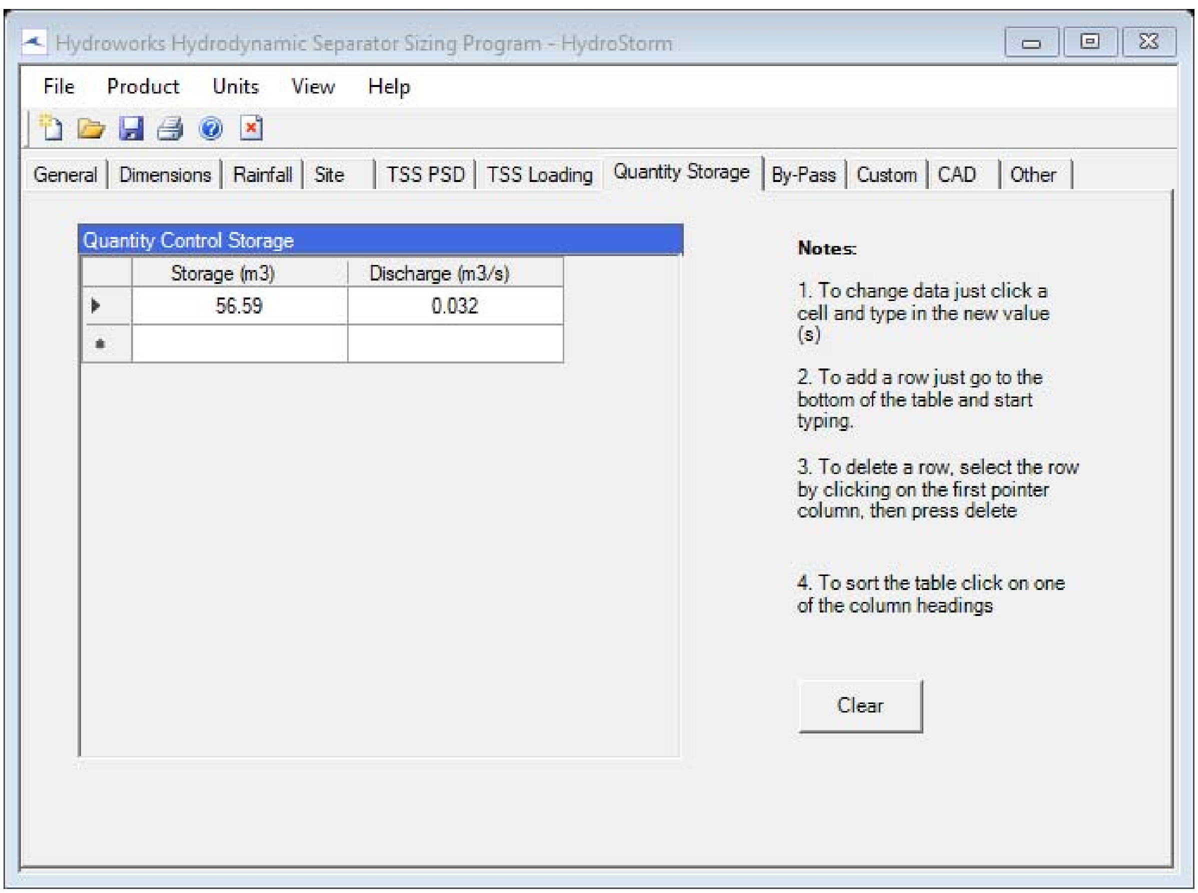
Generic HS 6 CAD Drawing



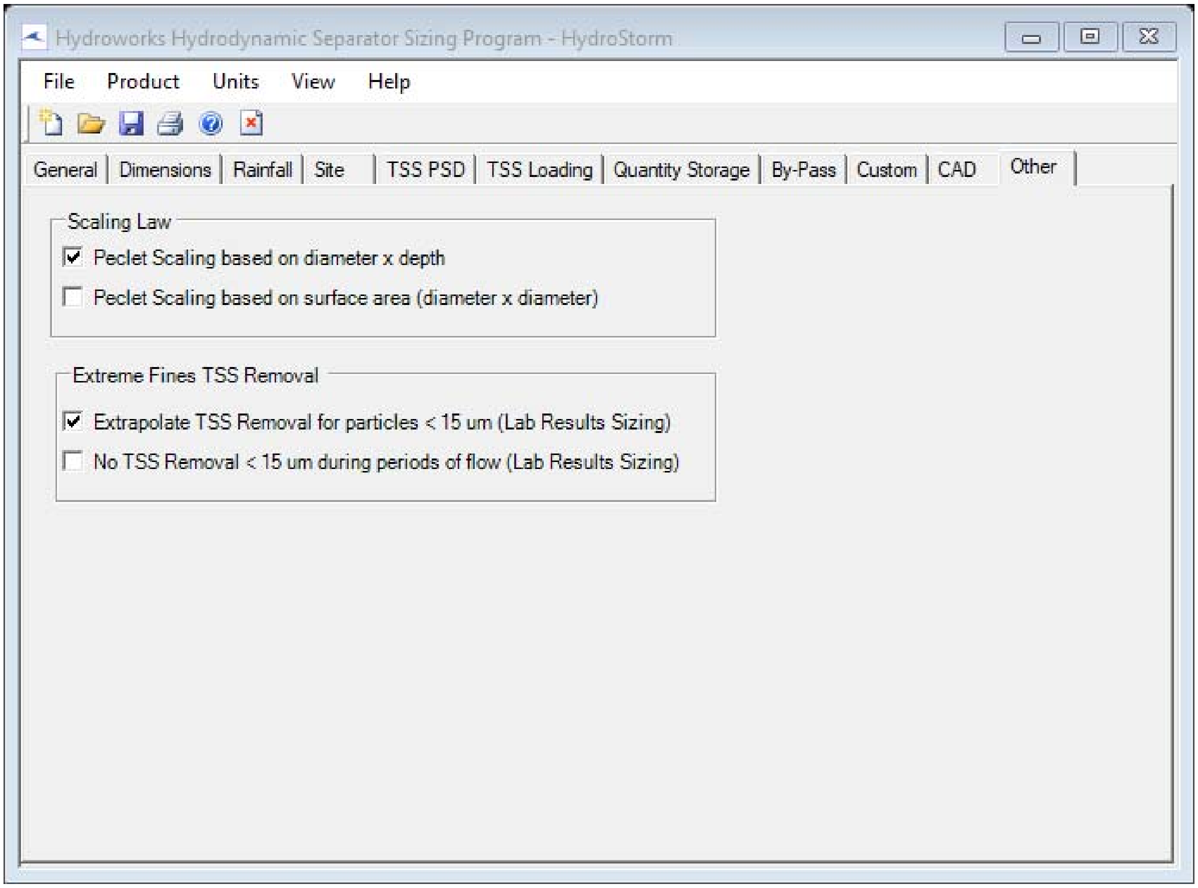
TSS Buildup And Washoff



Upstream Quantity Storage



Other Parameters



Hydroworks Sizing Program - Version 4.9

```
 *************************************************
*      Storm Water Management Sizing Model      *
*               Hydroworks, LLC                 *
*                 Version 4.4                   *
*                                               *
*         Continuous Simulation Program         *
*              Based on SWMM 4.4H               *
*              Hydroworks, LLC                  *
*               Graham Bryant                   *
*                2003 - 2013                    *
*************************************************

                Developed by

*************************************************
*               Hydroworks, LLC                 *
*             Metcalf & Eddy, Inc.              *
*            University of Florida              *
*       Water Resources Engineers, Inc.         *
*      (Now Camp Dresser & McKee, Inc.)         *
*              Modified SWMM 4.4                *
*************************************************

        Distributed and Maintained by

*************************************************
*                                               *
*                Hydroworks, LLC                *
*                 888-290-7900                  *
*              www.hydroworks.com               *
*                                               *
*************************************************

*************************************************
*     If any problems occur executing this      *
*     model, contact Mr. Graham Bryant at       *
*     Hydroworks, LLC by phone at 908-272-4411  *
*     or by e-mail: support@hydroworks.com      *
*************************************************

*************************************************
*     This model is based on EPA SWMM 4.4       *
*  "Nature is full of infinite causes which     *
*   have never occurred in experience" da Vinci *
*************************************************


***************************************************
* Entry made to the Rain Block                    *
* Created by the University of Florida - 1988     *
* Updated by Oregon State University, March 2000  *
***************************************************
```

```
     Cobourg Gas
     Parcel A


 ########################################
 #  Precipitation Block Input Commands  #
 ########################################

Station Name.........................  Kingston Pumping Station

Station Location.....................  Ontario

Station, ISTA........................    4175

Beginning date, IYBEG (Yr/Mo/Dy)......  1960/ 1/ 1

Ending date, IYEND (Yr/Mo/Dy).........  2007/12/31

Minimum interevent time, MIT..........     1

Number of ranked storms, NPTS.........    10

NWS format, IFORM (See text)..........     1

Print storm summary, ISUM (O-No 1-Yes)     0

Print all rainfall, IYEAR (O-No 1-Yes)     0

Save storm event data on NSCRAT(1)....     0
(IFILE =0 -Do not save, =1 -Save data)

IDECID 0 - Create interface file
       1 - Create file and analyze
       2 - Synoptic analysis..........     2

Plotting position parameter, A........  0.40

Storm event statistics, NOSTAT........  1100



KODEA (from optional group B0)........     2
 = 0, Do not include NCDC cumulative values.
 = 1, Average NCDC cumulative values.
 = 2, Use NCDC cumulative value as inst. rain.

KODEPR (from optional group B0).......     0
 Print NCDC special codes in event summary:
 = 0, only on days with events.
 = 1, on all days with codes present.
 Codes: A = accumulated value, I = incomplete value,
        M = missing value,     O = other code present
```

```
********************************************************
*  Precipitation output created using the Rain block   *
*  Number of precipitation stations...       1        *
********************************************************

Location Station Number
-------- -------------
       1.     4175


STATION ID ON PRECIP. DATA INPUT FILE = 4175
REQUESTED STATION ID =     4175  CHECK TO BE SURE THEY MATCH.



$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
Note, 15-min. data are being processed, but hourly
print-out, summaries, and statistics are based on
hourly totals only.  Data placed on interface file
are at correct 15-min. intervals.
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

###################################################
# Entry made to the Runoff Block, last updated by #
# Oregon State University, and Camp, Dresser and  #
# McKee, Inc., March 2002.                        #
###################################################
# "And wherever water goes, amoebae go along for  #
#  the ride"                      Tom Robbins     #
###################################################



                   Cobourg Gas

                   Parcel A



Snowmelt parameter - ISNOW.......................          0

Number of rain gages - NRGAG.....................          1

Horton infiltration equation used - INFILM.......          2
Maximum infiltration volume is limited to RMAXINF input on  subcatchment lines.
Infiltration volume regenerates during  non rainfall periods.

Quality is simulated - KWALTY....................          1

IVAP is negative.  Evaporation will be set to zero
    during time steps with rainfall.

Read evaporation data on line(s) F1 (F2) - IVAP..          1
```

```
Hour of day at start of storm - NHR.............          1

Minute of hour at start of storm - NMN..........          1

Time TZERO at start of storm (hours)............      1.017

Use Metric units for I/O - METRIC...............          1
 ===> Ft-sec units used in all internal computations

Runoff input print control...                             0

Runoff graph plot control....                             1

Runoff output print control..                             0

Print headers every 50 lines - NOHEAD (0=yes, 1=no)       0

Print land use load percentages -LANDUPR (0=no, 1=yes)     0

Limit number of groundwater convergence messages to 10000 (if simulated)

Month, day, year of start of storm is:            1/ 1/1960

Wet time step length (seconds).......                  300.

Dry time step length (seconds).......                  900.

Wet/Dry time step length (seconds)...                  450.

Simulation length is......                        20071231.0 Yr/Mo/Dy

Percent of impervious area with zero detention depth    25.0

Horton infiltration model being used
Rate for regeneration of infiltration = REGEN * DECAY
DECAY is read in for each subcatchment
REGEN = .........................................   0.25400


********************************************************
*   Processed Precipitation will be read from file     *
********************************************************

  #############################
  #        Data Group F1      #
  # Evaporation Rate (mm/day) #
  #############################

 JAN.  FEB.  MAR.  APR.  MAY   JUN.  JUL.  AUG.  SEP.  OCT.  NOV.  DEC.
 ----  ----  ----  ----  ----  ----  ----  ----  ----  ----  ----  ----
 0.00  0.00  0.00  2.54  2.54  3.81  3.81  3.81  2.54  2.54  0.00  0.00
```

```
*********************************************************
*        C H A N N E L   A N D   P I P E   D A T A      *
*********************************************************

Input   NAMEG:     Drains                              Invert  L Side   R Side  Intial     Max  Mann-    Full
equen  Channel       to     Channel  Width  Length      Slope   Slope    Slope   Depth   Depth   ings    Flow
umber    ID #      NGTO:     Type     (m)     (m)      (m/m)   (m/m)    (m/m)     (m)     (m)    "N"   (cms)
-----  ------------------  -------- ------ -------    ------- -------- ------- ------- ------- -----  -----
  1        201        200   Dummy     0.0     0.0     0.0000   0.0000  0.0000     0.0     0.0  0.0000 0.00E+00

 ****************************************************
 *         S U B C A T C H M E N T   D A T A      *
 ****************************************************

*NOTE. SEE LATER TABLE FOR OPTIONAL SUBCATCHMENT PARAMETERS*
      SUBCATCH-  CHANNEL      WIDTH    AREA  PERCENT    SLOPE    RESISTANCE  FACTOR    DEPRES. STORAGE(MM) INFILTRATION   DECAY RATE GAGE  MAXIMUM
       MENT NO.  OR INLET       (M)    (HA)  IMPERV.    (M/M)     IMPERV.     PERV.    IMPERV.    PERV.      RATE(MM/HR)    (1/SEC)    NO.  VOLUME
                                                                                                          MAXIMUM MINIMUM                       (MM)
 ---  --------   -------- --------- -------- -----   -------    -------  --------    ------    ------     ----   -------  -------  ------ -------
  1        300        200     52.46     0.28  84.00    0.0200      0.015     0.250      0.510     5.080    63.50   10.16    0.00055     1  101.60000

TOTAL NUMBER OF SUBCATCHMENTS...              1
TOTAL TRIBUTARY AREA (HECTARES).           0.28
IMPERVIOUS AREA (HECTARES)......           0.23
PERVIOUS AREA (HECTARES)........           0.04
TOTAL WIDTH (METERS)............          52.46
PERCENT IMPERVIOUSNESS..........          84.00

********************************************************
*      G R O U N D W A T E R   I N P U T   D A T A    *
********************************************************


    SUB-     CHANNEL     ========== E L E V A T I O N S ========  =========== F L O W   C O N S T A N T S ===========
    CATCH         OR      GROUND  BOTTOM   STAGE     BC      TW        A1          B1        A2          B2        A3
    NUMBER     INLET        (M)     (M)      (M)     (M)     (M) (MM/HR-M^B1)          (MM/HR-M^B2)          (MM/HR-M^2)
    ------     -----     -------  ------  ------  ------  ------ -----------  -------  -----------  -------  -----------
         0       602        3.05    0.00    0.00    0.61    0.61   3.484E-04    2.600   0.000E+00    1.000    0.00E+00


***********************************************************
* G R O U N D W A T E R   I N P U T   D A T A (CONTINUED) *
***********************************************************

               S O I L   P R O P E R T I E S
                       SATURATED                                       PERCOLATION     E T  P A R A M E T E R S
      SUBCAT.            HYDRAULIC  WILTING  FIELD   INITIAL     MAX. DEEP   PARAMETERS         DEPTH  FRACTION OF ET
      NO.    POROSITY CONDUCTIVITY  POINT  CAPACITY MOISTURE  PERCOLATION   HCO     PCO        OF ET  TO UPPER ZONE
                        (mm/hr)                                (mm/hr)                         (m)
     ----    ------     -------     ------  ------    ------    ----------  ------  ------     ------      ------
         0    .4000     127.000      .1500   .3000     .3000     5.080E-02   10.00    4.57       4.27       0.350
```

```
*******************************************************
*    Arrangement of Subcatchments and Channel/Pipes     *
*******************************************************
* See second subcatchment output table for connectivity *
* of subcatchment to subcatchment flows.                *
*******************************************************

   Channel
   or Pipe
       201     No Tributary Channel/Pipes
               No Tributary Subareas.....


    INLET
       200     Tributary Channel/Pipes...        201
               Tributary Subareas........        300


*********************************************************
* Hydrographs will be stored for the following   1 INLETS *
*********************************************************
           200

###################################################
#              Quality Simulation                 #
###################################################
#      General Quality Control Data Groups        #
###################################################

 Description                           Variable       Value
 -----------                           --------       -----

 Number of quality constituents.....    NQS.......         1

 Number of land uses................  JLAND.......         1

 Standard catchbasin volume.........  CBVOL.......      1.22 cubic meters

 Erosion is not simulated.........    IROS........         0

 DRY DAYS PRIOR TO START OF STORM... DRYDAY.......      3.00 DAYS

 DRY DAYS REQUIRED TO RECHARGE
 CATCHBASIN CONCENTRATION TO
 INITIAL VALUES.................... DRYBSN.......      5.00 DAYS

 DUST AND DIRT
 STREET SWEEPING EFFICIENCY......... REFFDD.......     0.300

 DAY OF YEAR ON WHICH STREET
 SWEEPING BEGINS................... KLNBGN.......       120

 DAY OF YEAR ON WHICH STREET
```

```
 SWEEPING ENDS..................... KLNEND.......       270


###########################################
#     Land use data on data group J2      #
###########################################

                                                             LIMITING                                  CLEANING  AVAIL.     DAYS SINCE
                                                             BUILDUP    BUILDUP  BUILDUP   INTERVAL  FACTOR       LAST
AND USE    BUILDUP EQUATION TYPE    FUNCTIONAL DEPENDENCE OF   QUANTITY   POWER    COEFF.    IN DAYS   FRACTION   SWEEPING
LNAME)             (METHOD)          BUILDUP PARAMETER(JACGUT)  (DDLIM)    (DDPOW)  (DDFACT)  (CLFREQ)  (AVSWP)     (DSLCL)
-------    --------------------     -------------------------  --------   -------  --------  --------  -------    ---------
Urban De   EXPONENTIAL(1)                   AREA(1)            2.802E+01     0.500    67.250    30.000     0.300    30.000


##############################################
#     Constituent data on data group J3      #
##############################################


                               Total Su
                               --------
Constituent units........      mg/l
Type of units............           0
KALC.....................           2
Type of buildup calc.....    EXPONENTIAL(2)
KWASH....................           0
Type of washoff calc.....  POWER EXPONEN.(0)
KACGUT...................           1
Dependence of buildup....         AREA(1)
LINKUP...................           0
Linkage to snowmelt......   NO SNOW LINKAGE
Buildup param 1 (QFACT1).          28.020
Buildup param 2 (QFACT2).           0.500
Buildup param 3 (QFACT3).          67.250
Buildup param 4 (QFACT4).           0.000
Buildup param 5 (QFACT5).           0.000
Washoff power (WASHPO)...           1.100
Washoff coef. (RCOEF)....           0.086
Init catchb conc (CBFACT)         100.000
Precip. conc. (CONCRN)...           0.000
Street sweep effic (REFF)           0.300
Remove fraction (REMOVE).           0.000
1st order QDECAY, 1/day..           0.000
Land use number..........               1

*************************************************
* Constant Groundwater Quality Concentration(s) *
*************************************************

 Total Susp has a concentration of..    0.0000   mg/l
```

```
************************************************
* REMOVAL FRACTIONS FOR SELECTED CHANNEL/PIPES *
* FROM J7 LINES                                *
************************************************

  CHANNEL/   CONSTITUENT
     PIPE Total Susp
----------  --------
       201     0.000


*****************************************************
*     Subcatchment surface quality on data group L1 *
*****************************************************


                                  Total   Number   Input
                           Land    Gutter     of    Loading
                   Land     Use    Length   Catch-  load/ha
            No.  Usage    No.      Km     Basins   Total Su
        ------ --------  ----   -------- --------  -------
   1        300 Urban De  1         0.10     2.00  0.0E+00
   Totals (Loads in kg or other)    0.10     2.00  0.0E+00

    ***********************
    *    DATA GROUP M1    *
    ***********************


TOTAL NUMBER OF PRINTED GUTTERS/INLETS...NPRNT..        1
NUMBER OF TIME STEPS BETWEEN PRINTINGS..INTERV..        0
STARTING AND STOPPING PRINTOUT DATES............        0        0


    ***********************
    *    DATA GROUP M3    *
    ***********************

CHANNEL/INLET PRINT DATA GROUPS......       -200



          ******************************************
          * Rainfall from Nat. Weather Serv. file  *
          * in units of hundredths of an inch      *
          ******************************************

         Cobourg Gas
         Parcel A
```

Rainfall Station Kingston Pumping Station
State/Province Ontario

Rainfall Depth Summary (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1960.	10.	0.	0.	0.	0.	0.	0.	0.	7.	78.	53.	18.	166.
1961.	0.	68.	65.	99.	122.	75.	48.	34.	39.	54.	99.	32.	736.
1962.	3.	8.	52.	68.	58.	61.	123.	59.	113.	95.	52.	20.	712.
1963.	0.	0.	12.	82.	84.	57.	23.	110.	59.	17.	146.	37.	627.
1964.	32.	3.	71.	80.	75.	29.	38.	54.	17.	41.	82.	76.	598.
1965.	17.	36.	2.	79.	36.	56.	60.	73.	101.	103.	133.	55.	750.
1966.	8.	32.	73.	29.	36.	71.	30.	74.	117.	36.	168.	72.	745.
1967.	35.	0.	35.	74.	64.	62.	68.	45.	125.	156.	102.	50.	818.
1968.	35.	22.	67.	37.	130.	118.	34.	89.	99.	85.	134.	37.	887.
1969.	50.	5.	65.	103.	0.	114.	52.	42.	27.	70.	0.	5.	532.
1970.	23.	18.	26.	42.	56.	53.	124.	11.	94.	72.	126.	20.	665.
1971.	17.	33.	2.	35.	52.	56.	92.	100.	66.	53.	0.	5.	511.
1972.	0.	0.	0.	30.	104.	125.	74.	104.	100.	170.	0.	0.	708.
1973.	0.	0.	0.	106.	79.	72.	32.	88.	101.	122.	0.	0.	599.
1974.	0.	0.	0.	53.	94.	67.	69.	27.	73.	59.	10.	0.	451.
1975.	0.	0.	0.	0.	59.	115.	37.	42.	166.	44.	0.	0.	463.
1976.	0.	0.	0.	72.	104.	148.	73.	70.	69.	93.	14.	0.	642.
1977.	0.	0.	0.	72.	34.	53.	47.	162.	109.	91.	6.	0.	574.
1978.	0.	0.	0.	63.	61.	48.	26.	87.	92.	79.	9.	0.	466.
1979.	0.	0.	0.	68.	31.	31.	20.	91.	157.	127.	0.	0.	525.
1980.	0.	0.	0.	153.	24.	63.	125.	60.	115.	114.	0.	0.	654.
1981.	0.	0.	0.	99.	125.	73.	66.	87.	167.	109.	0.	0.	726.
1982.	0.	0.	0.	41.	115.	118.	73.	81.	54.	81.	0.	0.	563.
1983.	0.	0.	0.	0.	68.	38.	62.	96.	56.	138.	8.	0.	466.
1984.	0.	0.	0.	137.	109.	29.	42.	162.	51.	25.	0.	0.	557.
1985.	0.	0.	0.	41.	76.	61.	70.	101.	81.	90.	0.	0.	520.
1986.	0.	0.	0.	72.	101.	123.	63.	135.	175.	2.	0.	0.	670.
1987.	0.	0.	0.	44.	63.	80.	53.	68.	133.	98.	0.	0.	538.
1988.	0.	0.	0.	68.	45.	38.	71.	73.	61.	162.	0.	0.	517.
1989.	0.	0.	0.	39.	101.	103.	14.	69.	98.	118.	0.	0.	541.
1990.	0.	0.	0.	88.	71.	104.	47.	52.	64.	165.	5.	0.	598.
1991.	0.	0.	0.	137.	61.	45.	85.	71.	91.	97.	0.	0.	587.
1992.	0.	0.	0.	46.	82.	55.	111.	136.	73.	110.	0.	0.	613.
1993.	0.	0.	0.	66.	64.	112.	22.	33.	94.	105.	0.	0.	495.
1994.	0.	0.	0.	93.	84.	89.	69.	121.	67.	28.	10.	0.	559.
1995.	0.	0.	0.	56.	61.	14.	54.	44.	2.	178.	6.	0.	414.
1996.	0.	0.	0.	119.	150.	68.	96.	46.	0.	90.	1.	0.	568.
1997.	0.	0.	0.	26.	59.	84.	26.	91.	81.	74.	16.	0.	457.
1998.	0.	0.	0.	41.	50.	110.	71.	89.	73.	62.	17.	0.	513.
1999.	0.	0.	0.	20.	38.	62.	61.	71.	118.	98.	0.	0.	467.
2000.	0.	0.	0.	150.	109.	104.	89.	75.	100.	39.	0.	0.	665.
2001.	0.	0.	0.	26.	58.	43.	41.	78.	110.	119.	0.	0.	476.
2002.	0.	0.	0.	71.	138.	95.	37.	36.	72.	103.	2.	0.	553.
2003.	0.	0.	0.	11.	120.	62.	118.	61.	79.	133.	20.	0.	606.

2005.	0.	0.	0.	36.	15.	31.	85.	100.	101.	56.	0.	0.	424.
2006.	0.	0.	0.	70.	55.	104.	57.	85.	130.	171.	0.	0.	672.
2007.	0.	0.	0.	76.	56.	35.	91.	32.	79.	6.	7.	0.	381.

Total Rainfall Depth for Simulation Period 26976. (mm)

Rainfall Intensity Analysis (mm/hr)

(mm/hr)	(#)	(%)	(mm)	(%)
2.50	29159	73.0	8889.	33.0
5.00	5437	13.6	4665.	17.3
7.50	2903	7.3	4257.	15.8
10.00	800	2.0	1717.	6.4
12.50	555	1.4	1514.	5.6
15.00	262	0.7	888.	3.3
17.50	240	0.6	967.	3.6
20.00	118	0.3	554.	2.1
22.50	120	0.3	633.	2.3
25.00	56	0.1	334.	1.2
27.50	56	0.1	367.	1.4
30.00	35	0.1	254.	0.9
32.50	46	0.1	363.	1.3
35.00	16	0.0	137.	0.5
37.50	17	0.0	153.	0.6
40.00	21	0.1	203.	0.8
42.50	12	0.0	123.	0.5
45.00	14	0.0	152.	0.6
47.50	4	0.0	46.	0.2
50.00	13	0.0	157.	0.6
>50.00	37	0.1	605.	2.2

Total # of Intensities 39921

Daily Rainfall Depth Analysis (mm)

(mm)	(#)	(%)	(mm)	(%)
2.50	1380	36.6	1639.	6.1
5.00	665	17.6	2381.	8.8
7.50	481	12.8	2913.	10.8
10.00	338	9.0	2905.	10.8
12.50	259	6.9	2918.	10.8
15.00	144	3.8	1951.	7.2
17.50	127	3.4	2053.	7.6
20.00	90	2.4	1683.	6.2
22.50	59	1.6	1244.	4.6
25.00	49	1.3	1162.	4.3
27.50	45	1.2	1185.	4.4
30.00	32	0.8	920.	3.4
32.50	21	0.6	653.	2.4
35.00	15	0.4	507.	1.9
37.50	8	0.2	293.	1.1

```
 40.00     18       0.5      693.       2.6
 42.50      7       0.2      288.       1.1
 45.00     12       0.3      525.       1.9
 47.50      6       0.2      275.       1.0
 50.00      3       0.1      145.       0.5
>50.00     10       0.3      642.       2.4

Total # Days with Rain   3769

************************************************
*      End of time step DO-loop in Runoff      *
************************************************

Final Date (Mo/Day/Year)   =                 12/31/2007
Total number of time steps =                    2675447
Final Julian Date  =                            2007365
Final time of day  =                             86397. seconds.
Final time of day  =                              24.00   hours.
Final running time =                        420768.0000   hours.
Final running time =                         17532.0000    days.

**************************************************
*     Extrapolation Summary for Watersheds       *
* # Steps ==> Total Number of Extrapolated Steps *
* # Calls ==> Total Number of OVERLND Calls      *
**************************************************

 Subcatch   # Steps   # Calls  Subcatch   # Steps   # Calls  Subcatch   # Steps   # Calls
 --------   -------   -------  --------   -------   -------  --------   -------   -------
      300   6592667   1570097

**************************************************
*     Extrapolation Summary for Channel/Pipes    *
* # Steps ==> Total Number of Extrapolated Steps *
* # Calls ==> Total Number of GUTNR Calls        *
**************************************************

Chan/Pipe   # Steps   # Calls Chan/Pipe   # Steps   # Calls Chan/Pipe   # Steps   # Calls
 --------   -------   -------  --------   -------   -------  --------   -------   -------
      201         0         0
^
**********************************************
*       Continuity Check for Surface Water   *
**********************************************
                                                                    Millimeters over
                                                      cubic meters  Total Basin
Total Precipitation (Rain plus Snow)                       74027.     26900.
Total Infiltration                                         11824.      4297.
Total Evaporation                                           6334.      2302.
Surface Runoff from Watersheds                             56508.     20534.
Total Water remaining in Surface Storage                       0.         0.
Infiltration over the Pervious Area...                     11824.     26855.
                      --------
Infiltration + Evaporation +
Surface Runoff + Snow removal +
```

```
Water remaining in Surface Storage +
Water remaining in Snow Cover.........                     74666.     27132.
Total Precipitation + Initial Storage.                     74027.     26900.


The error in continuity is calculated as
***************************************
* Precipitation + Initial Snow Cover  *
*       - Infiltration -              *
*Evaporation - Snow removal -         *
*Surface Runoff from Watersheds -     *
*Water in Surface Storage -           *
*Water remaining in Snow Cover        *
*-------------------------------------*
* Precipitation + Initial Snow Cover  *
***************************************
Error.................................       -0.864 Percent


**********************************************
*       Continuity Check for Channel/Pipes   *
**********************************************
                                                         Millimeters over
                                              cubic meters  Total Basin
Initial Channel/Pipe Storage................          0.          0.
Final Channel/Pipe Storage..................          0.          0.
Surface Runoff from Watersheds..............      56508.      20534.
Baseflow....................................          0.
Groundwater Subsurface Inflow...............          0.          0.
Evaporation Loss from Channels..............          0.          0.
Channel/Pipe/Inlet Outflow..................      56508.      20534.
Initial Storage + Inflow....................      56508.      20534.
Final Storage + Outflow.....................      56508.      20534.
********************************************
* Final Storage + Outflow + Evaporation  - *
* Watershed Runoff - Groundwater Inflow  - *
*     Initial Channel/Pipe Storage         *
*     ------------------------------       *
*  Final Storage + Outflow  + Evaporation  *
********************************************
Error.......................................      0.000 Percent

↑
***************************************************
*     Continuity Check for Subsurface Water       *
***************************************************

                                                          Millimeters over
                                          cubic meters      Subsurface Basin

Total Infiltration                                    0.          0.
Total Upper Zone ET                                   0.          0.
Total Lower Zone ET                                   0.          0.
Total Groundwater flow                                0.          0.
Total Deep percolation                                0.          0.
```

```
Initial Subsurface Storage                                      2516.       914.
Final Subsurface Storage                                        2516.       914.
Upper Zone ET over Pervious Area                                   0.         0.
Lower Zone ET over Pervious Area                                   0.         0.


******************************************
* Infiltration + Initial Storage - Final *
* Storage - Upper and Lower Zone ET -    *
* Groundwater Flow - Deep Percolation    *
* ------------------------------------ *
*     Infiltration + Initial Storage     *
******************************************
Error ....................................     0.000 Percent


                                  SUMMARY STATISTICS FOR SUBCATCHMENTS
                                  ====================================

                                                   PERVIOUS AREA     IMPERVIOUS AREA     TOTAL SUBCATCHMENT AREA
                                                ------------------- ----------------  -------------------------
                                          TOTAL    TOTAL        PEAK               PEAK                PEAK     PEAK
                GUTTER                  SIMULATED  RUNOFF TOTAL RUNOFF   RUNOFF   RUNOFF      RUNOFF  RUNOFF   UNIT
  SUBCATCH-  OR INLET   AREA  PERCENT  RAINFALL   DEPTH LOSSES  RATE     DEPTH     RATE        DEPTH   RATE    RUNOFF
  MENT NO.     NO.      (HA)  IMPER.   (MM)       (MM)   (MM)  (CMS)     (MM)   (CMS)        (MM)   (CMS)   (MM/HR)
--------------------------------------------------------------------------------------------------------------------
     300        200    0.28    84.026891.65    50.582********   0.00524433.273    0.065 20532.041    0.069   91.131

         *** NOTE *** IMPERVIOUS AREA STATISTICS AGGREGATE IMPERVIOUS AREAS WITH AND WITHOUT DEPRESSION STORAGE


                                       SUMMARY STATISTICS FOR CHANNEL/PIPES
                                     ================================================

                                          MAXIMUM   MAXIMUM   MAXIMUM  MAXIMUM    TIME        LENGTH     MAXIMUM    RATIO OF  RATIO OF
              FULL     FULL       FULL   COMPUTED  COMPUTED  COMPUTED COMPUTED     OF           OF      SURCHARGE   MAX. TO  MAX. DEPTH
  CHANNEL  FLOW   VELOCITY     DEPTH    INFLOW   OUTFLOW     DEPTH   VELOCITY OCCURRENCE    SURCHARGE   VOLUME     FULL      TO FULL
   NUMBER  (CMS)    (M/S)       (M)      (CMS)    (CMS)       (M)     (M/S)     DAY   HR.     (HOUR)    (CU-M)     FLOW       DEPTH
 -------- -------------------------   ------------------------------------------------   --------------------- -------------------
     201                                  0.00                             1/ 0/1900  0.00
     200                                  0.07                             8/14/1994  2.25

                                                TOTAL NUMBER OF CHANNELS/PIPES =    2

 *** NOTE ***  THE MAXIMUM FLOWS AND DEPTHS ARE CALCULATED AT THE END OF THE TIME INTERVAL

               #####################################################
               #             Runoff Quality Summary Page           #
               # If NDIM = 0 Units for:   loads    mass rates      #
               #             METRIC = 1    lb        lb/sec        #
               #             METRIC = 2    kg        kg/sec        #
```

```
               # If NDIM = 1 Loads are in units of quantity        #
               #             and mass rates are quantity/sec       #
               # If NDIM = 2 loads are in units of concentration   #
               #             times volume and mass rates have units#
               #             of concentration times volume/second  #
               #####################################################

              Total Su NDIM =  0
              METRIC =  2

                                  Total Su
                                  --------
Inputs
------
 1. INITIAL SURFACE LOAD........        6.
 2. TOTAL SURFACE BUILDUP.......     7387.
 3. INITIAL CATCHBASIN LOAD.....        0.
 4. TOTAL CATCHBASIN LOAD.......        0.
 5. TOTAL CATCHBASIN AND
    SURFACE BUILDUP (2+4).......     7387.

Remaining Loads
---------------
 6. LOAD REMAINING ON SURFACE...        5.
 7. REMAINING IN CATCHBASINS....        0.
 8. REMAINING IN CHANNEL/PIPES..        0.

Removals
--------
 9. STREET SWEEPING REMOVAL.....      548.
10. NET SURFACE BUILDUP (2-9)...     6838.
11. SURFACE WASHOFF.............     6832.
12. CATCHBASIN WASHOFF..........        0.
13. TOTAL WASHOFF (11+12).......     6832.
14. LOAD FROM OTHER CONSTITUENTS        0.
15. PRECIPITATION LOAD..........        0.
15a.SUM SURFACE LOAD (13+14+15).     6832.
16. TOTAL GROUNDWATER LOAD......        0.
16a.TOTAL I/I LOAD..............        0.
17. NET SUBCATCHMENT LOAD
    (15a-15b-15c-15d+16+16a)....     6832.
>>Removal in channel/pipes (17a, 17b):
17a.REMOVE BY BMP FRACTION......        0.
17b.REMOVE BY 1st ORDER DECAY...        0.
18. TOTAL LOAD TO INLETS........     6833.
19. FLOW WT'D AVE.CONCENTRATION  mg/l
    (INLET LOAD/TOTAL FLOW).....      121.

Percentages
-----------
20. STREET SWEEPING (9/2).......        7.
21. SURFACE WASHOFF (11/2)......       92.
22. NET SURFACE WASHOFF(11/10)..      100.
```

```
23. WASHOFF/SUBCAT LOAD(11/17)..      100.
24. SURFACE WASHOFF/INLET LOAD
    (11/18).....................      100.
25. CATCHBASIN WASHOFF/
    SUBCATCHMENT LOAD (12/17)...        0.
26. CATCHBASIN WASHOFF/
    INLET LOAD (12/18)..........        0.
27. OTHER CONSTITUENT LOAD/
    SUBCATCHMENT LOAD (14/17)...        0.
28. INSOLUBLE FRACTION/
    INLET LOAD (14/18)..........        0.
29. PRECIPITATION/
    SUBCATCHMENT LOAD (15/17)...        0.
30. PRECIPITATION/
    INLET LOAD (15/18)..........        0.
31. GROUNDWATER LOAD/
    SUBCATCHMENT LOAD (16/17)...        0.
32. GROUNDWATER LOAD/
    INLET LOAD (16/18)..........        0.
32a.INFILTRATION/INFLOW LOAD/
    SUBCATCHMENT LOAD (16a/17)..        0.
32b.INFILTRATION/INFLOW LOAD/
    INLET LOAD (16a/18).........        0.
32c.CH/PIPE BMP FRACTION REMOVAL/
    SUBCATCHMENT LOAD (17a/17)..        0.
32d.CH/PIPE 1st ORDER DECAY REMOVAL/
    SUBCATCHMENT LOAD (17b/17)..        0.
33. INLET LOAD SUMMATION ERROR
    (18+8+6a+17a+17b-17)/17.....        0.

CAUTION. Due to method of quality routing (Users Manual, Appendix IX)
quality routing through channel/pipes is sensitive to the time step.
Large "Inlet Load Summation Errors" may result.
These can be reduced by adjusting the time step(s).
Note: surface accumulation during dry time steps at end of simulation is
not included in totals.  Buildup is only performed at beginning of
wet steps or for street cleaning.


********************************************************
*            TSS Particle Size Distribution            *
********************************************************
   Diameter    %     Specific    Settling Velocity   Critical Peclet
     (um)             Gravity        (m/s)                Number


       2.     5.0      2.65         0.000003           0.141020
       5.     5.0      2.65         0.000017           0.155300
       8.    10.0      2.65         0.000043           0.169220
      20.    15.0      2.65         0.000267           0.221300
      50.    10.0      2.65         0.001629           0.326300
      75.     5.0      2.65         0.003548           0.386300
     100.    10.0      2.65         0.006044           0.421300
     150.    15.0      2.65         0.012234           0.450000
     250.    15.0      2.65         0.026615           0.450000
```

```
     500.     5.0      2.65         0.060604            0.450000
    1000.     5.0      2.65         0.111334            0.450000

*****************************************************
*                                                   *
*              Summary of TSS Removal               *
*                                                   *
*****************************************************

TSS Removal based on Exponential Lab Performance Curve

 Model      Low Q Treated  High Q Treated     Runoff Treated        TSS Removed
   #           (cms)          (cms)                (%)                   (%)

 HS 4         0.032          0.032               99.5                  72.5
 HS 5         0.032          0.032               99.5                  79.1
 HS 6         0.032          0.032               99.5                  84.2
 Unavaila     0.032          0.032               99.5                  87.3
 HS 8         0.032          0.032               99.5                  89.9
 Unavaila     0.032          0.032               99.5                  92.6
 HS 10        0.032          0.032               99.5                  94.4
 HS 12        0.032          0.032               99.5                  96.9

*****************************************************
*  Summary of Quantity and Quality Results at       *
*  Location        200  INFlow in cms.              *
*  Values are instantaneous at indicated time step  *
*****************************************************

  Cobourg Gas
 Parcel A

     Date     Time        Flow   Total Su
 Mo/Da/Year  Hr:Min        cum/s  mg/l
 ----------  -------    -------  --------
Flow wtd means.....        0.000      121.
Flow wtd std devs..        0.001       68.
Maximum value......        0.069      292.
Minimum value......        0.000        0.
Total loads........       56501.     6837.
                        Cub-Met  KILOGRAM

===> Runoff simulation ended normally.

===> SWMM 4.4    simulation ended normally.
     Always check output file for possible warning messages.

*******************************************************
*       SWMM 4.4    Simulation Date and Time Summary  *
*******************************************************
* Starting Date... March      10, 2020                *
*          Time...         10: 1:43.606               *
*   Ending Date... March      10, 2020                *
```

```
*           Time...         10: 1:47.872               *
*  Elapsed Time...               0.071 minutes.        *
*  Elapsed Time...               4.266 seconds.        *
*******************************************************
```

Hydroworks Sizing Summary

Cobourg Gas

Parcel B -Phase 1

03-10-2020

Recommended Size: HS 6

A HydroStorm HS 6 is recommended to provide 80 % annual TSS removal based on a drainage area of 0.2752 (ha) with an imperviousness of 84 % and Kingston Pumping Station, Ontario rainfall for the ETV Canada particle size distribution.

The recommended HydroStorm HS 6 treats 99 % of the annual runoff and provides 84 % annual TSS removal for the Kingston Pumping Station rainfall records and ETV Canada particle size distribution.

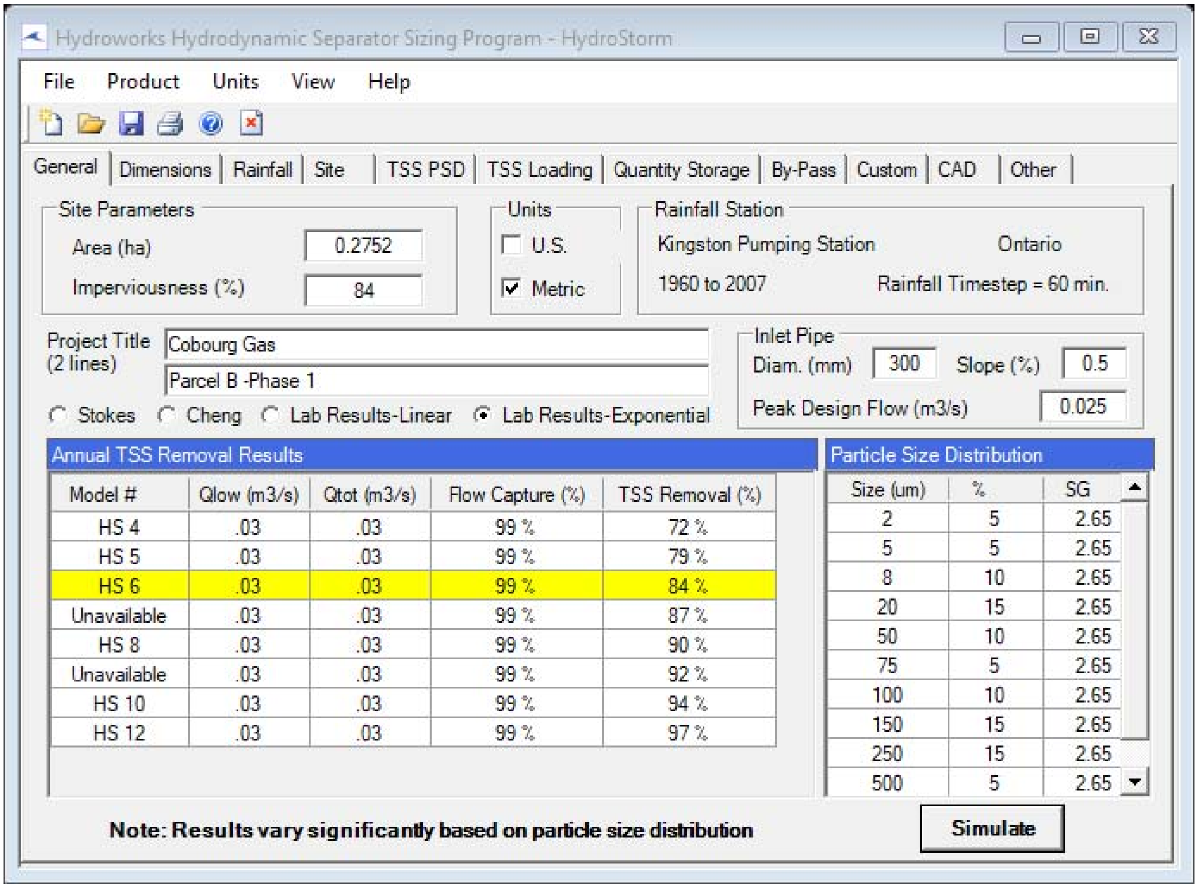
The HydroStorm has a headloss coefficient (K) of 1.04. The given peak flow Of .025 (m3/s) Is less than the full pipe flow Of .07 (m3/s) indicating free flow In the pipe during the peak flow assuming no tailwater condition. Partial pipe flow was assumed For the headloss calculations. The normal depth Is greater than the critical dpeth For the peak flow And 300 (mm) pipe diameter And .5 % slope given. Normal depth was assumed For the headloss calculations. The headloss was calculated To be 42 (mm) based On a flow depth Of 126 (mm) .

This summary report provides the main parameters that were used for sizing. These parameters are shown on the summary tables and graphs provided in this report.

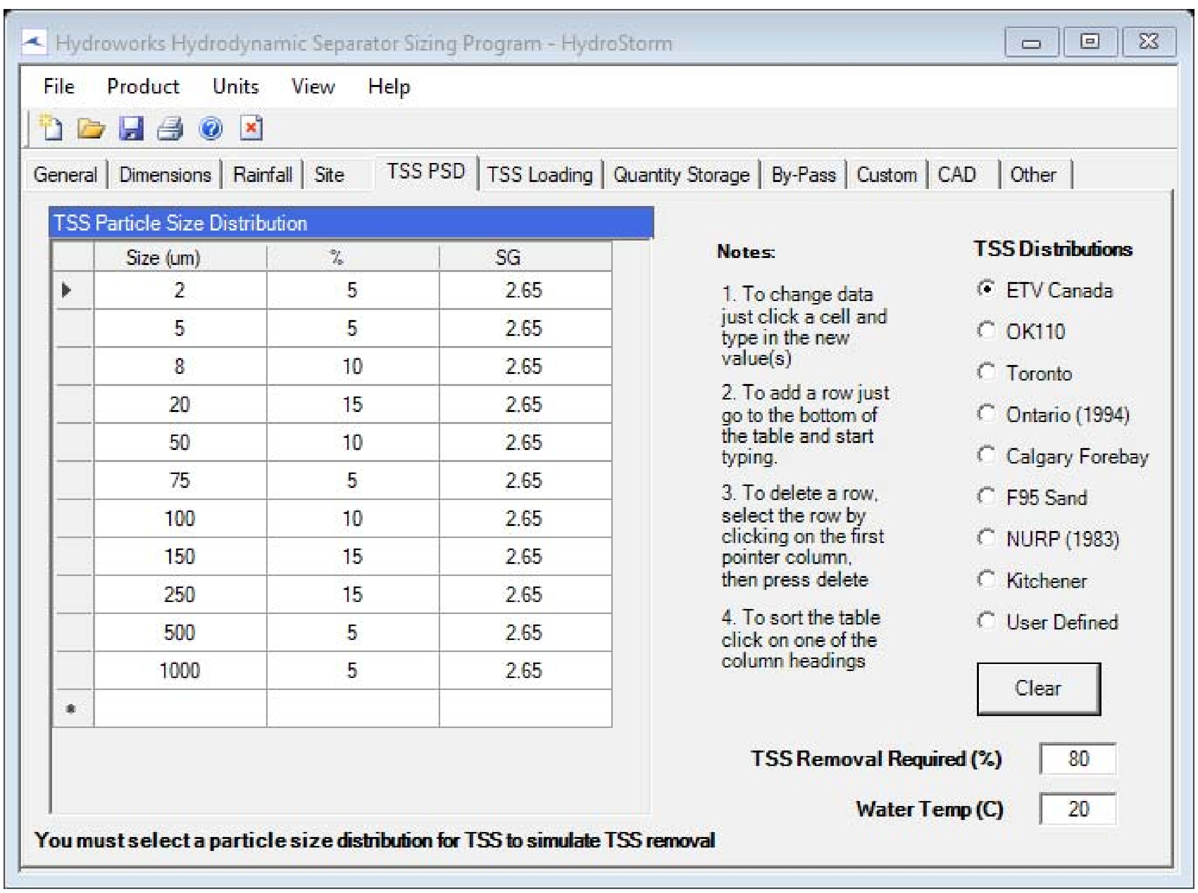
If you have any questions regarding this sizing summary please do not hesitate to contact Hydroworks at 888-290-7900 or email us at support@hydroworks.com.

The sizing program is for sizing purposes only and does not address any site specific parameters such as hydraulic gradeline, tailwater submergence, groundwater, soils bearing capacity, etc. Headloss calculations are not a hydraulic gradeline calculation since this requires a starting water level and an analysis of the entire system downstream of the HydroStorm . Design liability is only valid for lawsuits brought within the United States where Hydroworks has its corporate headquarters.

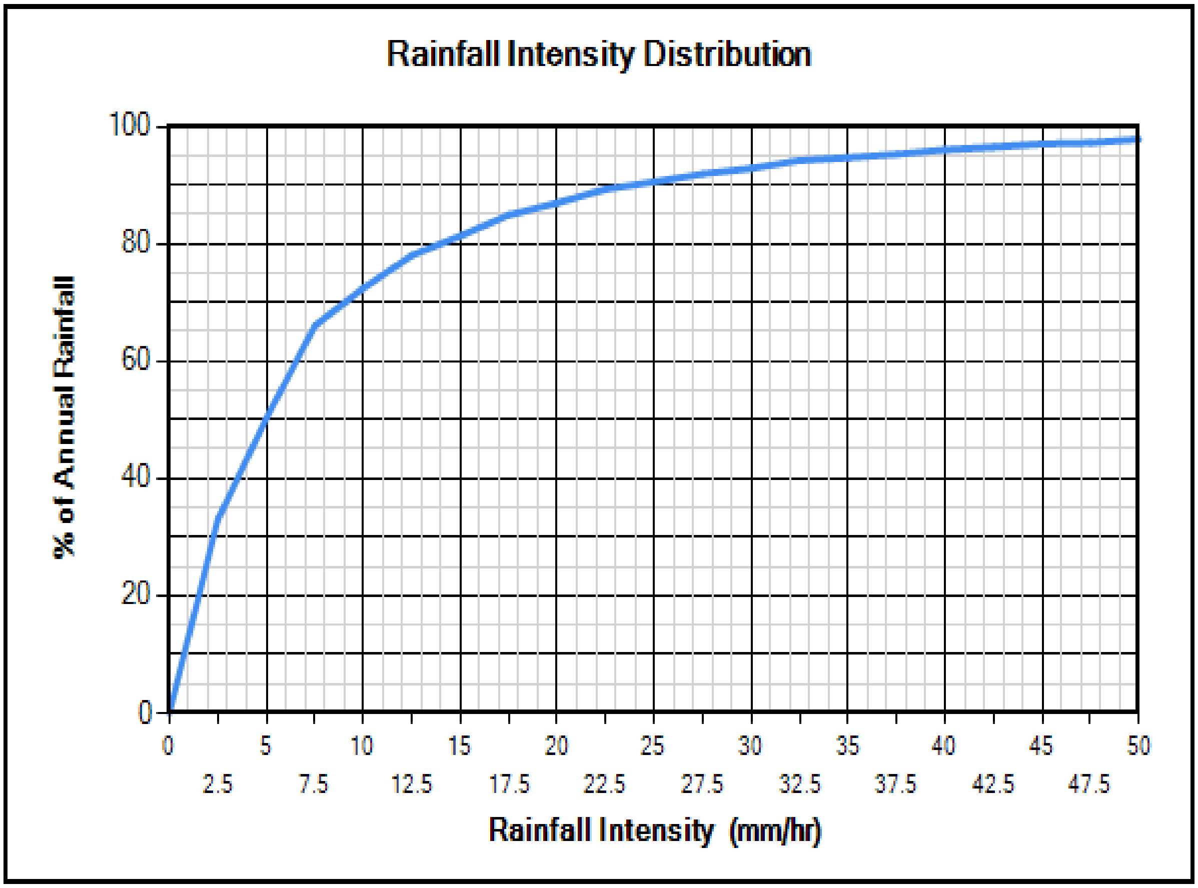
TSS Removal Sizing Summary



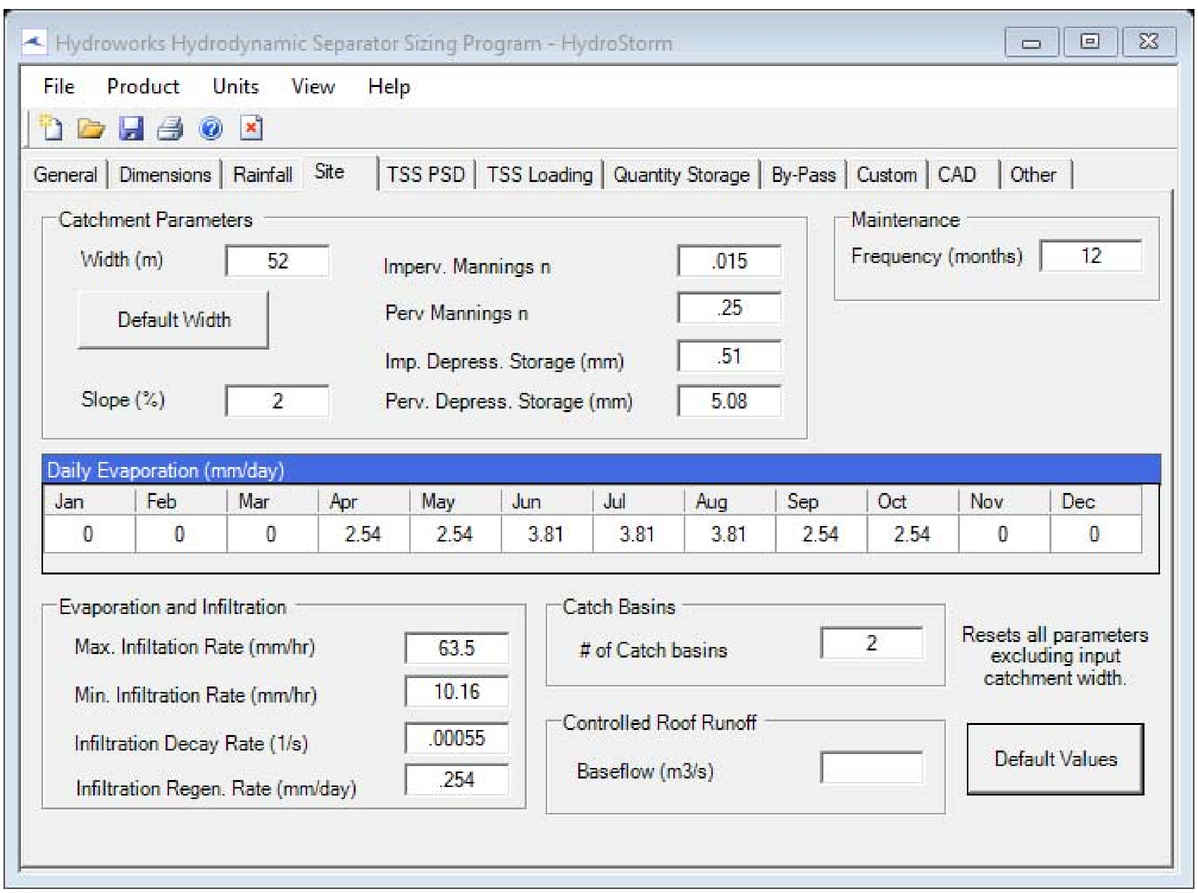
TSS Particle Size Distribution



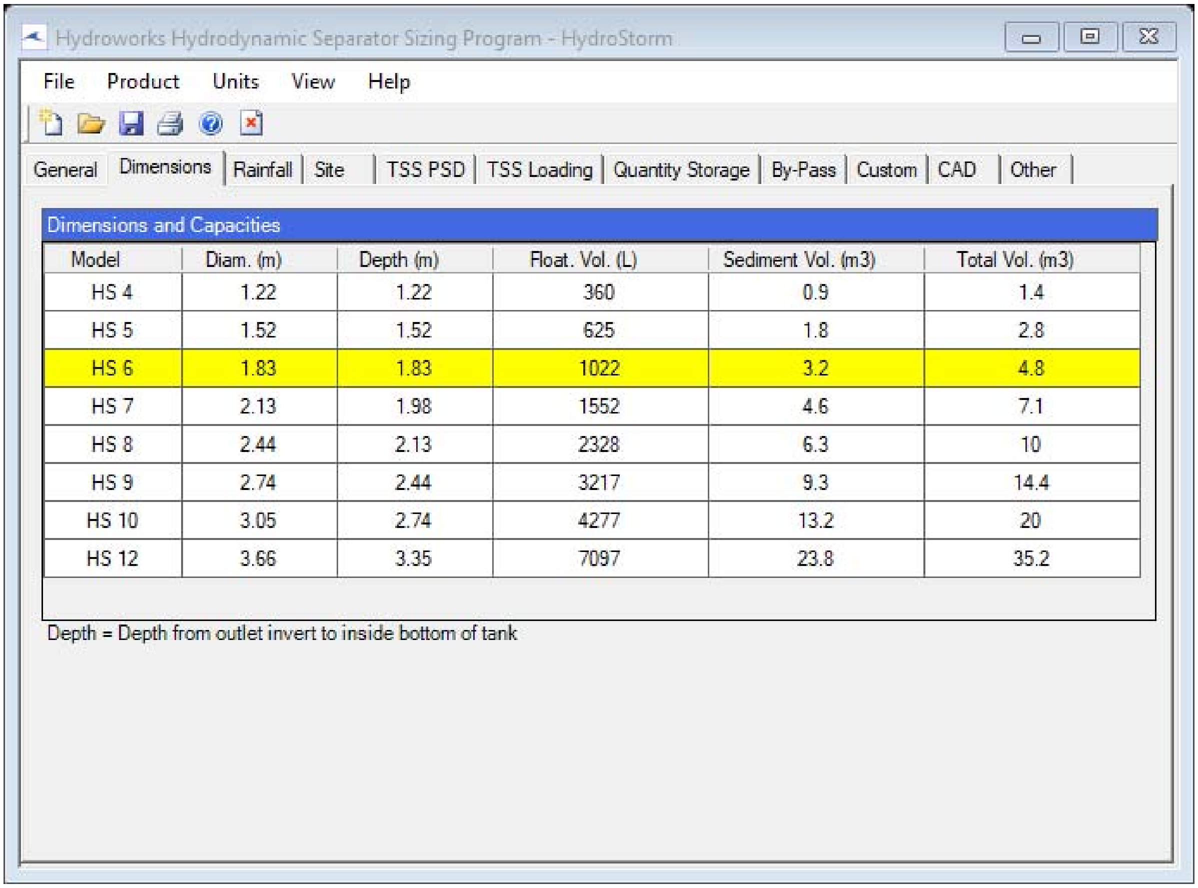
Rainfall Station - Kingston Pumping Station, Ontario(1960 to 2007)



Site Physical Characteristics



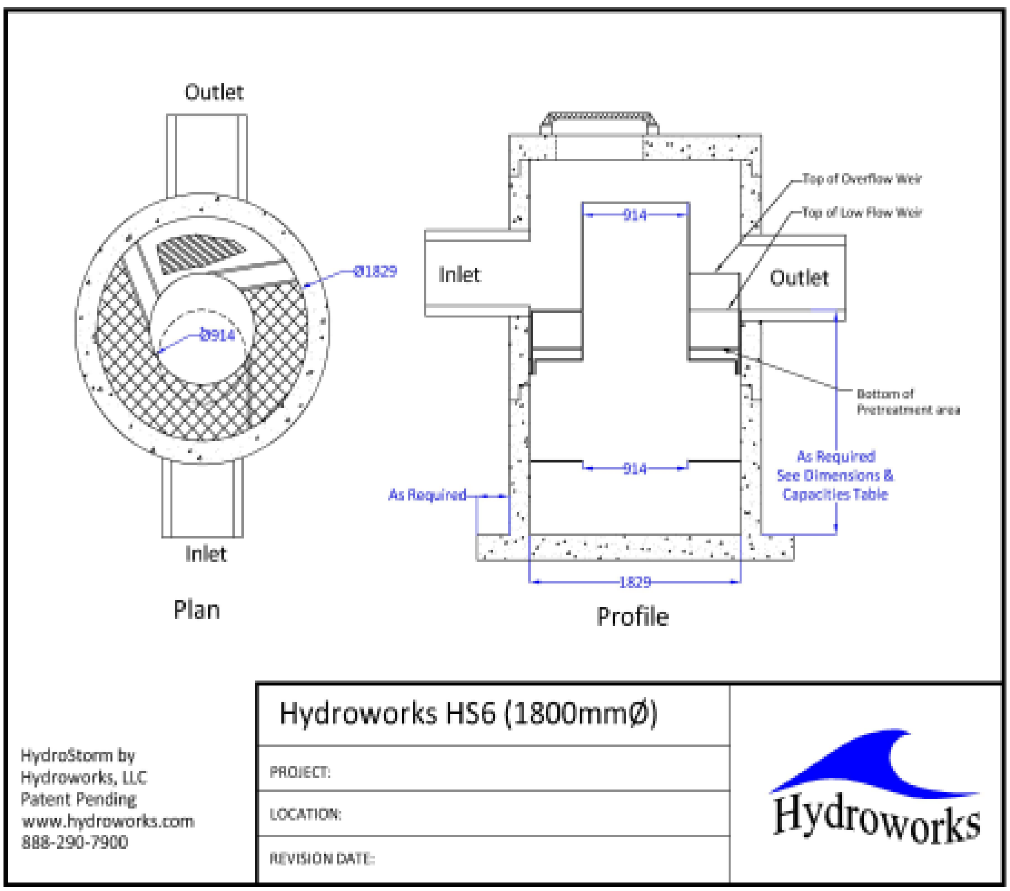
Dimensions And Capacities



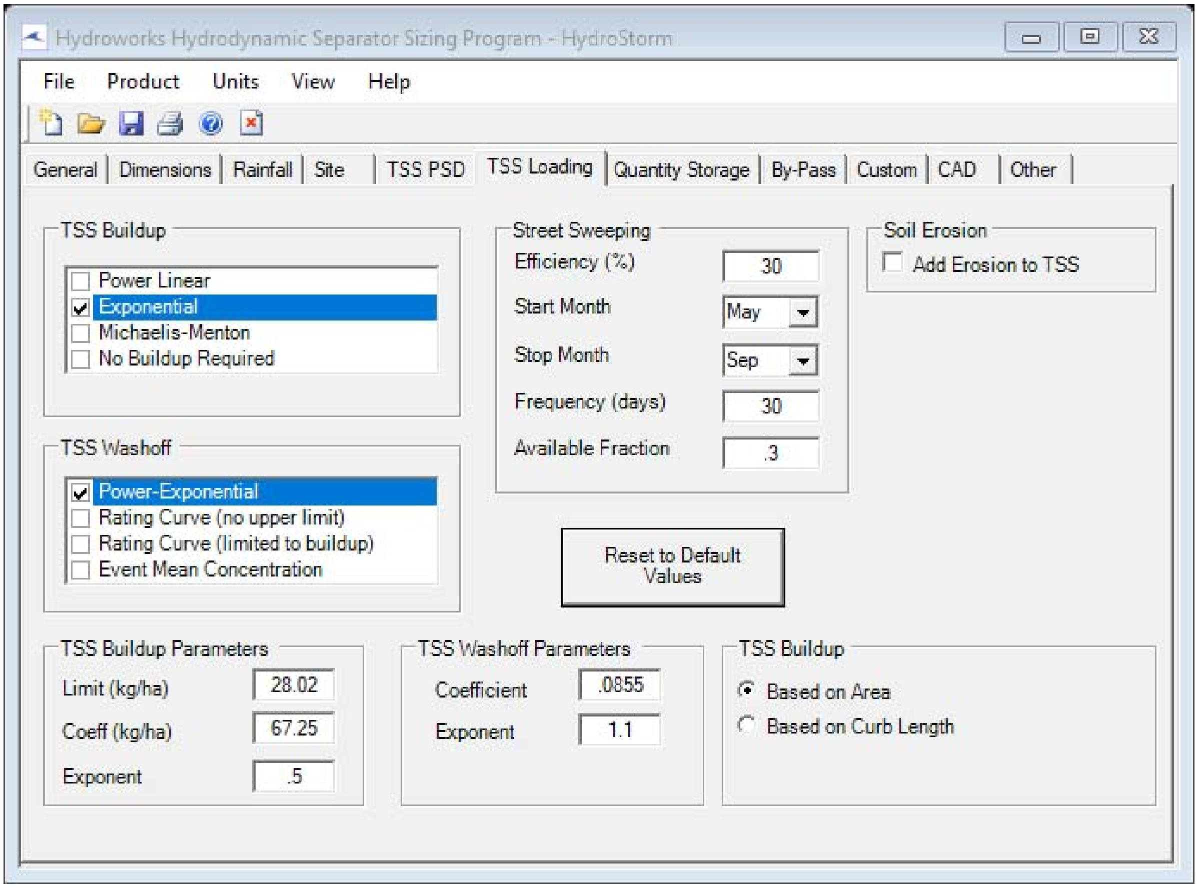
Model	Diam. (m)	Depth (m)	Float. Vol. (L)	Sediment Vol. (m3)	Total Vol. (m3)
HS 4	1.22	1.22	360	0.9	1.4
HS 5	1.52	1.52	625	1.8	2.8
HS 6	1.83	1.83	1022	3.2	4.8
HS 7	2.13	1.98	1552	4.6	7.1
HS 8	2.44	2.13	2328	6.3	10
HS 9	2.74	2.44	3217	9.3	14.4
HS 10	3.05	2.74	4277	13.2	20
HS 12	3.66	3.35	7097	23.8	35.2

Depth = Depth from outlet invert to inside bottom of tank

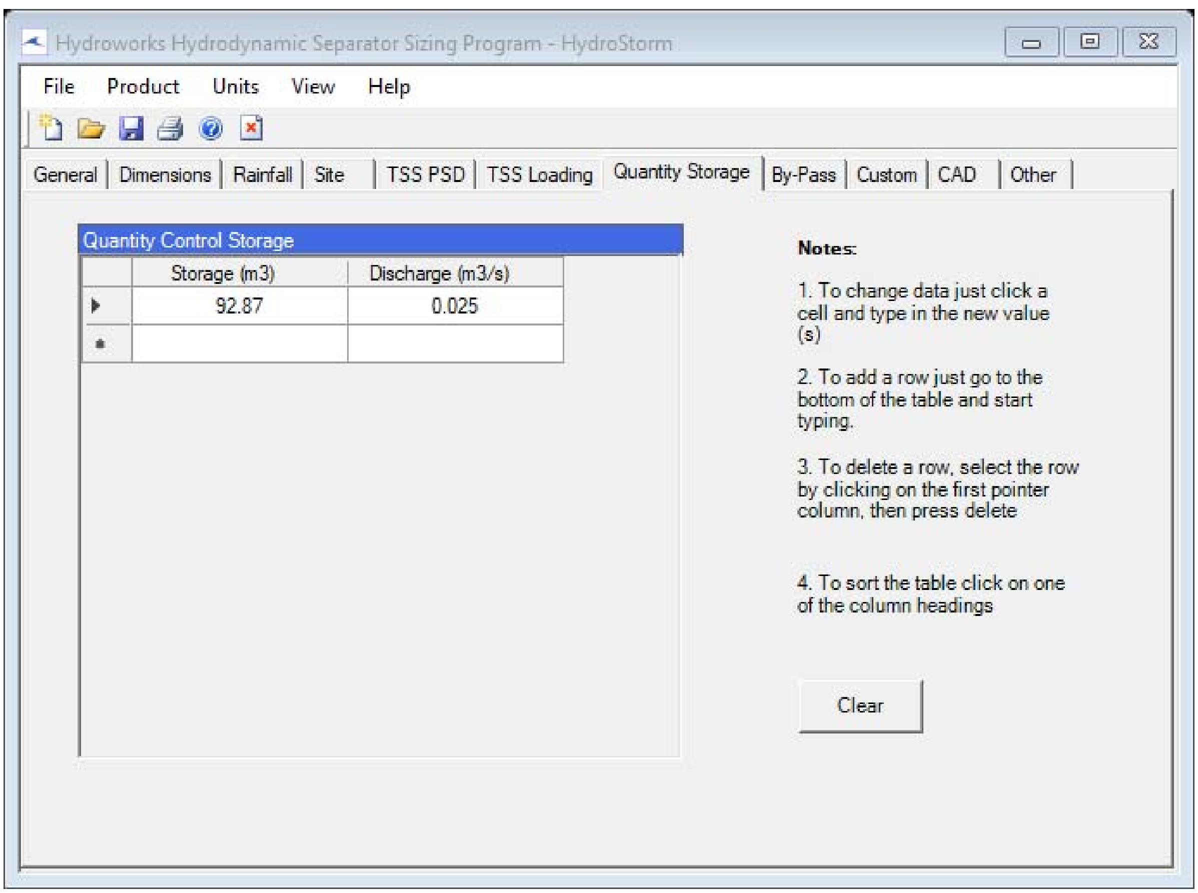
Generic HS 6 CAD Drawing



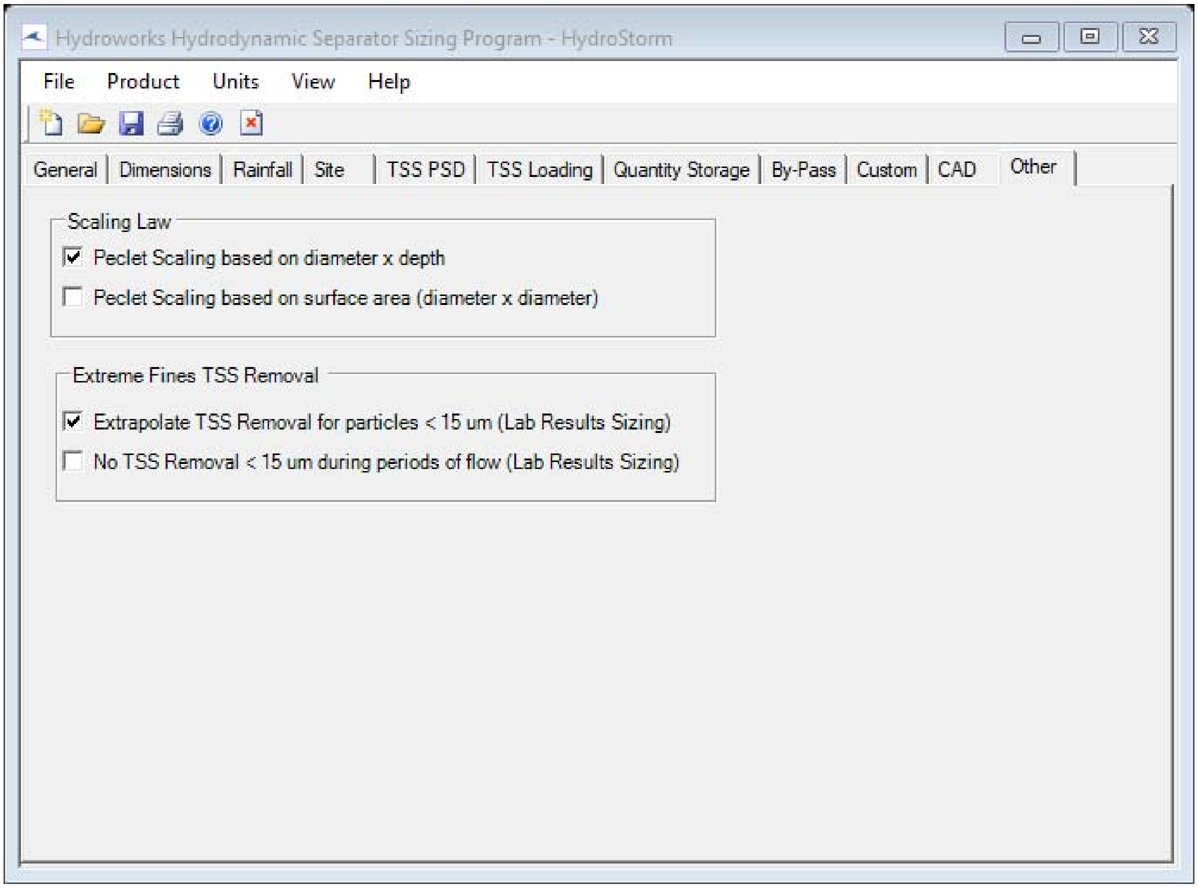
TSS Buildup And Washoff



Upstream Quantity Storage



Other Parameters



Hydroworks Sizing Program - Version 4.9

```
 ***************************************************
*      Storm Water Management Sizing Model       *
*               Hydroworks, LLC                  *
*                Version 4.4                     *
*                                                *
*        Continuous Simulation Program          *
*              Based on SWMM 4.4H                *
*              Hydroworks, LLC                   *
*               Graham Bryant                    *
*                2003 - 2013                     *
**************************************************

                 Developed by

**************************************************
*               Hydroworks, LLC                  *
*             Metcalf & Eddy, Inc.               *
*            University of Florida               *
*       Water Resources Engineers, Inc.          *
*      (Now Camp Dresser & McKee, Inc.)          *
*              Modified SWMM 4.4                 *
**************************************************

         Distributed and Maintained by

**************************************************
*                                                *
*                Hydroworks, LLC                 *
*                 888-290-7900                   *
*              www.hydroworks.com                *
*                                                *
**************************************************

**************************************************
*     If any problems occur executing this       *
*     model, contact Mr. Graham Bryant at        *
*     Hydroworks, LLC by phone at 908-272-4411  *
*     or by e-mail: support@hydroworks.com       *
**************************************************

**************************************************
*     This model is based on EPA SWMM 4.4        *
*  "Nature is full of infinite causes which      *
*   have never occurred in experience" da Vinci *
**************************************************

***************************************************
* Entry made to the Rain Block                    *
* Created by the University of Florida - 1988     *
* Updated by Oregon State University, March 2000  *
***************************************************
```

```
     Cobourg Gas
     Parcel B -Phase 1


 ########################################
 #  Precipitation Block Input Commands  #
 ########################################

Station Name.........................  Kingston Pumping Station

Station Location.....................  Ontario

Station, ISTA........................    4175

Beginning date, IYBEG (Yr/Mo/Dy)......  1960/ 1/ 1

Ending date, IYEND (Yr/Mo/Dy).........  2007/12/31

Minimum interevent time, MIT..........     1

Number of ranked storms, NPTS.........    10

NWS format, IFORM (See text)..........     1

Print storm summary, ISUM (O-No 1-Yes)     0

Print all rainfall, IYEAR (O-No 1-Yes)     0

Save storm event data on NSCRAT(1)....     0
(IFILE =0 -Do not save, =1 -Save data)

IDECID 0 - Create interface file
       1 - Create file and analyze
       2 - Synoptic analysis..........     2

Plotting position parameter, A........  0.40

Storm event statistics, NOSTAT........  1100



KODEA (from optional group B0)........     2
 = 0, Do not include NCDC cumulative values.
 = 1, Average NCDC cumulative values.
 = 2, Use NCDC cumulative value as inst. rain.

KODEPR (from optional group B0).......     0
 Print NCDC special codes in event summary:
 = 0, only on days with events.
 = 1, on all days with codes present.
 Codes: A = accumulated value, I = incomplete value,
        M = missing value,     O = other code present
```

```
********************************************************
*  Precipitation output created using the Rain block   *
*  Number of precipitation stations...        1        *
********************************************************

Location Station Number
-------- -------------
      1.     4175


STATION ID ON PRECIP. DATA INPUT FILE = 4175
REQUESTED STATION ID =     4175  CHECK TO BE SURE THEY MATCH.



$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
Note, 15-min. data are being processed, but hourly
print-out, summaries, and statistics are based on
hourly totals only.  Data placed on interface file
are at correct 15-min. intervals.
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

###################################################
# Entry made to the Runoff Block, last updated by #
# Oregon State University, and Camp, Dresser and  #
# McKee, Inc., March 2002.                        #
###################################################
# "And wherever water goes, amoebae go along for  #
#  the ride"                      Tom Robbins     #
###################################################



                   Cobourg Gas

                   Parcel B -Phase 1



Snowmelt parameter - ISNOW.......................          0

Number of rain gages - NRGAG.....................          1

Horton infiltration equation used - INFILM.......          2
Maximum infiltration volume is limited to RMAXINF input on  subcatchment lines.
Infiltration volume regenerates during  non rainfall periods.

Quality is simulated - KWALTY....................          1

IVAP is negative.  Evaporation will be set to zero
    during time steps with rainfall.

Read evaporation data on line(s) F1 (F2) - IVAP..          1
```

```
Hour of day at start of storm - NHR.............          1

Minute of hour at start of storm - NMN..........          1

Time TZERO at start of storm (hours)............      1.017

Use Metric units for I/O - METRIC...............          1
 ===> Ft-sec units used in all internal computations

Runoff input print control...                             0

Runoff graph plot control....                             1

Runoff output print control..                             0

Print headers every 50 lines - NOHEAD (0=yes, 1=no)       0

Print land use load percentages -LANDUPR (0=no, 1=yes)    0

Limit number of groundwater convergence messages to 10000 (if simulated)

Month, day, year of start of storm is:              1/ 1/1960

Wet time step length (seconds).......                   300.

Dry time step length (seconds).......                   900.

Wet/Dry time step length (seconds)...                   450.

Simulation length is......                        20071231.0 Yr/Mo/Dy

Percent of impervious area with zero detention depth    25.0

Horton infiltration model being used
Rate for regeneration of infiltration = REGEN * DECAY
DECAY is read in for each subcatchment
REGEN = ..........................................   0.25400
```

```
********************************************************
*   Processed Precipitation will be read from file     *
********************************************************

  #############################
  #        Data Group F1      #
  # Evaporation Rate (mm/day) #
  #############################
```

JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
0.00	0.00	0.00	2.54	2.54	3.81	3.81	3.81	2.54	2.54	0.00	0.00

C H A N N E L   A N D   P I P E   D A T A

Input equen umber	NAMEG: Channel ID #	Drains to NGTO:	Channel Type	Width (m)	Length (m)	Invert Slope (m/m)	L Side Slope (m/m)	R Side Slope (m/m)	Intial Depth (m)	Max Depth (m)	Mann-ings "N"	Full Flow (cms)
1	201	200	Dummy	0.0	0.0	0.0000	0.0000	0.0000	0.0	0.0	0.0000	0.00E+00

S U B C A T C H M E N T   D A T A

NOTE. SEE LATER TABLE FOR OPTIONAL SUBCATCHMENT PARAMETERS

SUBCATCH-MENT NO.	CHANNEL OR INLET	WIDTH (M)	AREA (HA)	PERCENT IMPERV.	SLOPE (M/M)	RESISTANCE IMPERV.	FACTOR PERV.	DEPRES. IMPERV.	STORAGE(MM) PERV.	INFILTRATION RATE(MM/HR) MAXIMUM	MINIMUM	DECAY RATE (1/SEC)	GAGE NO.	MAXIMUM VOLUME (MM)
1	300	200	52.46	0.28	84.00	0.0200	0.015	0.250	0.510	5.080	63.50	10.16	0.00055	1	101.60000

TOTAL NUMBER OF SUBCATCHMENTS... 1
TOTAL TRIBUTARY AREA (HECTARES). 0.28
IMPERVIOUS AREA (HECTARES)...... 0.23
PERVIOUS AREA (HECTARES)........ 0.04
TOTAL WIDTH (METERS)............ 52.46
PERCENT IMPERVIOUSNESS.......... 84.00

G R O U N D W A T E R   I N P U T   D A T A

SUB-CATCH NUMBER	CHANNEL OR INLET	ELEVATIONS GROUND (M)	BOTTOM (M)	STAGE (M)	BC (M)	TW (M)	FLOW CONSTANTS A1 (MM/HR-M^B1)	B1	A2 (MM/HR-M^B2)	B2	A3 (MM/HR-M^2)
0	602	3.05	0.00	0.00	0.61	0.61	3.484E-04	2.600	0.000E+00	1.000	0.00E+00

G R O U N D W A T E R   I N P U T   D A T A (CONTINUED)

S O I L   P R O P E R T I E S

SUBCAT. NO.	POROSITY	SATURATED HYDRAULIC CONDUCTIVITY (mm/hr)	WILTING POINT	FIELD CAPACITY	INITIAL MOISTURE	MAX. DEEP PERCOLATION (mm/hr)	PERCOLATION PARAMETERS HCO	PCO	ET PARAMETERS DEPTH OF ET (m)	FRACTION OF ET TO UPPER ZONE
0	.4000	127.000	.1500	.3000	.3000	5.080E-02	10.00	4.57	4.27	0.350

```
*********************************************************
*    Arrangement of Subcatchments and Channel/Pipes     *
*********************************************************
* See second subcatchment output table for connectivity *
* of subcatchment to subcatchment flows.                *
*********************************************************

   Channel
   or Pipe
       201     No Tributary Channel/Pipes
               No Tributary Subareas.....


    INLET
       200     Tributary Channel/Pipes...        201
               Tributary Subareas........        300


***********************************************************
* Hydrographs will be stored for the following   1 INLETS *
***********************************************************
           200

###################################################
#              Quality Simulation                 #
###################################################
#      General Quality Control Data Groups        #
###################################################

 Description                           Variable      Value
 -----------                           --------      -----

 Number of quality constituents.....    NQS.......        1

 Number of land uses................  JLAND.......        1

 Standard catchbasin volume.........  CBVOL.......     1.22 cubic meters

 Erosion is not simulated.........    IROS........        0

 DRY DAYS PRIOR TO START OF STORM... DRYDAY.......     3.00 DAYS

 DRY DAYS REQUIRED TO RECHARGE
 CATCHBASIN CONCENTRATION TO
 INITIAL VALUES..................... DRYBSN.......     5.00 DAYS

 DUST AND DIRT
 STREET SWEEPING EFFICIENCY......... REFFDD.......    0.300

 DAY OF YEAR ON WHICH STREET
 SWEEPING BEGINS.................... KLNBGN.......      120

 DAY OF YEAR ON WHICH STREET
```

```
 SWEEPING ENDS..................... KLNEND.......       270


###########################################
#     Land use data on data group J2      #
###########################################

                                                              LIMITING                               CLEANING  AVAIL.     DAYS SINCE
                                                              BUILDUP    BUILDUP  BUILDUP   INTERVAL  FACTOR       LAST
AND USE   BUILDUP EQUATION TYPE   FUNCTIONAL DEPENDENCE OF   QUANTITY   POWER    COEFF.    IN DAYS   FRACTION   SWEEPING
LNAME)            (METHOD)        BUILDUP PARAMETER(JACGUT)  (DDLIM)    (DDPOW)  (DDFACT)  (CLFREQ)  (AVSWP)     (DSLCL)
-------   --------------------    ------------------------   --------   -------  --------  --------  -------    ---------
Urban De  EXPONENTIAL(1)                  AREA(1)           2.802E+01     0.500    67.250    30.000     0.300    30.000


↑
##############################################
#     Constituent data on data group J3      #
##############################################


                               Total Su
                               --------
Constituent units........      mg/l
Type of units............          0
KALC.....................          2
Type of buildup calc.....    EXPONENTIAL(2)
KWASH....................          0
Type of washoff calc.....  POWER EXPONEN.(0)
KACGUT...................          1
Dependence of buildup....         AREA(1)
LINKUP...................          0
Linkage to snowmelt......   NO SNOW LINKAGE
Buildup param 1 (QFACT1).         28.020
Buildup param 2 (QFACT2).          0.500
Buildup param 3 (QFACT3).         67.250
Buildup param 4 (QFACT4).          0.000
Buildup param 5 (QFACT5).          0.000
Washoff power (WASHPO)...          1.100
Washoff coef. (RCOEF)....          0.086
Init catchb conc (CBFACT)        100.000
Precip. conc. (CONCRN)...          0.000
Street sweep effic (REFF)          0.300
Remove fraction (REMOVE).          0.000
1st order QDECAY, 1/day..          0.000
Land use number..........              1


*************************************************
* Constant Groundwater Quality Concentration(s) *
*************************************************

 Total Susp has a concentration of..    0.0000   mg/l
```

```
************************************************
* REMOVAL FRACTIONS FOR SELECTED CHANNEL/PIPES *
* FROM J7 LINES                                *
************************************************

  CHANNEL/   CONSTITUENT
     PIPE Total Susp
----------  --------
       201     0.000


*****************************************************
*     Subcatchment surface quality on data group L1 *
*****************************************************



                                  Total   Number   Input
                           Land    Gutter     of    Loading
                   Land     Use    Length   Catch-  load/ha
              No.  Usage    No.      Km     Basins   Total Su
          ------ --------  ----   -------- --------  -------
   1        300 Urban De  1          0.10     2.00  0.0E+00
   Totals (Loads in kg or other)    0.10     2.00  0.0E+00

    ***********************
    *    DATA GROUP M1    *
    ***********************


TOTAL NUMBER OF PRINTED GUTTERS/INLETS...NPRNT..        1
NUMBER OF TIME STEPS BETWEEN PRINTINGS..INTERV..        0
STARTING AND STOPPING PRINTOUT DATES...........         0        0


    ***********************
    *    DATA GROUP M3    *
    ***********************

CHANNEL/INLET PRINT DATA GROUPS......       -200





          ******************************************
          * Rainfall from Nat. Weather Serv. file  *
          * in units of hundredths of an inch      *
          ******************************************

         Cobourg Gas
         Parcel B -Phase 1
```

Rainfall Station Kingston Pumping Station
State/Province Ontario

Rainfall Depth Summary (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1960.	10.	0.	0.	0.	0.	0.	0.	0.	7.	78.	53.	18.	166.
1961.	0.	68.	65.	99.	122.	75.	48.	34.	39.	54.	99.	32.	736.
1962.	3.	8.	52.	68.	58.	61.	123.	59.	113.	95.	52.	20.	712.
1963.	0.	0.	12.	82.	84.	57.	23.	110.	59.	17.	146.	37.	627.
1964.	32.	3.	71.	80.	75.	29.	38.	54.	17.	41.	82.	76.	598.
1965.	17.	36.	2.	79.	36.	56.	60.	73.	101.	103.	133.	55.	750.
1966.	8.	32.	73.	29.	36.	71.	30.	74.	117.	36.	168.	72.	745.
1967.	35.	0.	35.	74.	64.	62.	68.	45.	125.	156.	102.	50.	818.
1968.	35.	22.	67.	37.	130.	118.	34.	89.	99.	85.	134.	37.	887.
1969.	50.	5.	65.	103.	0.	114.	52.	42.	27.	70.	0.	5.	532.
1970.	23.	18.	26.	42.	56.	53.	124.	11.	94.	72.	126.	20.	665.
1971.	17.	33.	2.	35.	52.	56.	92.	100.	66.	53.	0.	5.	511.
1972.	0.	0.	0.	30.	104.	125.	74.	104.	100.	170.	0.	0.	708.
1973.	0.	0.	0.	106.	79.	72.	32.	88.	101.	122.	0.	0.	599.
1974.	0.	0.	0.	53.	94.	67.	69.	27.	73.	59.	10.	0.	451.
1975.	0.	0.	0.	0.	59.	115.	37.	42.	166.	44.	0.	0.	463.
1976.	0.	0.	0.	72.	104.	148.	73.	70.	69.	93.	14.	0.	642.
1977.	0.	0.	0.	72.	34.	53.	47.	162.	109.	91.	6.	0.	574.
1978.	0.	0.	0.	63.	61.	48.	26.	87.	92.	79.	9.	0.	466.
1979.	0.	0.	0.	68.	31.	31.	20.	91.	157.	127.	0.	0.	525.
1980.	0.	0.	0.	153.	24.	63.	125.	60.	115.	114.	0.	0.	654.
1981.	0.	0.	0.	99.	125.	73.	66.	87.	167.	109.	0.	0.	726.
1982.	0.	0.	0.	41.	115.	118.	73.	81.	54.	81.	0.	0.	563.
1983.	0.	0.	0.	0.	68.	38.	62.	96.	56.	138.	8.	0.	466.
1984.	0.	0.	0.	137.	109.	29.	42.	162.	51.	25.	0.	0.	557.
1985.	0.	0.	0.	41.	76.	61.	70.	101.	81.	90.	0.	0.	520.
1986.	0.	0.	0.	72.	101.	123.	63.	135.	175.	2.	0.	0.	670.
1987.	0.	0.	0.	44.	63.	80.	53.	68.	133.	98.	0.	0.	538.
1988.	0.	0.	0.	68.	45.	38.	71.	73.	61.	162.	0.	0.	517.
1989.	0.	0.	0.	39.	101.	103.	14.	69.	98.	118.	0.	0.	541.
1990.	0.	0.	0.	88.	71.	104.	47.	52.	64.	165.	5.	0.	598.
1991.	0.	0.	0.	137.	61.	45.	85.	71.	91.	97.	0.	0.	587.
1992.	0.	0.	0.	46.	82.	55.	111.	136.	73.	110.	0.	0.	613.
1993.	0.	0.	0.	66.	64.	112.	22.	33.	94.	105.	0.	0.	495.
1994.	0.	0.	0.	93.	84.	89.	69.	121.	67.	28.	10.	0.	559.
1995.	0.	0.	0.	56.	61.	14.	54.	44.	2.	178.	6.	0.	414.
1996.	0.	0.	0.	119.	150.	68.	96.	46.	0.	90.	1.	0.	568.
1997.	0.	0.	0.	26.	59.	84.	26.	91.	81.	74.	16.	0.	457.
1998.	0.	0.	0.	41.	50.	110.	71.	89.	73.	62.	17.	0.	513.
1999.	0.	0.	0.	20.	38.	62.	61.	71.	118.	98.	0.	0.	467.
2000.	0.	0.	0.	150.	109.	104.	89.	75.	100.	39.	0.	0.	665.
2001.	0.	0.	0.	26.	58.	43.	41.	78.	110.	119.	0.	0.	476.
2002.	0.	0.	0.	71.	138.	95.	37.	36.	72.	103.	2.	0.	553.
2003.	0.	0.	0.	11.	120.	62.	118.	61.	79.	133.	20.	0.	606.

2005.	0.	0.	0.	36.	15.	31.	85.	100.	101.	56.	0.	0.	424.
2006.	0.	0.	0.	70.	55.	104.	57.	85.	130.	171.	0.	0.	672.
2007.	0.	0.	0.	76.	56.	35.	91.	32.	79.	6.	7.	0.	381.

Total Rainfall Depth for Simulation Period 26976. (mm)

Rainfall Intensity Analysis (mm/hr)

(mm/hr)	(#)	(%)	(mm)	(%)
2.50	29159	73.0	8889.	33.0
5.00	5437	13.6	4665.	17.3
7.50	2903	7.3	4257.	15.8
10.00	800	2.0	1717.	6.4
12.50	555	1.4	1514.	5.6
15.00	262	0.7	888.	3.3
17.50	240	0.6	967.	3.6
20.00	118	0.3	554.	2.1
22.50	120	0.3	633.	2.3
25.00	56	0.1	334.	1.2
27.50	56	0.1	367.	1.4
30.00	35	0.1	254.	0.9
32.50	46	0.1	363.	1.3
35.00	16	0.0	137.	0.5
37.50	17	0.0	153.	0.6
40.00	21	0.1	203.	0.8
42.50	12	0.0	123.	0.5
45.00	14	0.0	152.	0.6
47.50	4	0.0	46.	0.2
50.00	13	0.0	157.	0.6
>50.00	37	0.1	605.	2.2

Total # of Intensities 39921

Daily Rainfall Depth Analysis (mm)

(mm)	(#)	(%)	(mm)	(%)
2.50	1380	36.6	1639.	6.1
5.00	665	17.6	2381.	8.8
7.50	481	12.8	2913.	10.8
10.00	338	9.0	2905.	10.8
12.50	259	6.9	2918.	10.8
15.00	144	3.8	1951.	7.2
17.50	127	3.4	2053.	7.6
20.00	90	2.4	1683.	6.2
22.50	59	1.6	1244.	4.6
25.00	49	1.3	1162.	4.3
27.50	45	1.2	1185.	4.4
30.00	32	0.8	920.	3.4
32.50	21	0.6	653.	2.4
35.00	15	0.4	507.	1.9
37.50	8	0.2	293.	1.1

```
 40.00     18       0.5      693.       2.6
 42.50      7       0.2      288.       1.1
 45.00     12       0.3      525.       1.9
 47.50      6       0.2      275.       1.0
 50.00      3       0.1      145.       0.5
>50.00     10       0.3      642.       2.4

Total # Days with Rain   3769

************************************************
*      End of time step DO-loop in Runoff      *
************************************************

Final Date (Mo/Day/Year)   =                  12/31/2007
Total number of time steps =                     2675447
Final Julian Date  =                             2007365
Final time of day  =                              86397. seconds.
Final time of day  =                               24.00   hours.
Final running time =                         420768.0000   hours.
Final running time =                          17532.0000    days.

**************************************************
*     Extrapolation Summary for Watersheds       *
* # Steps ==> Total Number of Extrapolated Steps *
* # Calls ==> Total Number of OVERLND Calls      *
**************************************************

 Subcatch   # Steps   # Calls  Subcatch   # Steps   # Calls  Subcatch   # Steps   # Calls
 --------   -------   -------  --------   -------   -------  --------   -------   -------
      300   6592667   1570097

**************************************************
*     Extrapolation Summary for Channel/Pipes    *
* # Steps ==> Total Number of Extrapolated Steps *
* # Calls ==> Total Number of GUTNR Calls        *
**************************************************

Chan/Pipe   # Steps   # Calls Chan/Pipe   # Steps   # Calls Chan/Pipe   # Steps   # Calls
 --------   -------   -------  --------   -------   -------  --------   -------   -------
      201         0         0
↑
**********************************************
*       Continuity Check for Surface Water   *
**********************************************
                                                                   Millimeters over
                                                       cubic meters  Total Basin
Total Precipitation (Rain plus Snow)                        74027.     26900.
Total Infiltration                                          11824.      4297.
Total Evaporation                                            6334.      2302.
Surface Runoff from Watersheds                              56508.     20534.
Total Water remaining in Surface Storage                        0.         0.
Infiltration over the Pervious Area...                      11824.     26855.
                      --------
Infiltration + Evaporation +
Surface Runoff + Snow removal +
```

```
Water remaining in Surface Storage +
Water remaining in Snow Cover.........                      74666.     27132.
Total Precipitation + Initial Storage.                      74027.     26900.


The error in continuity is calculated as
***************************************
* Precipitation + Initial Snow Cover  *
*      - Infiltration -               *
*Evaporation - Snow removal -         *
*Surface Runoff from Watersheds -     *
*Water in Surface Storage -           *
*Water remaining in Snow Cover        *
*-------------------------------------*
* Precipitation + Initial Snow Cover  *
***************************************
Error..................................       -0.864 Percent


**********************************************
*       Continuity Check for Channel/Pipes   *
**********************************************
                                                                 Millimeters over
                                                   cubic meters  Total Basin
Initial Channel/Pipe Storage................                0.         0.
Final Channel/Pipe Storage..................                0.         0.
Surface Runoff from Watersheds..............            56508.     20534.
Baseflow....................................                0.
Groundwater Subsurface Inflow...............                0.         0.
Evaporation Loss from Channels..............                0.         0.
Channel/Pipe/Inlet Outflow..................            56508.     20534.
Initial Storage + Inflow....................            56508.     20534.
Final Storage + Outflow.....................            56508.     20534.
********************************************
* Final Storage + Outflow + Evaporation  - *
* Watershed Runoff - Groundwater Inflow  - *
*     Initial Channel/Pipe Storage         *
*     ------------------------------       *
*  Final Storage + Outflow  + Evaporation  *
********************************************
Error.......................................      0.000 Percent

🡅
***************************************************
*     Continuity Check for Subsurface Water       *
***************************************************

                                                                  Millimeters over
                                               cubic meters       Subsurface Basin

Total Infiltration                                          0.         0.
Total Upper Zone ET                                         0.         0.
Total Lower Zone ET                                         0.         0.
Total Groundwater flow                                      0.         0.
Total Deep percolation                                      0.         0.
```

```
Initial Subsurface Storage                              2516.       914.
Final Subsurface Storage                                2516.       914.
Upper Zone ET over Pervious Area                           0.         0.
Lower Zone ET over Pervious Area                           0.         0.

******************************************
* Infiltration + Initial Storage - Final *
* Storage - Upper and Lower Zone ET -    *
* Groundwater Flow - Deep Percolation    *
* -------------------------------------- *
*     Infiltration + Initial Storage     *
******************************************
Error ..................................     0.000 Percent
```

SUMMARY STATISTICS FOR SUBCATCHMENTS

					PERVIOUS AREA			IMPERVIOUS AREA		TOTAL SUBCATCHMENT AREA		
SUBCATCH- MENT NO.	GUTTER OR INLET NO.	AREA (HA)	PERCENT IMPER.	TOTAL SIMULATED RAINFALL (MM)	TOTAL RUNOFF DEPTH (MM)	TOTAL LOSSES (MM)	PEAK RUNOFF RATE (CMS)	RUNOFF DEPTH (MM)	PEAK RUNOFF RATE (CMS)	RUNOFF DEPTH (MM)	PEAK RUNOFF RATE (CMS)	PEAK UNIT RUNOFF (MM/HR)
300	200	0.28	84.02	6891.65	50.582	********	0.005	24433.273	0.065	20532.041	0.069	91.131

*** NOTE *** IMPERVIOUS AREA STATISTICS AGGREGATE IMPERVIOUS AREAS WITH AND WITHOUT DEPRESSION STORAGE

SUMMARY STATISTICS FOR CHANNEL/PIPES

CHANNEL NUMBER	FULL FLOW (CMS)	FULL VELOCITY (M/S)	FULL DEPTH (M)	MAXIMUM COMPUTED INFLOW (CMS)	MAXIMUM COMPUTED OUTFLOW (CMS)	MAXIMUM COMPUTED DEPTH (M)	MAXIMUM COMPUTED VELOCITY (M/S)	TIME OF OCCURRENCE DAY	TIME OF OCCURRENCE HR.	LENGTH OF SURCHARGE (HOUR)	MAXIMUM SURCHARGE VOLUME (CU-M)	RATIO OF MAX. TO FULL FLOW	RATIO OF MAX. DEPTH TO FULL DEPTH
201				0.00				1/ 0/1900	0.00				
200				0.07				8/14/1994	2.25				

TOTAL NUMBER OF CHANNELS/PIPES = 2

*** NOTE *** THE MAXIMUM FLOWS AND DEPTHS ARE CALCULATED AT THE END OF THE TIME INTERVAL

```
#####################################################
#              Runoff Quality Summary Page          #
# If NDIM = 0 Units for:   loads    mass rates      #
#              METRIC = 1    lb        lb/sec       #
#              METRIC = 2    kg        kg/sec       #
```

```
 # If NDIM = 1 Loads are in units of quantity        #
 #             and mass rates are quantity/sec       #
 # If NDIM = 2 loads are in units of concentration   #
 #             times volume and mass rates have units#
 #             of concentration times volume/second  #
 #####################################################

Total Su NDIM =  0
METRIC =  2

                                  Total Su
                                  --------
Inputs
------
 1. INITIAL SURFACE LOAD........        6.
 2. TOTAL SURFACE BUILDUP.......     7387.
 3. INITIAL CATCHBASIN LOAD.....        0.
 4. TOTAL CATCHBASIN LOAD.......        0.
 5. TOTAL CATCHBASIN AND
    SURFACE BUILDUP (2+4).......     7387.

Remaining Loads
---------------
 6. LOAD REMAINING ON SURFACE...        5.
 7. REMAINING IN CATCHBASINS....        0.
 8. REMAINING IN CHANNEL/PIPES..        0.

Removals
--------
 9. STREET SWEEPING REMOVAL.....      548.
10. NET SURFACE BUILDUP (2-9)...     6838.
11. SURFACE WASHOFF.............     6832.
12. CATCHBASIN WASHOFF..........        0.
13. TOTAL WASHOFF (11+12).......     6832.
14. LOAD FROM OTHER CONSTITUENTS        0.
15. PRECIPITATION LOAD..........        0.
15a.SUM SURFACE LOAD (13+14+15).     6832.
16. TOTAL GROUNDWATER LOAD......        0.
16a.TOTAL I/I LOAD..............        0.
17. NET SUBCATCHMENT LOAD
    (15a-15b-15c-15d+16+16a)....     6832.
>>Removal in channel/pipes (17a, 17b):
17a.REMOVE BY BMP FRACTION......        0.
17b.REMOVE BY 1st ORDER DECAY...        0.
18. TOTAL LOAD TO INLETS........     6833.
19. FLOW WT'D AVE.CONCENTRATION  mg/l
    (INLET LOAD/TOTAL FLOW).....      121.

Percentages
-----------
20. STREET SWEEPING (9/2).......        7.
21. SURFACE WASHOFF (11/2)......       92.
22. NET SURFACE WASHOFF(11/10)..      100.
```

```
23. WASHOFF/SUBCAT LOAD(11/17)..      100.
24. SURFACE WASHOFF/INLET LOAD
    (11/18).....................      100.
25. CATCHBASIN WASHOFF/
    SUBCATCHMENT LOAD (12/17)...        0.
26. CATCHBASIN WASHOFF/
    INLET LOAD (12/18)..........        0.
27. OTHER CONSTITUENT LOAD/
    SUBCATCHMENT LOAD (14/17)...        0.
28. INSOLUBLE FRACTION/
    INLET LOAD (14/18)..........        0.
29. PRECIPITATION/
    SUBCATCHMENT LOAD (15/17)...        0.
30. PRECIPITATION/
    INLET LOAD (15/18)..........        0.
31. GROUNDWATER LOAD/
    SUBCATCHMENT LOAD (16/17)...        0.
32. GROUNDWATER LOAD/
    INLET LOAD (16/18)..........        0.
32a.INFILTRATION/INFLOW LOAD/
    SUBCATCHMENT LOAD (16a/17)..        0.
32b.INFILTRATION/INFLOW LOAD/
    INLET LOAD (16a/18).........        0.
32c.CH/PIPE BMP FRACTION REMOVAL/
    SUBCATCHMENT LOAD (17a/17)..        0.
32d.CH/PIPE 1st ORDER DECAY REMOVAL/
    SUBCATCHMENT LOAD (17b/17)..        0.
33. INLET LOAD SUMMATION ERROR
    (18+8+6a+17a+17b-17)/17.....        0.

CAUTION. Due to method of quality routing (Users Manual, Appendix IX)
quality routing through channel/pipes is sensitive to the time step.
Large "Inlet Load Summation Errors" may result.
These can be reduced by adjusting the time step(s).
Note: surface accumulation during dry time steps at end of simulation is
not included in totals.  Buildup is only performed at beginning of
wet steps or for street cleaning.


********************************************************
*            TSS Particle Size Distribution            *
********************************************************
```

Diameter (um)	%	Specific Gravity	Settling Velocity (m/s)	Critical Peclet Number
2.	5.0	2.65	0.000003	0.141020
5.	5.0	2.65	0.000017	0.155300
8.	10.0	2.65	0.000043	0.169220
20.	15.0	2.65	0.000267	0.221300
50.	10.0	2.65	0.001629	0.326300
75.	5.0	2.65	0.003548	0.386300
100.	10.0	2.65	0.006044	0.421300
150.	15.0	2.65	0.012234	0.450000
250.	15.0	2.65	0.026615	0.450000

```
     500.     5.0      2.65         0.060604            0.450000
    1000.     5.0      2.65         0.111334            0.450000

****************************************************
*                                                  *
*              Summary of TSS Removal              *
*                                                  *
****************************************************

TSS Removal based on Exponential Lab Performance Curve

 Model      Low Q Treated  High Q Treated     Runoff Treated        TSS Removed
   #           (cms)          (cms)               (%)                   (%)

 HS 4         0.025          0.025               99.0                  72.3
 HS 5         0.025          0.025               99.0                  79.0
 HS 6         0.025          0.025               99.0                  84.1
 Unavaila     0.025          0.025               99.0                  87.1
 HS 8         0.025          0.025               99.0                  89.9
 Unavaila     0.025          0.025               99.0                  92.4
 HS 10        0.025          0.025               99.0                  94.2
 HS 12        0.025          0.025               99.0                  96.6

****************************************************
*  Summary of Quantity and Quality Results at      *
*  Location        200  INFlow in cms.             *
*  Values are instantaneous at indicated time step *
****************************************************

  Cobourg Gas
 Parcel B -Phase 1

     Date     Time        Flow   Total Su
 Mo/Da/Year  Hr:Min        cum/s  mg/l
 ----------  -------    -------  --------
Flow wtd means.....        0.000      121.
Flow wtd std devs..        0.001       68.
Maximum value......        0.069      292.
Minimum value......        0.000        0.
Total loads........       56501.     6837.
                        Cub-Met  KILOGRAM

===> Runoff simulation ended normally.

===> SWMM 4.4    simulation ended normally.
     Always check output file for possible warning messages.

*******************************************************
*       SWMM 4.4    Simulation Date and Time Summary  *
*******************************************************
* Starting Date... March      10, 2020                *
*          Time...         10:10:31.990               *
*   Ending Date... March      10, 2020                *
```

```
*           Time...         10:10:36.210               *
*  Elapsed Time...               0.070 minutes.        *
*  Elapsed Time...               4.220 seconds.        *
*******************************************************
```