GUIDO DE BRES CHRISTIAN HIGH SCHOOL
350 ALBRIGHT ROAD, HAMILTON

STORM WATER MANAGEMENT DESIGN BRIEF
NEW DEVELOPMENT DRAINAGE SYSTEM

REV 1 – April 15, 2023

PREPARED BY:

HALLEX ENGINEERING LTD.

HALLEX PROJECT #221119

HALLEX NIAGARA
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HALLEX HAMILTON
745 SOUTH SERVICE ROAD, UNIT 205
STONEY CREEK, ON L8E 5Z2

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1. PRE-DEVELOPMENT CONDITIONS

1.1 LOCATION

The proposed Guido de Bres Christian High School development is located at 350 Albright Road, which is west of the Albright Road and Harrisford Street intersection in the City of Hamilton, ON.

1.2 DRAINAGE PATTERN

The current drainage path for the site consists partly of overland sheet flow to the northerly wooded property, partly of existing sewers draining to the existing 1200mm municipal storm sewer draining northerly through the Red Hill Neighbourhood Park and partly of overland sheet flow to the existing 200mm municipal storm sewer at Albright Road. The 200mm storm sewer at Albright Road ultimately drains east to the 1200mm municipal storm sewer at the Red Hill Neighbourhood Park. Given the development will take place on the south side of the existing building, the proposed stormwater management controls will ensure the storm flows are controlled to the pre-development flow rate to the existing 1200mm municipal storm sewer.

2. PROPOSED WORK

2.1 GRADING

The objective of the design is to utilize the existing natural slope and achieve the minimum and maximum slopes in the grading of the asphalt surfaces. This will ensure the surface not only drains as per the design, but is not too steep. The grading of the subject area of the site to be developed also ensures that the storm water flow will drain through the onsite drainage system for storm water quantity and quality controls. The proposed drainage system onsite has been designed according to the five and one-hundred-year storm events as per the City of Hamilton intensity-duration-frequency curve.

2.2 DRAINAGE

The proposed design requires 219.7 metres of storm sewer piping, three precast catch basins, two precast maintenance holes, and a HydroDome HD10 oil and grit separator.

3. DESIGN CONSIDERATIONS

3.1 PRE-DEVELOPMENT SITE DRAINAGE

3.1.1 Peak Runoff

The total drainage area for the development is 2.426 hectares with an existing runoff coefficient of 0.56 based on the existing roof, asphalt and grass surfaces.

The time of concentration is determined to be 10 minutes to the start of the existing drainage system as required by the City of Hamilton municipal standards.

Using the Rational Method, the peak flow rates are $Q = \frac{CiA}{360}$

Subcatchment	Description	Draining to	Area, ha	Tc, min
Area.1	Sheet	North Property	1.123	10
Area.2	Sewer	RHN Park	0.973	10
Area.3	Sheet	Albright Road	0.330	10
5-year Storm	A,ha	C	i,mm/h	Q, L/s
Area.1	1.123	0.37	103	119.2
Area.2	0.973	0.85	103	237.7
Area.3	0.330	0.33	103	30.7
TOTAL	2.426	0.56	103	387.6
100-year Storm	A,ha	C	i,mm/h	Q, L/s
Area.1	1.123	0.37	182	210.4
Area.2	0.973	0.85	182	419.5
Area.3	0.330	0.33	182	54.1
TOTAL	2.426	0.56	182	684.0

Therefore, the total pre-development flow for the subject site is 387.6L/s for the five-year storm and 684.0L/s for the one-hundred-year storm.

3.1.2 Quantity

There is no known storm quantity control measure in place for the pre-development condition.

3.1.3 Quality

There is no known storm quality control measure in place for the pre-development condition.

3.2 POST-DEVELOPMENT SITE DRAINAGE

3.2.1 Peak Runoff

The proposed Guido de Bres Christian High School development consists of the construction of a new gymnasium addition, asphalt laneway & parking areas and grass areas. The resulting runoff coefficient in the post-development condition of the site is 0.61.

The proposed addition and parking areas will drain through the proposed onsite storm drainage system and shall discharge to the existing 1200mm municipal storm sewer at the Red Hill Neighbourhood Park property. The existing catchbasins and storm sewers in the remaining area of the site is to remain unaltered and will continue to drain to the existing 1200mm municipal storm sewer.

The site's storm sewer pipes are designed according to the 5-year minor storm. Utilizing the minimum recommended time of concentration of 10 minutes, the time for storm water to flow from the farthest drainage area to the existing 1200mm storm sewer, as outlined in Exhibit #1, is calculated to be 12.28 minutes.

Using the Rational Method, the peak flow rates are as follows:

Subcatchment	Description	Draining to	Area, ha	Tc, min
Area.1	Sheet	North Property	0.974	10
Area.2	Sewer	RHN Park	0.972	10
Prop. Sewer	Sewer	RHN Park	0.500	10
5-year Storm	A,ha	C	i,mm/h	Q, L/s
Area.1	0.974	0.32	103	87.2
Area.2	0.972	0.85	103	232.9
Prop. Sewer	0.500	0.74	103	105.6
TOTAL	2.425	0.61	103	425.7
100-year Storm	A,ha	C	i,mm/h	Q, L/s
Area.1	0.974	0.32	182	153.9
Area.2	0.972	0.85	182	411.0
Prop. Sewer	0.500	0.74	182	186.4
TOTAL	2.425	0.61	182	751.2

Therefore, the total post-development flow for the subject site is 425.7L/s for the five-year storm and 751.2L/s for the one-hundred-year storm. The flows and other design information are contained in Exhibit #1 for the five -year storm and Exhibit #2 for the one-hundred-year storm at the end of the design brief.

3.2.2 Quantity

The post-development storm water runoff for Area.1 draining to the northerly wooded property will decrease as a result of the development. As such, stormwater quantity controls are not proposed for this drainage area.

The post-development storm water runoff for Area.3 draining 200mm municipal storm sewer at Albright Road will be eliminated as a result of the development. As such, stormwater quantity controls are not proposed for this drainage area.

The post-development storm water runoff to the existing 1200mm municipal storm sewer at the Red Hill Neighbourhood Park is higher than the pre-development runoff. As such, storm water detention is required to ensure that the existing municipal sewer does not surcharge as a result of the proposed development.

Stormwater quantity controls for the site will be achieved by utilizing a 110mm diameter orifice plate at the outlet side of MH.2. The orifice plate will ensure the post-development runoff is controlled to the pre-development runoff rate for the five and one-hundred-year storm events. The resulting 94m^3 volume generated from the five-year storm and 182m^3 volume generated from the one-hundred-year storm will be contained within the proposed sewer system and temporary surface ponding. The storage within the pipes consist of only the static portion of the pipe as the dynamic portion is required to remain in a state of flow as per the design. In addition, storage is provided within each node consisting of the catchbasins and manholes.

The storage volume for the five, ten, twenty-five, fifty and one-hundred-year storms are calculated using EPA SWMM v5.1 software (Refer to Appendix 'A' for EPA SWMM v5.1 – Output Files)

The following table summarizes the pre-development flow rates, the post-development uncontrolled flow rates and the post-development controlled flow rates for the subject site:

	Pre- Development / Allowable Flow Rate (L/s)	Post- Development Uncontrolled Flow Rate (L/s)	Post- Development Controlled Flow Rate (L/s)
5-year Storm			
North Property (Area.1)	119.2	87.2	87.2
RHN Park (Area.2, Area.3 & Prop. Sewer)	268.4	338.5	264.2
TOTAL	387.6	425.7	351.4
100-year Storm			
North Property (Area.1)	210.4	153.9	153.9
RHN Park (Area.2, Area.3 & Prop. Sewer)	473.6	597.4	461.6
TOTAL	684.0	751.2	615.5

The orifice plate sizing and subsequent storage volume for the detained flow are indicated in Exhibit #3 for the five -year storm and Exhibit #4 for the one-hundred-year storm at the end of the design brief.

3.2.3 Quality

The storm water collected in the proposed development passes through a CB Shield within each catchbasin and then through a HydroDome HD10 in order to achieve a treatment train approach for water quality control. The HydroDome is ETV verified and achieves a total suspended solids removal of at least 72%. This value is greater than the required 'Normal' treatment of 70% as indicated in the MOE Stormwater Management Planning and Design Manual, dated March 2003 (refer to Chapter 3: Environmental Design Criteria, Section 3.3.1.1. Level of Protection). The CB Shield schematic is included in Appendix 'B' of this report and the design calculations from the manufacturer as well as the ETV Verification are included in Appendix 'C' of this report.

3.2.4 Maintenance Recommendations

The storm sewer system includes pipes, catchbasins, maintenance holes and the oil/grit separator. It is important to regularly inspect the elements to ensure that storm water is flowing as originally designed. Debris and sediment commonly clog the system and reduce the overall effectiveness.

The following maintenance and inspection tasks should be done:

1. Inspect the inlet pipes and outlet pipes for structural integrity. (Annually) Check inlet/ outlet pipes for structural integrity to ensure they aren't crumbling or broken.
2. Conduct routine inspections for trash or other debris that may be blocking the inlet and outlet pipes. (Monthly and after rain events) Remove all trash and debris.
3. Inspect and clean the storm sewer system (Every 5 years or as needed). Catchbasins to be inspected annually and debris removed when the debris reaches a depth of ½ from the bottom of the sump to the bottom of the pipe.
4. Inspect for sediment accumulation at pipes (Semi-annually and after rain events). It is important to clean out sediment that might be restricting water flow.
5. Do not dump any materials in the storm sewer system.
6. Inspect the HydroDome Oil/Grit Separator (Annually). Procedures for inspection are provided in the HydroDome Owner's Manual. A vacuum truck is to be used for maintenance of the HydroDome.

4. CONCLUSION

The aforementioned calculations and recommendations for the storm drainage system are based on the current design for the site as of writing this report.

We trust this report meets your approval. Please contact the undersigned should you have any questions or comments.

Yours truly,
HALLEX ENGINEERING LTD

LICENSED PROFESSIONAL ENGINEER
J. A. HALUCHA
2023/04/15
221119
PROVINCE OF ONTARIO

Jim Halucha P.Eng
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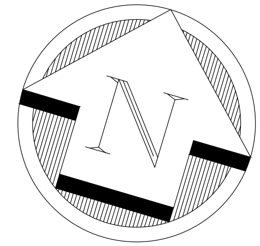

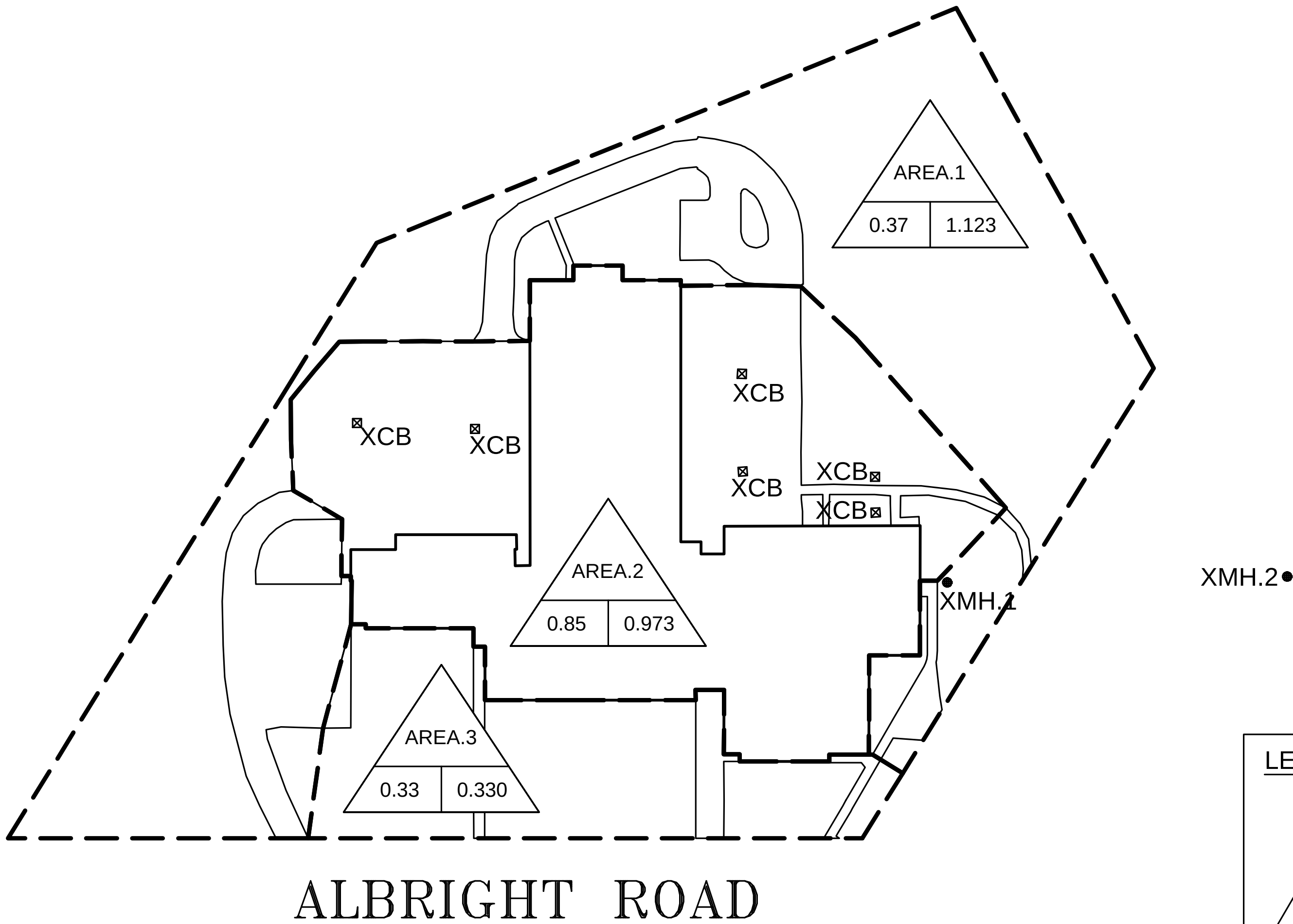

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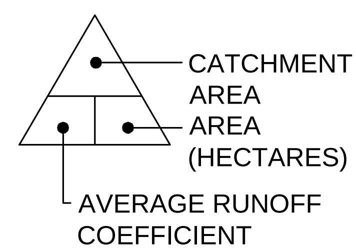

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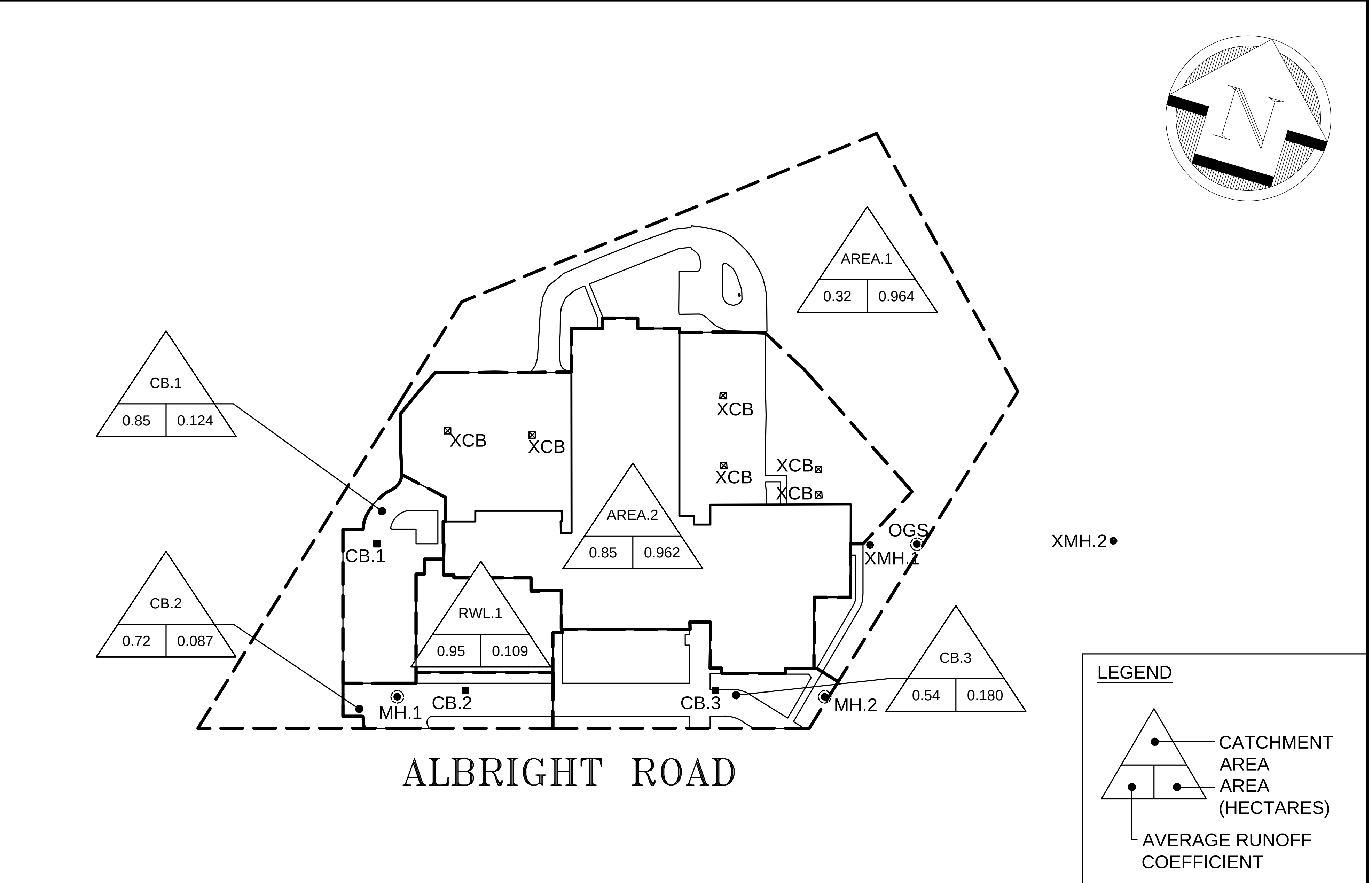
PROJECT:
GUIDO DE BRES CHRISTIAN HIGH SCHOOL
350 ALBRIGHT ROAD, HAMILTON, ON, L8K 5J4

SHEET TITLE:
PRE-DEVELOPMENT CATCHMENT AREA PLAN

DATE: 04/15/2023
SCALE: 1:1500
DR. BY: JS
CH. BY: JH
JOB No.: 221119
DWG. CSK1
REV. 1



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PROJECT:
GUIDO DE BRES CHRISTIAN HIGH SCHOOL
350 ALBRIGHT ROAD, HAMILTON, ON, L8K 5J4

SHEET TITLE:
POST-DEVELOPMENT CATCHMENT AREA PLAN

DATE: 04/15/2023
SCALE: 1:1500
DR. BY: JS
CH. BY: JH
JOB No.: 221119
DWG. CSK2
REV. 1

4/15/2023
Job: 221119

Guido de Bres Christian High School
Exhibit #1 - 5 Year Post - Development Calculations

MUNICIPALITY: **Hamilton**

Rainfall Intensity Values = A= 1049.500, B= 8.000, C= 0.803

manning's n = 0.013 PVC Pipe; 0.013 Conc Pipe; 0.024 Corr. Stl Pipe; 0.035 Grass Swale

Location			Length of Pipe	Area		Flow Time		Rainfall Intensity	Unit rate of Runoff	Design Flows		Flow Control	Sewer/Channel Design				Invert Elevations		
Pipe	From Node	To Node		Incre-ment	Cum Total	To Upper	In Section			Cum Flow	Cum Flow		Slope	Capacity Full	Velocity Full	*Dia/ Depth	Up-stream	Down-stream	
			(m)	(ha)	(ha)	(min)	(min)	mm/hr	m^3/ha*day	(m^3/d)	(m^3/s)	(m^3/s)	(m/m)	(m^3/s)	(m/s)	(m)	(m)	(m)	
1	**Area 1**	**Prpty N**	**N/A**	**0.964**	**0.964**	**10.00**	**N/A**	**103**	**28439**	**7535.0**	**0.0872**	**0.0872**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	
Paved	-	-	-	0.098	-	-	-	-	22256.3	2181.1	-	-	-	-	-	-	-	-	
Grass	-	-	-	0.866	-	-	-	-	6182.3	5353.9	-	-	-	-	-	-	-	-	
2	**Area 2**	**XMH. 1**	**N/A**	**0.962**	**0.962**	**10.00**	**N/A**	**103**	**51931**	**20124.6**	**0.2329**	**0.2329**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	
Roof	-	-	-	0.533	-	-	-	-	23492.7	12521.6	-	-	-	-	-	-	-	-	
Paved	-	-	-	0.308	-	-	-	-	22256.3	6854.9	-	-	-	-	-	-	-	-	
Grass	-	-	-	0.121	-	-	-	-	6182.3	748.1	-	-	-	-	-	-	-	-	
3	**CB. 1**	**MH. 1**	**42.8**	**0.124**	**0.124**	**10.00**	**0.69**	**103**	**28439**	**2615.1**	**0.0303**	**0.0303**	**0.0100**	**0.0328**	**1.0440**	**0.200**	**111.15**	**110.72**	
Paved	-	-	-	0.115	-	-	-	-	22256.3	2559.5	-	-	-	-	-	-	-	-	
Grass	-	-	-	0.009	-	-	-	-	6182.3	55.6	-	-	-	-	-	-	-	-	
4	**CB. 2**	**MH. 1**	**1.5**	**0.087**	**0.087**	**10.00**	**0.03**	**103**	**28439**	**1550.5**	**0.0179**	**0.0179**	**0.0100**	**0.0328**	**1.0440**	**0.200**	**111.30**	**111.28**	
Paved	-	-	-	0.063	-	-	-	-	22256.3	1402.1	-	-	-	-	-	-	-	-	
Grass	-	-	-	0.024	-	-	-	-	6182.3	148.4	-	-	-	-	-	-	-	-	
5	**CB. 3**	**MH. 1**	**1.5**	**0.180**	**0.180**	**10.00**	**0.03**	**103**	**28439**	**2398.7**	**0.0278**	**0.0278**	**0.0100**	**0.0328**	**1.0440**	**0.200**	**111.05**	**111.03**	
Paved	-	-	-	0.080	-	-	-	-	22256.3	1780.5	-	-	-	-	-	-	-	-	
Grass	-	-	-	0.100	-	-	-	-	6182.3	618.2	-	-	-	-	-	-	-	-	
6	**RWL. 1**	**MH. 1**	**5.5**	**0.109**	**0.109**	**10.00**	**0.08**	**103**	**23493**	**2560.7**	**0.0296**	**0.0296**	**0.0100**	**0.0595**	**1.2115**	**0.250**	**111.35**	**111.29**	
Roof	-	-	-	0.109	-	-	-	-	23492.7	2560.7	-	-	-	-	-	-	-	-	
7	**MH. 1**	**MH. 2**	**120**	**0.000**	**0.500**	**10.69**	**0.83**	**100**	**0**	**9125.1**	**0.1056**	**0.1056**	**0.0050**	**2.7568**	**2.4376**	**1.200**	**109.51**	**108.91**	
8	**MH. 2**	**OGS**	**48.4**	**0.000**	**0.500**	**11.52**	**0.25**	**97**	**0**	**9125.1**	**0.1056**	**0.0313**	**0.0600**	**0.2369**	**3.3510**	**0.300**	**108.85**	**105.94**	
9	**XMH. 1**	**OGS**	**11.5**	**0.000**	**0.962**	**10.00**	**0.11**	**103**	**0**	**20124.6**	**0.2329**	**0.2329**	**0.0100**	**0.2851**	**1.7926**	**0.450**	**105.95**	**105.83**	* Assumed Slope
10	**OGS**	**XMH. 2**	**54.2**	**0.000**	**1.462**	**11.77**	**0.51**	**96**	**0**	**29249.7**	**0.3385**	**0.2642**	**0.0100**	**0.2851**	**1.7926**	**0.450**	**105.80**	**105.25**	* Assumed Slope

Run-off Coefficients Used:

Roof Structure	C =	0.95
Paved Surface	C =	0.90
Grass Surface	C =	0.25

Velocity Range:

Minimum Velocity = 0.75 m/s
Maximum Velocity = 3.65 m/s

Time of Concentration:

Time of Concentration = 10 min

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Guido de Bres Christian High School
Exhibit #2 - 100 Year Post - Development Calculations

MUNICIPALITY: **Hamilton**

Rainfall Intensity Values = A= 2317.400, B= 11.000, C= 0.836

manning's n = 0.013 PVC Pipe; 0.013 Conc Pipe; 0.024 Corr. Stl Pipe; 0.035 Grass Swale

Location: Pipe	Location: From Node	Location: To Node	Length of Pipe (m)	Area: Incre-ment (ha)	Area: Cum Total (ha)	Flow Time: To Upper (min)	Flow Time: In Section (min)	Rainfall Intensity mm/hr	Unit rate of Runoff m^3/ha*day	Design Flows: Cum Flow (m^3/d)	Design Flows: Cum Flow (m^3/s)	Flow Control (m^3/s)	Sewer/Channel Design: Slope (m/m)	Sewer/Channel Design: Capacity Full (m^3/s)	Sewer/Channel Design: Velocity Full (m/s)	Sewer/Channel Design: *Dia/ Depth (m)	Invert Elevations: Up-stream (m)	Invert Elevations: Down-stream (m)	
1	**Area 1**	**Prpty N**	**N/A**	**0.964**	**0.964**	**10.00**	**N/A**	**182**	**50180**	**13295.6**	**0.1539**	**0.1539**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	
Paved	-	-	-	0.098	-	-	-	-	39271.7	3848.6	-	-	-	-	-	-	-	-	
Grass	-	-	-	0.866	-	-	-	-	10908.8	9447.0	-	-	-	-	-	-	-	-	
2	**Area 2**	**XMH. 1**	**N/A**	**0.962**	**0.962**	**10.00**	**N/A**	**182**	**91634**	**35510.3**	**0.4110**	**0.4110**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	
Roof	-	-	-	0.533	-	-	-	-	41453.4	22094.7	-	-	-	-	-	-	-	-	
Paved	-	-	-	0.308	-	-	-	-	39271.7	12095.7	-	-	-	-	-	-	-	-	
Grass	-	-	-	0.121	-	-	-	-	10908.8	1320.0	-	-	-	-	-	-	-	-	
3	**CB. 1**	**MH. 1**	**42.8**	**0.124**	**0.124**	**10.00**	**0.69**	**182**	**50180**	**4614.4**	**0.0534**	**0.0534**	**0.0100**	**0.0328**	**1.0440**	**0.200**	**111.15**	**110.72**	
Paved	-	-	-	0.115	-	-	-	-	39271.7	4516.2	-	-	-	-	-	-	-	-	
Grass	-	-	-	0.009	-	-	-	-	10908.8	98.2	-	-	-	-	-	-	-	-	
4	**CB. 2**	**MH. 1**	**1.5**	**0.087**	**0.087**	**10.00**	**0.03**	**182**	**50180**	**2735.9**	**0.0317**	**0.0317**	**0.0100**	**0.0328**	**1.0440**	**0.200**	**111.30**	**111.28**	
Paved	-	-	-	0.063	-	-	-	-	39271.7	2474.1	-	-	-	-	-	-	-	-	
Grass	-	-	-	0.024	-	-	-	-	10908.8	261.8	-	-	-	-	-	-	-	-	
5	**CB. 3**	**MH. 1**	**1.5**	**0.180**	**0.180**	**10.00**	**0.03**	**182**	**50180**	**4232.6**	**0.0490**	**0.0490**	**0.0100**	**0.0328**	**1.0440**	**0.200**	**111.05**	**111.03**	
Paved	-	-	-	0.080	-	-	-	-	39271.7	3141.7	-	-	-	-	-	-	-	-	
Grass	-	-	-	0.100	-	-	-	-	10908.8	1090.9	-	-	-	-	-	-	-	-	
6	**RWL. 1**	**MH. 1**	**5.5**	**0.109**	**0.109**	**10.00**	**0.08**	**182**	**41453**	**4518.4**	**0.0523**	**0.0523**	**0.0100**	**0.0595**	**1.2115**	**0.250**	**111.35**	**111.29**	
Roof	-	-	-	0.109	-	-	-	-	41453.4	4518.4	-	-	-	-	-	-	-	-	
7	**MH. 1**	**MH. 2**	**120**	**0.000**	**0.500**	**10.69**	**0.83**	**177**	**0**	**16101.4**	**0.1864**	**0.1864**	**0.0050**	**2.7568**	**2.4376**	**1.200**	**109.51**	**108.91**	
8	**MH. 2**	**OGS**	**48.4**	**0.000**	**0.500**	**11.52**	**0.25**	**171**	**0**	**16101.4**	**0.1864**	**0.0506**	**0.0600**	**0.2369**	**3.3510**	**0.300**	**108.85**	**105.94**	
9	**XMH. 1**	**OGS**	**11.5**	**0.000**	**0.962**	**10.00**	**0.11**	**182**	**0**	**35510.3**	**0.4110**	**0.4110**	**0.0100**	**0.2851**	**1.7926**	**0.450**	**105.95**	**105.83**	* Assumed Slope
10	**OGS**	**XMH. 2**	**54.2**	**0.000**	**1.462**	**11.77**	**0.51**	**170**	**0**	**51611.7**	**0.5974**	**0.4616**	**0.0100**	**0.2851**	**1.7926**	**0.450**	**105.80**	**105.25**	* Assumed Slope

Run-off Coefficients Used:

Roof Structure	C =	0.95
Paved Surface	C =	0.90
Grass Surface	C =	0.25

Velocity Range:

Minimum Velocity = 0.75 m/s
Maximum Velocity = 3.65 m/s

Time of Concentration:

Time of Concentration = 10 min

Guido de Bres Christian High School
Exhibit #3 - 5 Year Orifice Plate and
Storage Volume Calcs

Site Data

Site Discharge	Total Flow (m^3/s)	Adj. Flow (to Sewer in Park) (m^3/s)	Adj. Flow (w/o Flow Bypass) (m^3/s)	Total Storm Volume (m^3)
Pre - Develop.	0.3876	0.2684	0.0355	
Post - Develop.	0.4257	0.3385	0.1056	94.0

Control Node Data

Outlet Pipe	Storm Control Node	Outlet Pipe Size (m)	Outlet Invert Elev. (m)	Elev. @ Orifice (m)
8	MH. 2	0.300	108.85	108.91

* Volume calculated using SWMM 5.1 modelling software in accordance with the flow rate for actual size of the orifice.

Head Height 1.43 m **Storm Retention Elev. Check** **110.34 m**

Pipe Storage

Pipes	From Node	To Node	Pipe Length (m)	Design Flow (m^3/s)	Storage Pipe Size (m)	Pipe Capacity (m^3/s)	Dynamic (Pipe %)	Static (Pipe %)	Static Volume (m^3)	Volume Part. Full (m^3)	Inv. El @ Upper (m)	Inv. El @ Lower (m)
7	MH. 1	MH. 2	120.0	0.1056	1.200	2.7568	3.83%	96.17%	130.51	88.67	109.51	108.91
Total			**120.0**						**130.51**	**88.67**		

Node Storage

Outlet Pipe	Node	Lid Elevation (m)	Utility Dimensions Size (m)	Utility Dimensions Area (m^2)	Storage Volume (m^3)
7	MH. 1	112.93	1.800	2.54	2.11
8	MH. 2	112.80	1.800	2.54	3.65
Total					**5.76**

Total Storage = 94.4 m^3 **Required Storage Achieved**

Orifice Diameter Calculation (A=Q/(Cd*sqrt(2*g*h)))

Coefficient of Discharge	Cd =	0.62	(sharp)	0.62 Sharp Orifice coefficient of discharge
Allowable Flow Rate	Q =	0.0355	m^3/s	0.80 Tube coefficient of discharge
Force of Gravity	g =	9.81	m/s/s	
Head Height	h =	1.43	m	
Dia of Max. Orifice	dia =	117.21	mm	Use - 110 mm

Flow Rate for Actual Size of Hole (Q=Cd*A*sqrt(2*g*h))

Area of Orifice	A =	0.0095	m^2
Flow Rate through Orifice	Q =	0.0313	m^3/s

Guido de Bres Christian High School
Exhibit #4 - 100 Year Orifice Plate and Storage Volume Calcs

Site Data

Site Discharge	Total Flow (m^3/s)	Adj. Flow (to Sewer in Park) (m^3/s)	Adj. Flow (w/o Flow Bypass) (m^3/s)	Total Storm Volume (m^3)
Pre - Develop.	0.6840	0.4736	0.0626	
Post - Develop.	0.7512	0.5974	0.1864	182.0

Control Node Data

Outlet Pipe	Storm Control Node	Outlet Pipe Size (m)	Outlet Invert Elev. (m)	Elev. @ Orifice (m)
8	MH. 2	0.300	108.85	108.91

* Volume calculated using SWMM 5.1 modelling software in accordance with the flow rate for actual size of the orifice.

Head Height 3.75 m **Storm Retention Elev. Check** **112.66 m**

Pipe Storage

Pipes	From Node	To Node	Pipe Length (m)	Design Flow (m^3/s)	Storage Pipe Size (m)	Pipe Capacity (m^3/s)	Dynamic (Pipe %)	Static (Pipe %)	Static Volume (m^3)	Volume Part. Full (m^3)	Inv. El @ Upper (m)	Inv. El @ Lower (m)
3	CB. 1	MH. 1	42.8	0.0534	0.200	0.0328	100.00%	0.00%	0	0	111.15	110.72
4	CB. 2	MH. 1	1.5	0.0317	0.200	0.0328	96.55%	3.45%	0	0	111.30	111.28
5	CB. 3	MH. 1	1.5	0.0490	0.200	0.0328	100.00%	0.00%	0	0	111.05	111.03
7	MH. 1	MH. 2	120.0	0.1864	1.200	2.7568	6.76%	93.24%	126.54	126.54	109.51	108.91
Total			**165.8**						**126.54**	**126.54**		

Node Storage

Outlet Pipe	Node	Lid Elevation (m)	Utility Dimensions Size (m)	Area (m^2)	Storage Volume (m^3)
3	CB. 1	112.55	0.600	0.36	0.50
4	CB. 2	112.70	0.600	0.36	0.48
5	CB. 3	112.45	0.600	0.36	0.50
7	MH. 1	112.93	1.800	2.54	8.01
8	MH. 2	112.80	1.800	2.54	9.55
Total					**19.04**

Surface Water Storage

Outlet Pipe	Node	Lid Elevation (m)	Surface Ponding Area (m^2)	Elevation (m)	Storage Volume (m^3)
3	CB. 1	112.55	101.70	112.66	5.59
5	CB. 3	112.45	302.40	112.66	31.75
Total					**37.35**

Total Storage = **182.9 m^3** **Required Storage Achieved**

Orifice Diameter Calculation (A=Q/(Cd*sqrt(2*g*h)))

Coefficient of Discharge	Cd =	0.62 (sharp)	0.62 Sharp Orifice coefficient of discharge
Allowable Flow Rate	Q =	0.0626 m^3/s	0.80 Tube coefficient of discharge
Force of Gravity	g =	9.81 m/s/s	
Head Height	h =	3.75 m	
Dia of Max. Orifice	dia =	122.41 mm	Use - 110 mm

Flow Rate for Actual Size of Hole (Q=Cd*A*sqrt(2*g*h))

Area of Orifice A = 0.0095 m^2

Flow Rate through Orifice Q = 0.0506 m^3/s

APPENDIX ‘A’

EPA SWMM v5.1

Output File

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.012)

Guido de Bres Christian High School, 5yr Storm

****
Element Count
****
Number of rain gages 1
Number of subcatchments ... 1
Number of nodes 2
Number of links 1
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
1	MTHOPE5Y3H	INTENSITY	10 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
Site	0.50	150.00	73.80	1.5000	1	Storage_Facility

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
Park	OUTFALL	100.00	0.00	0.0	
Storage_Facility	STORAGE	101.00	1.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
Outlet	Storage_Facility	Park	ORIFICE			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow

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

****
Analysis Options
****

```
Flow Units ............... LPS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... CURVE_NUMBER
Flow Routing Method ...... DYNWAVE
Starting Date ............ 08/08/2014 00:00:00
Ending Date .............. 08/08/2014 06:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 01:00:00
Routing Time Step ........ 30.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.001524 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         0.023        46.987
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.006        12.063
Surface Runoff ...........         0.017        34.078
Final Storage ............         0.000         0.971
Continuity Error (%) .....        -0.266


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.017         0.170
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         0.016         0.161
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.001         0.009
Continuity Error (%) .....         0.000


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


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


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :    29.50 sec
Average Time Step           :    29.96 sec
Maximum Time Step           :    30.00 sec
Percent in Steady State     :     0.00
```

Average Iterations per Step : 2.00
Percent Not Converging : 0.00

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
Site	46.99	0.00	0.00	12.06	34.08	0.17	105.61	0.725

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
Park	OUTFALL	0.00	0.00	100.00	0 00:00	0.00
Storage_Facility	STORAGE	0.04	0.13	101.13	0 01:51	0.13

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow LPS	Maximum Total Inflow LPS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
Park	OUTFALL	0.00	31.30	0 01:52	0	0.161	0.000
Storage_Facility	STORAGE	105.61	105.61	0 01:40	0.17	0.17	-0.002

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow LPS
Storage_Facility	0.030	4	0	0	0.094	13	0 01:51	31.30

****
Outfall Loading Summary

****

Outfall Node	Flow Freq Pcnt	Avg Flow LPS	Max Flow LPS	Total Volume 10^6 ltr
Park	91.68	8.14	31.30	0.161
System	91.68	8.14	31.30	0.161

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
Outlet	ORIFICE	31.30	0 01:52			0.38

****
Flow Classification Summary
****

	Adjusted	---------- Fraction of Time in Flow Class ----------								
	/Actual		Up	Down	Sub	Sup	Up	Down	Norm	Inlet
Conduit	Length	Dry	Dry	Dry	Crit	Crit	Crit	Crit	Ltd	Ctrl

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Sat Apr 15 14:06:29 2023
Analysis ended on: Sat Apr 15 14:06:29 2023
Total elapsed time: < 1 sec

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.012)

Guido de Bres Christian High School, 100yr Storm

****
Element Count
****
Number of rain gages 1
Number of subcatchments ... 1
Number of nodes 2
Number of links 1
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
1	MTHOPE100Y3H	INTENSITY	10 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
Site	0.50	150.00	73.80	1.5000	1	Storage_Facility

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
Park	OUTFALL	100.00	0.00	0.0	
Storage_Facility	STORAGE	101.00	1.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
Outlet	Storage_Facility	Park	ORIFICE			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow

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

****
Analysis Options
****

```
Flow Units ............... LPS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... CURVE_NUMBER
Flow Routing Method ...... DYNWAVE
Starting Date ............ 08/08/2014 00:00:00
Ending Date .............. 08/08/2014 06:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 01:00:00
Routing Time Step ........ 30.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.001524 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         0.043        86.130
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.011        22.260
Surface Runoff ...........         0.032        63.108
Final Storage ............         0.000         0.929
Continuity Error (%) .....        -0.194


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.032         0.316
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         0.029         0.293
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.002         0.022
Continuity Error (%) .....         0.000


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


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


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :    29.50 sec
Average Time Step           :    29.96 sec
Maximum Time Step           :    30.00 sec
Percent in Steady State     :     0.00
```

```
Average Iterations per Step :     2.00
Percent Not Converging      :     0.00
```

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
Site	86.13	0.00	0.00	22.26	63.11	0.32	186.35	0.733

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
Park	OUTFALL	0.00	0.00	100.00	0 00:00	0.00
Storage_Facility	STORAGE	0.09	0.26	101.26	0 01:53	0.26

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow LPS	Maximum Total Inflow LPS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
Park	OUTFALL	0.00	50.60	0 01:53	0	0.293	0.000
Storage_Facility	STORAGE	186.35	186.35	0 01:40	0.316	0.316	-0.002

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow LPS
Storage_Facility	0.063	9	0	0	0.182	26	0 01:53	50.60

****
Outfall Loading Summary

****

Outfall Node	Flow Freq Pcnt	Avg Flow LPS	Max Flow LPS	Total Volume 10^6 ltr
Park	93.07	14.58	50.60	0.293
System	93.07	14.58	50.60	0.293

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
Outlet	ORIFICE	50.60	0 01:53			1.00

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl

(---------- Fraction of Time in Flow Class ---------- spans Dry through Inlet Ctrl)

****
Conduit Surcharge Summary
****

No conduits were surcharged.

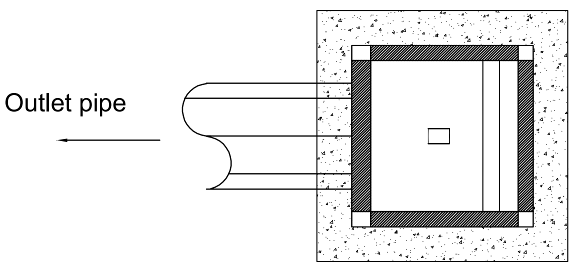
Analysis begun on: Sat Apr 15 14:09:38 2023
Analysis ended on: Sat Apr 15 14:09:38 2023
Total elapsed time: < 1 sec

APPENDIX ‘B’

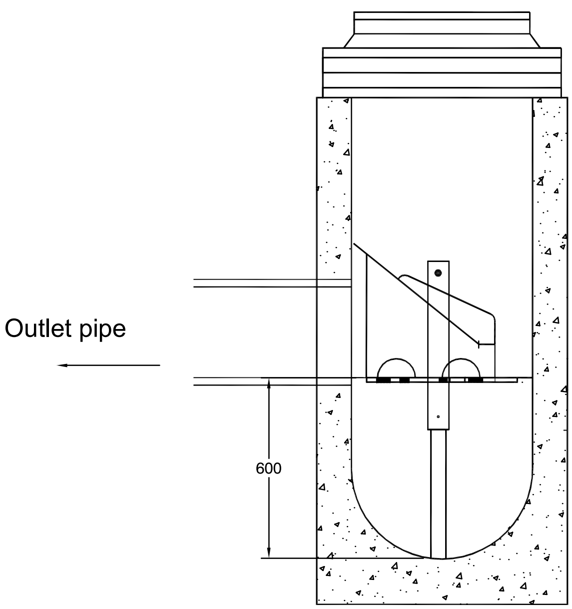
CB Shield Schematics

Notes

1. CB Shield can be installed at any time. In a non frozen condition.
2. The **frame and cover <u>MUST BE</u> well aligned** with the catchbasin for proper installation.
3. The catchbasin sump must be clean before installation
4. The grate should be at the same level as the standing water in the sump.



Top view



Profile view

CB Shield (600mm Sump)

APPENDIX ‘C’

HydroDome HD10

Sizing Calculations and Schematic

Hydroworks Sizing Summary

Guido de Bres Christian High School
350 Albright Road, Hamilton

04-15-2023

Recommended Size: HydroDome HD 10

A HydroDome HD 10 is recommended to provide 70.0 % annual TSS removal based on a drainage area of 1.462 (ha) with an imperviousness of 80.9 % and Hamilton Airport, Ontario rainfall for the ETV Canada particle size distribution.

The recommended HydroDome HD 10 treats 100 % of the annual runoff and provides 72 % annual TSS removal for the Hamilton Airport rainfall records and ETV Canada particle size distribution.

The HydroDome has a siphon which creates a discontinuity in headloss. Since a peak flow was not specified, headloss was calculated using the full pipe flow of .29 (m3/s) for the given 450 (mm) pipe diameter at 1% slope. The headloss was calculated to be 330 (mm) above the crown of the 450 (mm) outlet pipe.

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.

TSS Removal Sizing Summary

Hydroworks Siphon Separator Sizing Program - HydroDome

File Product Units CAD Video Help

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

Site Parameters

Area (ha) 1.462

Imperviousness (%) 80.9

Units

☐ U.S.

☑ Metric

Rainfall Station

Hamilton Airport Ontario

1970 To 2006 Rainfall Timestep = 60 min.

Project Title (2 lines): Guido de Bres Christian High School / 350 Albright Road, Hamilton

Outlet Pipe

Diam. (mm) 450 Slope (%) 1

Peak Design Flow (m3/s)

Lab Sizing Results ☐ Post Treatment Recharge

HydroDome Annual Sizing Results

Model #	Qlow (m3/s)	Qtot (m3/s)	Flow Capture (%)	TSS Removal (%)
Unavailable	.285	.285	100 %	49 %
HD 4	.285	.285	100 %	57 %
HD 5	.285	.285	100 %	63 %
HD 6	.285	.285	100 %	66 %
Unavailable	.285	.285	100 %	68 %
HD 8	.285	.285	100 %	69 %
HD 10	.285	.285	100 %	72 %
HD 12	.285	.285	100 %	74 %

Particle Size Distribution

Size (um)	%	SG
1	5	2.65
3	5	2.65
4	5	2.65
5	1	2.65
6	4	2.65
10	10	2.65
15	5	2.65
35	10	2.65
65	5	2.65
90	10	2.65

Note: Results vary significantly based on particle size distribution

Simulate

TSS Particle Size Distribution

Hydroworks Siphon Separator Sizing Program - HydroDome

File Product Units CAD Video Help

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

TSS Particle Size Distribution

Size (um)	%	SG
1	5	2.65
3	5	2.65
4	5	2.65
5	1	2.65
6	4	2.65
10	10	2.65
15	5	2.65
35	10	2.65
65	5	2.65
90	10	2.65
125	15	2.65
200	15	2.65
325	5	2.65
750	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

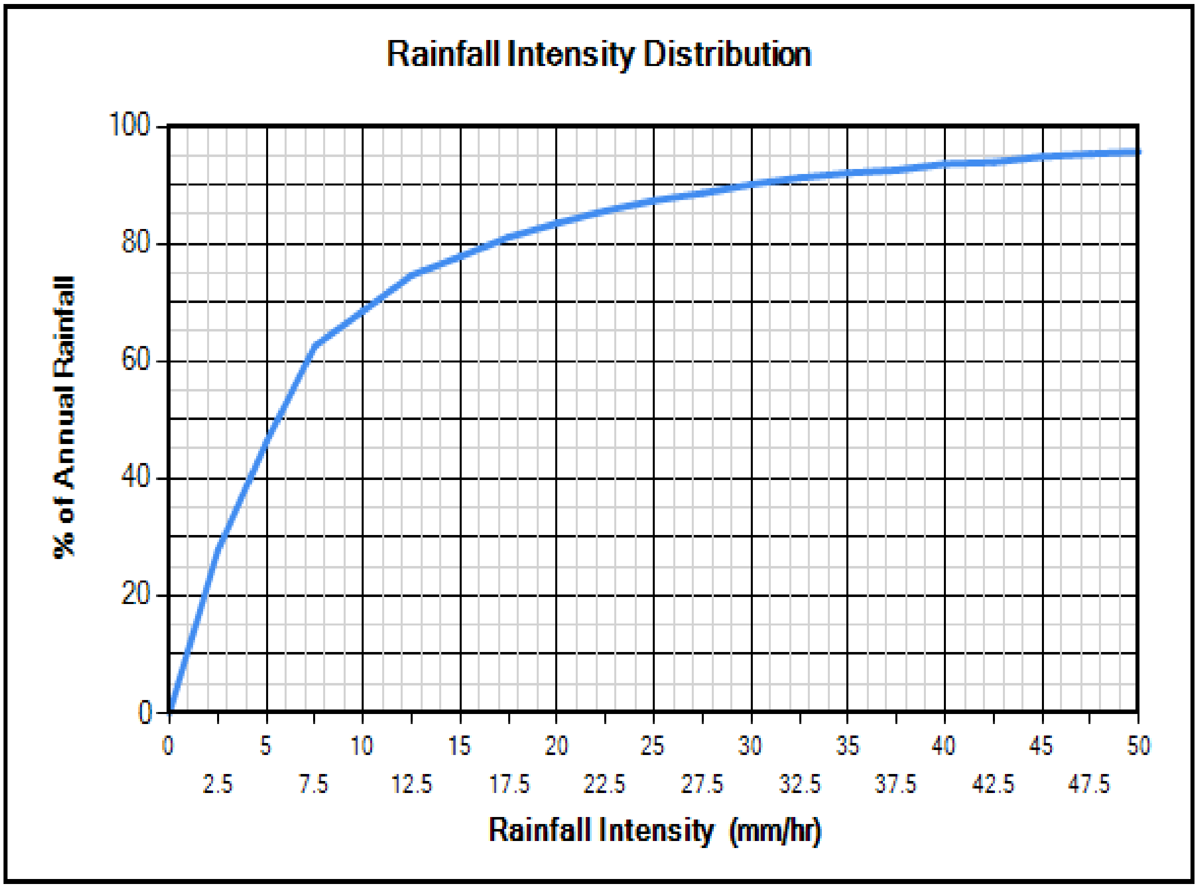
- ○ Standard Design
- ● ETV Canada
- ○ OK110
- ○ Toronto
- ○ Ontario Fine
- ○ Calgary Forebay
- ○ Kitchener
- ○ User Defined

Clear

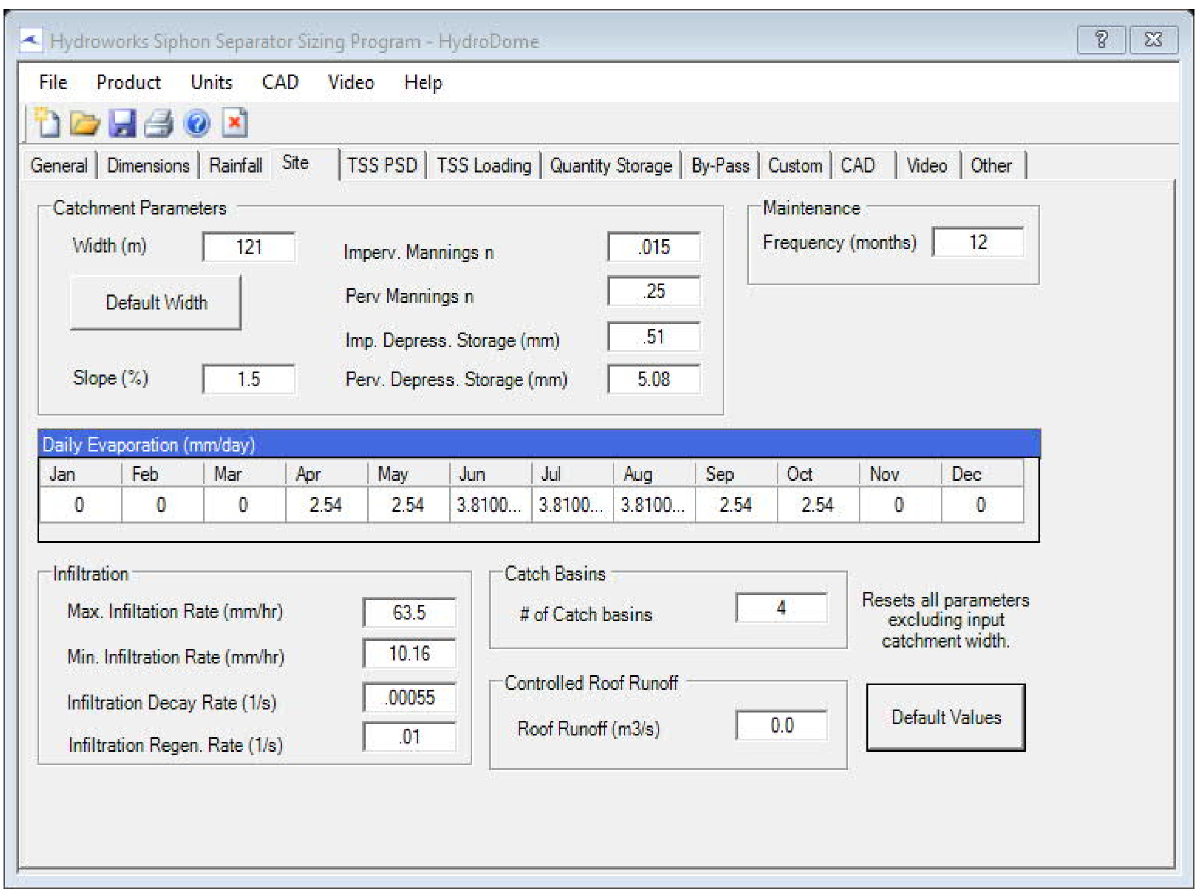
You must select a particle size distribution for TSS to simulate TSS removal

Water Temp (C) 20

Rainfall Station - Hamilton Airport, Ontario(1970 To 2006)



Site Physical Characteristics



Dimensions And Capacities

Hydroworks Siphon Separator Sizing Program - HydroDome

File Product Units CAD Video Help

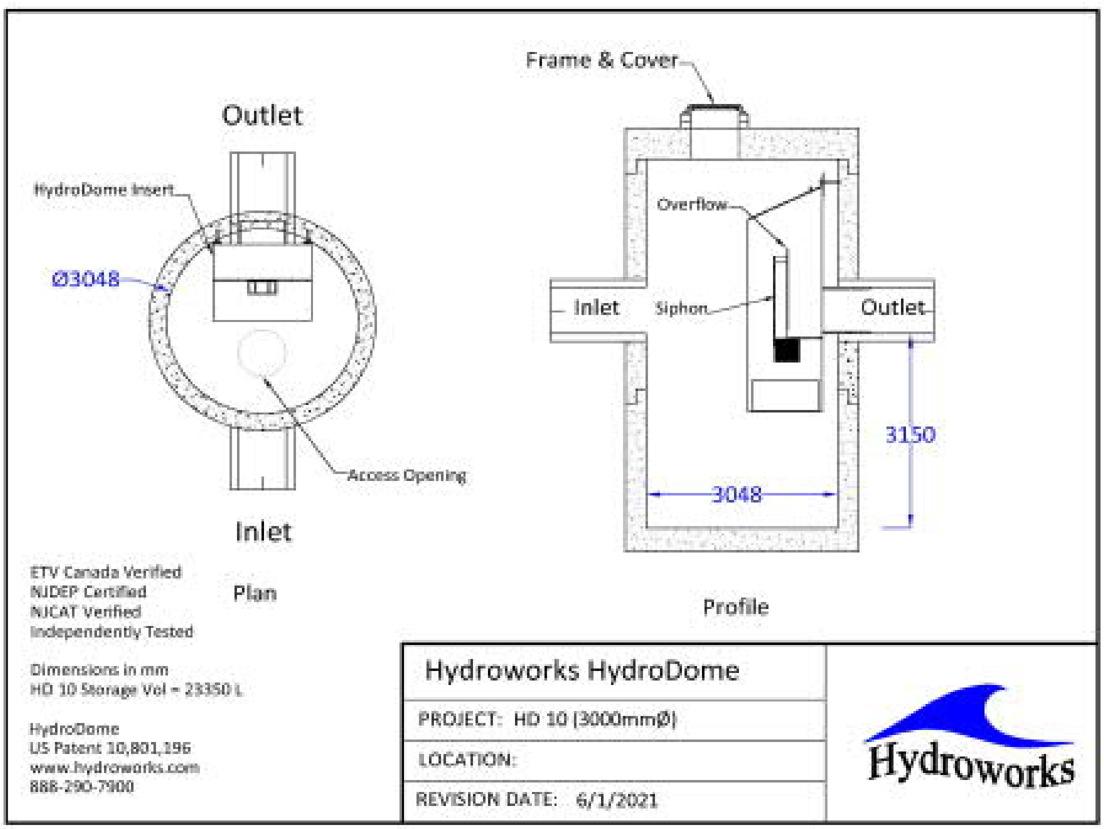
General | Dimensions | Rainfall | Site | TSS PSD | TSS Loading | Quantity Storage | By-Pass | Custom | CAD | Video | Other

Dimensions and Capacities

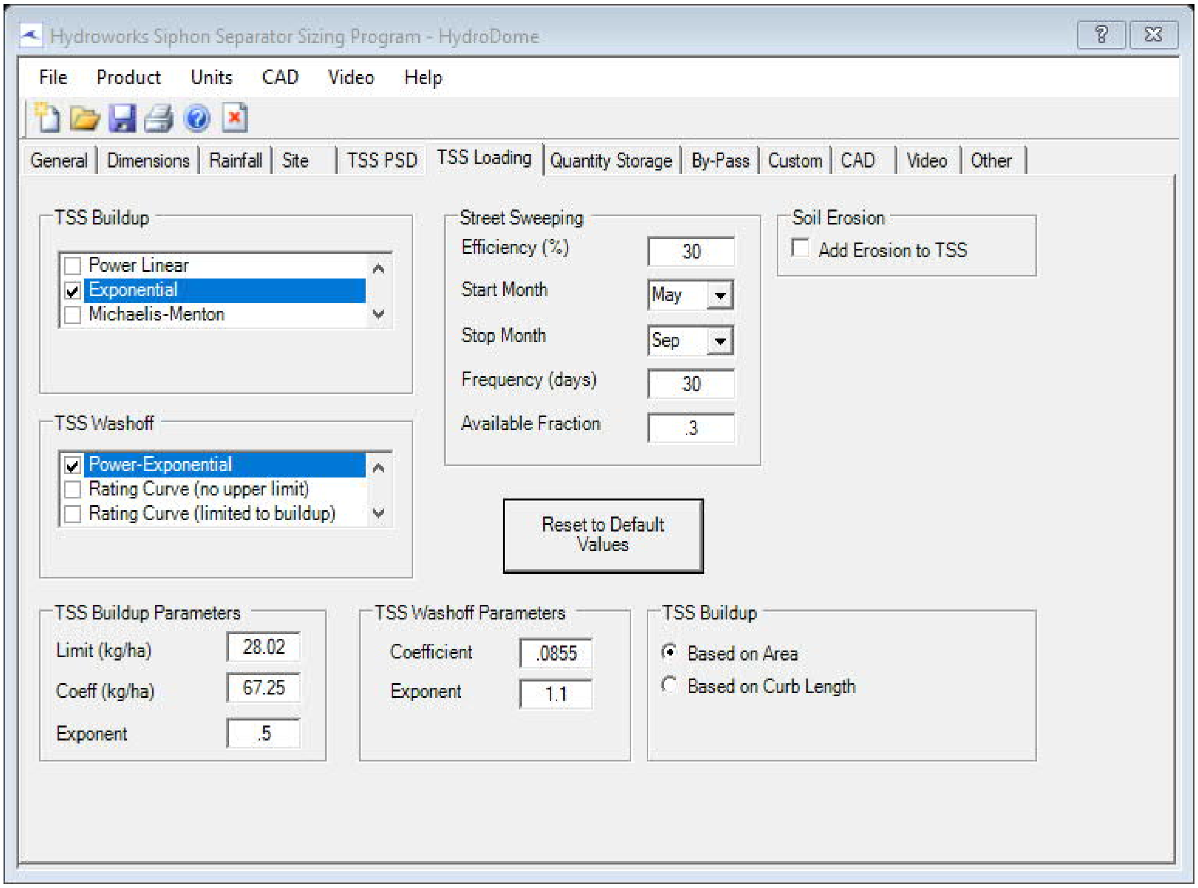
Model	Diam. (m)	Depth (m)	Float. Vol. (L)	Sediment Vol. (m3)	Total Vol. (m3)
Unavailable	0.91	1.52	148	0.7	1
HD 4	1.22	1.68	333	1.2	2
HD 5	1.52	1.83	621	1.9	3.3
HD 6	1.83	1.83	903	2.8	4.8
Unavailable	2.13	1.83	1225	3.8	6.5
HD 8	2.44	1.83	1596	5	8.5
HD 10	3.05	1.83	2503	7.8	13.4
HD 12	3.66	1.83	3613	11.2	19.2

Depth = Depth from outlet invert to inside bottom of tank

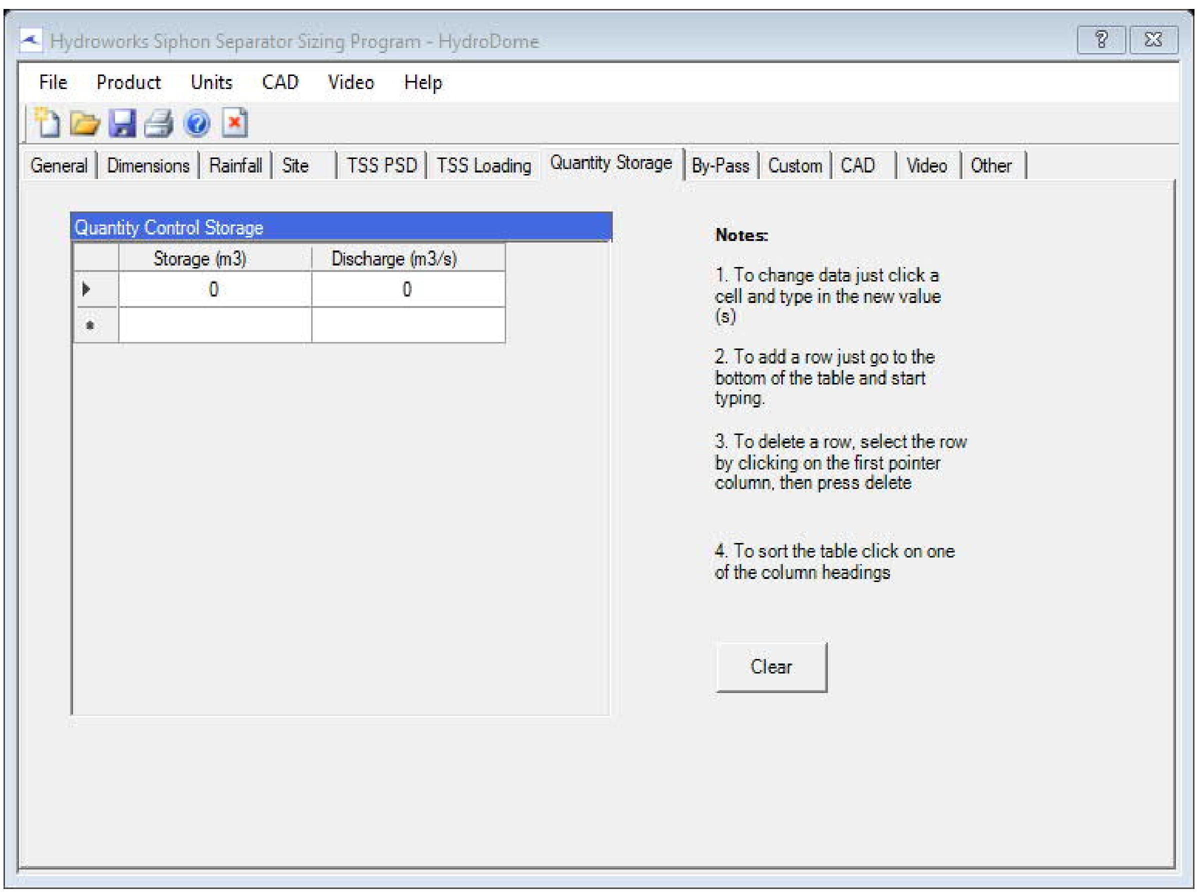
Generic HD 10 CAD Drawing



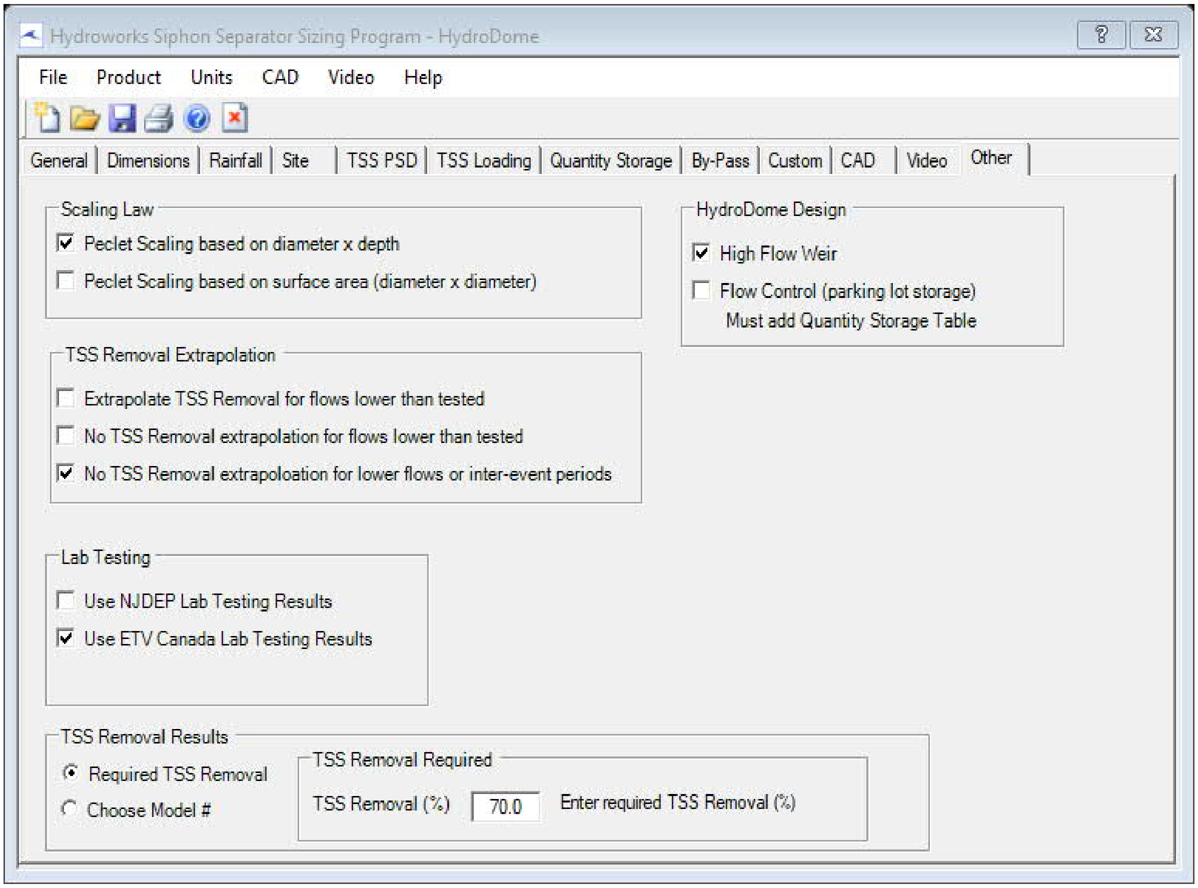
TSS Buildup And Washoff



Upstream Quantity Storage



Other Parameters



Flagged Issues

If there is underground detention storage upstream of the HydroDome please contact Hydroworks to ensure it has been modeled correctly.

Hydroworks Sizing Program - Version 5.6

1-800-290-7900
www.hydroworks.com

Verification Statement

Hydroworks HydroDome HD3 Oil-Grit Separator
Registration number: (V-2021-09-02)
Date of issue: 2021-October-04

Technology type	Oil-Grit Separator		
Application	Technology to remove oil, sediment, trash and debris from storm-water and snowmelt runoff as well as other pollutants that attach to sediment particles, such as nutrients and metals.		
Company	Hydroworks, LLC.		
Address	257 Cox St., Roselle, NJ 07203 USA	**Phone**	+1-888-290-7900
Website	https://hydroworks.com	**E-mail**	gbryant@hydroworks.com

Verified Performance Claims
The Hydroworks HydroDome HD3 Oil-Grit Separator (OGS) was tested by Alden Research Laboratory, Holden, Massachusetts, USA in 2021. The performance test results were verified by 'The Sir Sandford Fleming College of Applied Arts and Technology's Centre for Advancement of Water and Wastewater Technologies' (CAWT) following the requirements of ISO 14034:2016 and the VerifiGlobal Performance Verification Protocol. The following performance claims were verified:

Sediment removal test: The Hydroworks HydroDome HD3 OGS device, with a false floor set to 50% of the manufacturer's recommended maximum sediment storage depth and a constant influent test sediment concentration of 200 mg/L and particle size distribution of 1-1000 µm, removed 83.9, 77.6, 68.4, 66.9, 59.4, 52.4, and 46.0 percent of influent sediment by mass at surface loading rates of 40, 80, 200, 400, 600, 1000, and 1400 L/min/m^2 respectively.

Scour test: The Hydroworks HydroDome HD3 OGS device with 15.2 cm (6 inch) of test sediment preloaded onto a false floor reaching 50% of the manufacturer's recommended maximum sediment sump storage depth, generated corrected effluent sediment concentrations on average of 0.54, 0.70, 0.0, 0.0, and 0.11 mg/L at 5-min duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/m^2, respectively.

Light liquid re-entrainment test: The Hydroworks HydroDome HD3 OGS with surrogate low-density polyethylene beads preloaded within the inner chamber, representing a floating light-liquid volume equal to a depth of 50.8 mm (2 inch) over the sedimentation area, retained 100, 100, 100, 100, and 99.7 percent of loaded beads by mass during the 5-minute duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/m^2, respectively.

The above verified claims can be applied to other units smaller or larger than the tested unit, provided that the untested units meet the scaling rule specified in the Procedure for Laboratory Testing of Oil Grit Separators (Version 3.0, June 2014)

Technology Application

HydroDome is a hydrodynamic separator that provides benefits for both water quality and water quantity (i.e., flow control). HydroDome combines the function of separator, hood, and flow control with active storage to provide a multi-purpose stormwater management solution in one structure. HydroDome also functions as an oil separator due to the submerged inlet design and the fact that the design raises the water level with flow to maximize the distance between any floatables (oil, trash) and the discharge entrance to the HydroDome.

Technology Description

HydroDome comes complete and slides into the outlet pipe from a drainage structure and is secured to the wall with anchor bolts. It consists of a siphon with flow control, that regulates the water level in the structure and the flow rate in the outflow, and an optional high flow weir. A schematic of the Hydroworks HydroDone OGS is shown in Figure 1.

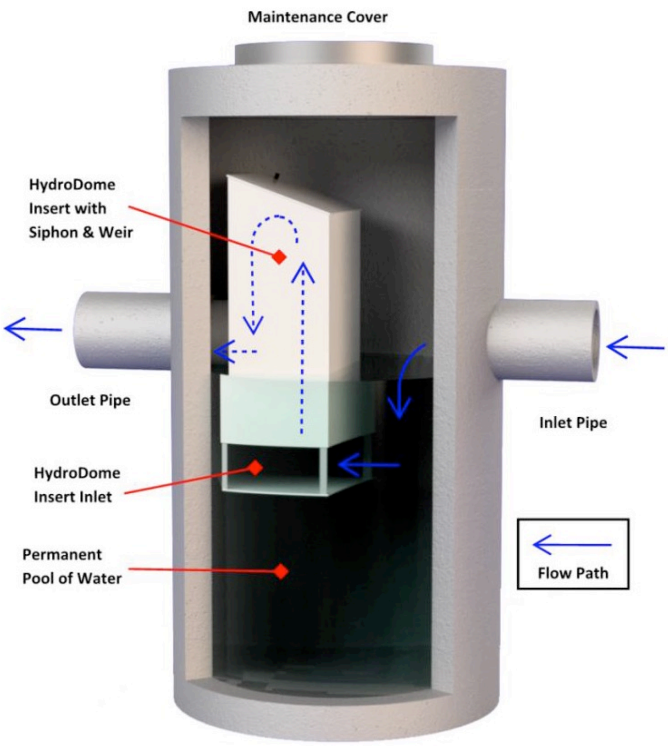


Figure 1: Schematic of the Hydroworks HydroDome Oil-Grit Separator

The siphon raises the water level to a pre-determined level without allowing water to exit the structure. The raised water level provides:
- Greater time for initial total suspended solids (TSS) removal and for floatables to prevent re-entrainment in the flow,
- Additional dilution to reduce effluent concentrations of any pollutants, and
- A greater volume, or buffer, of water to prevent scour of previously settled solids.

Water flows into the device through horizontal openings at the bottom of the HydroDome. Water then must travel upwards through the siphon. A foam filter is located at the entrance to the siphon inlet to provide secondary protection from its clogging (the outer housing of the HydroDome and submerged inlet provide primary protection). Once the water level reaches a pre-determined height, the siphon begins to engage, and water flows out of the structure downstream. The siphon flow is controlled by an orifice, whose size can be changed to provide the desired flow control. The water level continues to rise or begins to lower depending on the rate of flow from the orifice compared to the inflow of water to the structure.

An optional weir above the siphon provides a high flow path to prevent the system from surcharging. In cases where parking lot storage is desired, there would not be a high flow weir. A scour protection plate minimizes scour by preventing upward velocities/flow from the structure floor during periods of peak flow. Therefore, HydroDome combines the function of separator, hood, and flow control with active storage to provide a multi-purpose stormwater management solution in one structure.

Description of Test Procedure

For the purposes of this verification, a Hydroworks HydroDome 3-ft diameter (HD3) stormwater treatment unit was tested. The HD3 test unit was a full-scale 3 ft (0.91 m) diameter tank with an internal treatment hood that included a high flow weir. The test tank was fabricated from plastic and included 18-inch (457 mm) diameter inlet and outlet pipes, oriented along the center-line of the tank. The pipe inverts were located 48 inches (1.22 m) above the sump floor and were set with 1% slopes. The 100% and 50% sediment sump storage depths were 12 inches (0.305 m) and 6 inches (0.152 m), respectively. The effective treatment sedimentation area was 7.07 ft^2 (0.656 m^2).

The test data and results for this verification were obtained from independent testing conducted at Alden Research Laboratory in accordance with the *Procedure for Laboratory Testing of Oil-Grit Separators (Version 3.0, June 2014)*[1]. Use of this procedure is intended to ensure that technologies in this category are subjected to stringent requirements in generating verifiable performance test data.

The verification plan was followed with one minor variance from the *Procedure*. This variance includes the required minimum amount of test sediment to be fed into the test unit for each tested surface loading rate (SLR). Although the *Procedure* requires a minimum of 11.3 kg of test sediment, during the 40 L/min/m^2 SLR test, only 6.45 kg was fed into the unit, which is 4.85 kg less than the specified minimum. This variance to the *Procedure* was agreed to by Toronto and Region Conservation Authority (TRCA), the author of the *Procedure*, based on previous conversations with Alden Labs, noting that the length of time to conduct the test with 11.3 kg of sediment at 40 L/min/m^2 would be over 36 hours.

Verification Results

CAWT verified the performance test data and other information pertaining to the HydroDome HD3 Oil-Grit Separator. A Verification Plan was prepared to guide the verification process based on the requirements of ISO 14034:2016 and the VerifiGlobal Performance Verification Protocol.

The test sediment consisted of ground silica (1 – 1000 micron) with a specific gravity of 2.65, uniformly mixed to meet the particle size distribution specified in the testing procedure.

The “*Procedure for Laboratory Testing of Oil Grit Separators”* (TRCA, 2014) requires that the three-sample average of the test sediment particle size distribution (PSD) meet the specified PSD. The allowable tolerance of 6% variation from the specified PSD curve was met at each discrete particle size tested and the d50 was finer than 75 µm.

Comparison of the individual sample and average test sediment PSD to the specified PSD is shown in Figure 2. This figure indicates that the test sediment used for the removal and scour tests met the above-mentioned criteria. The median particle size was 64 µm.

Samples from test sediment batches used for each run met the specified PSD within the required tolerance thresholds.

The capacity of the HydroDome HD3 device to retain sediment was determined at seven surface loading rates using the modified mass balance method. This method involved measuring the mass and particle size distribution of the injected and retained sediment for each test run.

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[1] The *Procedure for Laboratory Testing of Oil-Grit Separators (Version 3.0, June 2014)* was originally prepared by the Toronto and Region Conservation Authority (TRCA) in association with a 31 member advisory committee from various stakeholder groups.

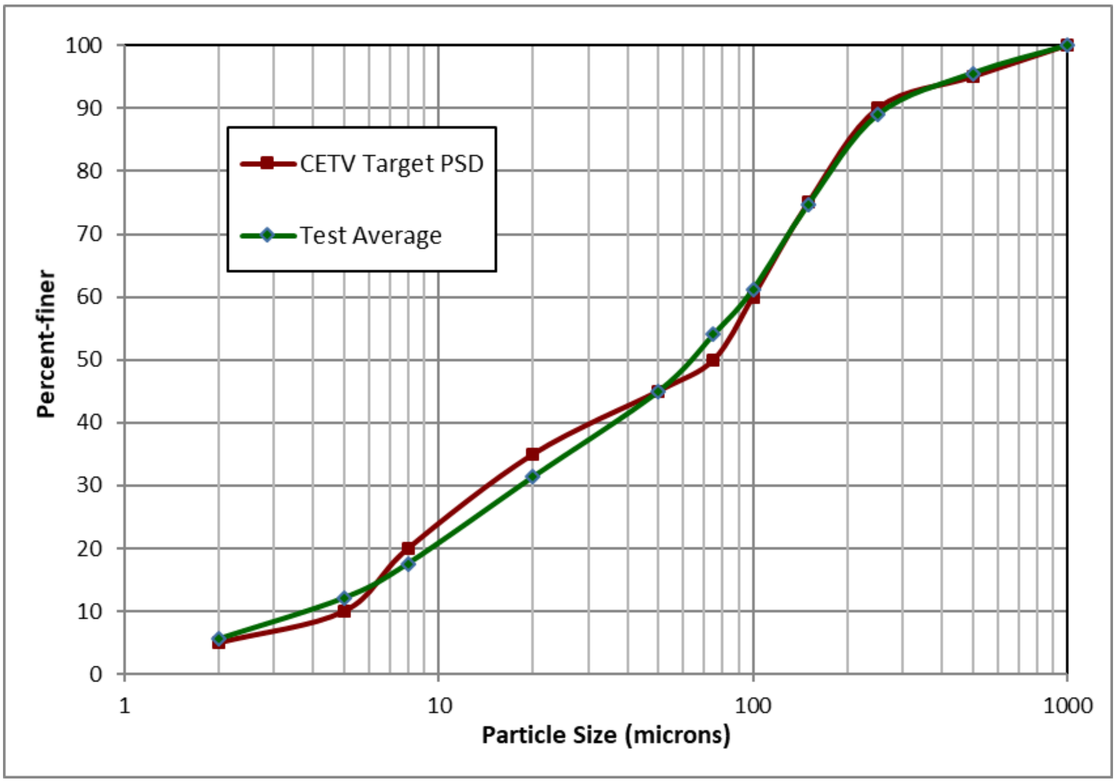

Figure 2 - Average particle size distribution (PSD) of the test sediment used for the sediment removal and scour test compared to the specified PSD

Performance was evaluated with a false floor simulating the technology filled to 50% of the manufacturer's recommended maximum sediment storage depth. The test was carried out with clean water that maintained a sediment concentration below 20 mg/L. Based on these conditions, removal efficiencies for individual particle size classes and for the test sediment, as a whole, were determined for each of the tested surface loading rates (Table 1).

In some instances, the removal efficiencies were above 100% for certain particle size fractions. These discrepancies are not unique to any one test laboratory and are attributed to errors relating to the blending of sediment, collection of representative samples for laboratory submission, and laboratory analysis of PSD. Due to these errors, caution should be exercised in applying the removal efficiencies by particle size fraction for the purposes of sizing the tested device (see Bulletin # CETV 2016-11-0001).

Particle Range (µm)	**40** L/min/m^2	**80** L/min/m^2	**200** L/min/m^2	**400** L/min/m^2	**600** L/min/m^2	**1000** L/min/m^2	**1400** L/min/m^2	**Average**
>500	100%	125%	140%	140%	200%	200%	180%	155%
250-500	114%	129%	150%	143%	143%	183%	217%	154%
150-250	150%	136%	157%	153%	179%	221%	220%	174%
100-150	116%	126%	129%	148%	157%	162%	139%	140%
75-100	136%	155%	178%	190%	180%	170%	133%	163%
50-75	91%	100%	128%	270%	126%	82%	75%	125%
20-50	111%	97%	93%	51%	58%	42%	73%	75%
8-20	75%	79%	38%	34%	29%	17%	26%	42%
5-8	53%	34%	16%	7%	0%	0%	23%	19%
2-5	37%	29%	14%	0%	0%	0%	1%	12%

Table 1 - Removal efficiencies (%) of the HydroDome HD3 Oil-Grit Separator for individual particle size classes at specified surface loading rates

Figure 3 compares the particle size distribution (PSD) of the three-sample average of the test sediment to the PSD of the sediment retained by the HydroDome HD3 OGS device at each of the tested surface loading rates. As expected, the capture efficiency for fine particles was generally found to decrease as surface loading rates increased, particularly in the 400 to 1400 L/min/m^2 range.

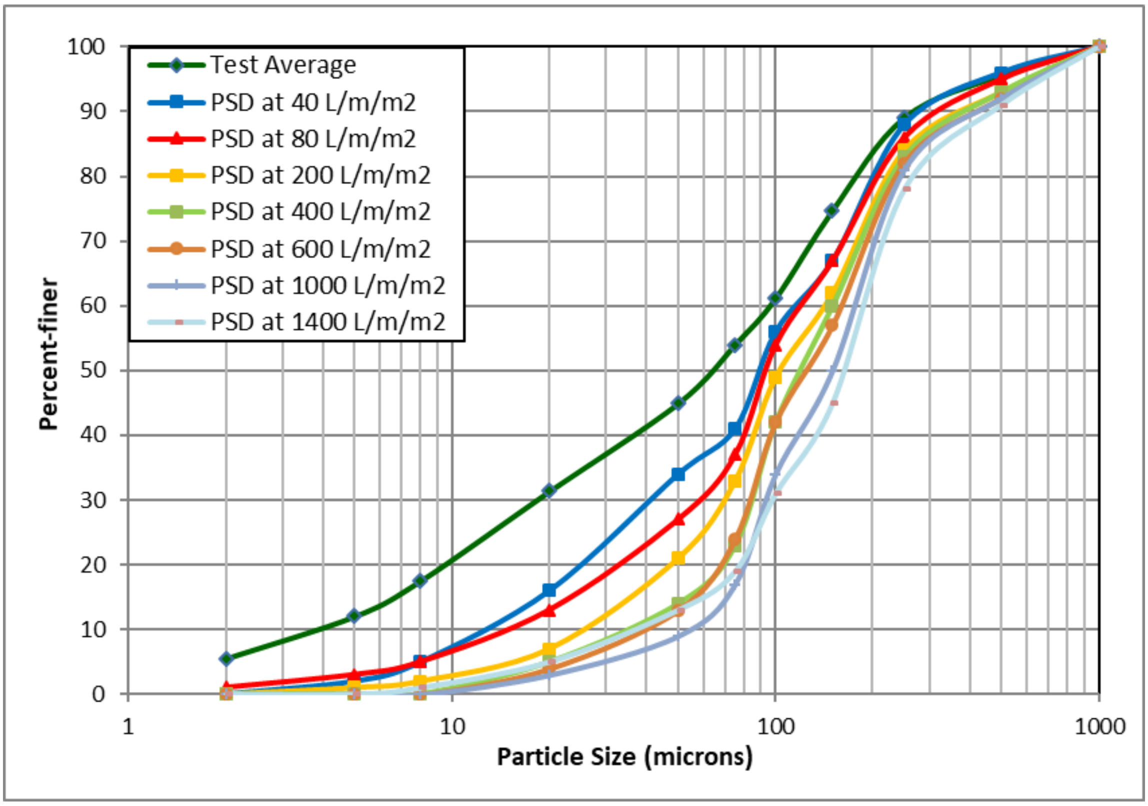

Figure 3 - Particle size distribution of sediment retained in the HydroDome HD3 Oil-Grit Separator in relation to the injected test sediment average

Table 2 shows the results of the sediment scour and re-suspension test for the HydroDome HD3 Oil-Grit Separator unit. The scour test involved preloading 15.2 cm (6 inches) of fresh test sediment into the sedimentation sump of the device. The sediment was placed on a false floor to mimic a device filled to 50% of the maximum recommended sediment storage depth.

Measured Concentration at Each surface Loading Rate					
Effluent Sample No.	200 L/min/m^2	800 L/min/m^2	1400 L/min/m^2	2000 L/min/m^2	2600 L/min/m^2
1	1.2	0.3	0.0	0.0	0.0
2	0.7	0.0	0.0	0.0	0.0
3	0.5	0.0	0.0	0.0	0.5
4	0.1	3.2	0.0	0.0	0.0
5	0.3	0.0	0.0	0.0	0.0
Average	**0.5**	**0.7**	**0.0**	**0.0**	**0.1**

Table 2 - Scour test adjusted effluent sediment concentration at each surface loading rate

Clean water was run through the device at five surface loading rates over a 30-minute period. Each flow rate was maintained for 5 minutes with a one-minute transition time between flow rates. Effluent samples were collected at one minute sampling intervals and analyzed for suspended solids concentration (SSC) and PSD by recognized methods. The effluent samples were subsequently adjusted based on the background concentration of the influent water.

Results showed average adjusted effluent sediment concentrations below 0.7 mg/L at all surface loading rates. The magnitude of scour is dependent on the internal flow patterns (velocity and turbulence) and water volume within the unit, which is related to the depth below the inlet and outlet. The HD3 possessed a large water volume in the sump and consequently, low velocity, which prevented incipient motion of the sediment of sufficient magnitude for scour to occur.

The average measured effluent scour sediment concentrations (adjusted for background) for each tested SLR were not adjusted for particle size based on the D5 of particles captured for the 40 L/min/m^2 removal efficiency test since there was negligible scour.

The capacity of the device to retain light liquid was determined at five surface loading rates in a range between 200 and 2600 L/min/m^2 using low-density polyethylene beads, Dow Chemical Dowlex^{tm} 2517, with a density of 0.917 g/cm^3. This material was specified as the acceptable surrogate to represent floating liquid for a qualitative assessment of liquid behaviour during operation.

Performance was evaluated with a total of 32.8 litres (18.94 kg) of pellets preloaded into the treatment vault by introducing them into the crown of the influent pipe, to a volume equal to a depth of 50.8 mm (2 inch) over the sedimentation area of 0.66 m^2. The effluent was collected in flow-designated nets to allow for quantification of any re-entrained pellets for each test SLR. The collected pellets were dried and the mass of collected pellets was quantified for each SLR, as well as the overall test.

The recorded average flow data, as well as quantified volume and mass of collected pellets for each target SLR and overall test, is shown in Table 3. The maximum re-entrainment of 0.3% occurred at 2600 L/min/m^2. The total retention rate was 99.7%.

Light-liquid Re-Suspension Data				**Starting Volume**	(Liters) **32.8**	**Starting Mass**	(grams) **18938**
Action	**Time Stamp** (minutes)	**Meter**	**Target Flow** (L/min/m^2)	**Recorded Flow** (L/min/m^2)	**COV**	**Collected Mass** (grams)	**Retained Mass**
Start D.A. Recording	0.0						
Flow set	1.0	4"	200	**207**	0.057	0	**100.0%**
Stop Collection	6.0			3.4%			
Flow set	7.0	4"	800	**826**	0.008	0	**100.0%**
Stop Collection	12.0			3.2%			
Flow set	13.0	6"	1400	**1407**	0.009	0	**100.0%**
Stop Collection	18.0			0.5%			
Flow set	19.0	6"	2000	**2022**	0.004	0.3	**100.0%**
Stop Collection	24.0			1.1%			
Flow set	25.0	6"	2600	**2599**	0.003	54.9	**99.7%**
Stop Collection	30.0			-0.1%			
Hydroworks HD 3				Interim Collection Net		1.3	
				Total		**56.5**	**99.7%**

Table 3 - Light-liquid recorded flow and re-entrainment data

Quality assurance

Performance testing and verification of the HydroDome HD3 Oil Grit Separator were performed in accordance with the requirements of ISO 14034:2016 and the VerifiGlobal Performance Verification Protocol. The verifier, CAWT, has confirmed that quality assurance requirements were addressed throughout the performance testing process and in the generation of performance test results. This includes reviewing all data sheets and data downloads, as well as overall management of the test system, quality control and data integrity.

In addition, QA/QC measures are documented in the *"Procedure for Laboratory Testing of Oil-Grit Separators"* (TRCA, 2014) to ensure results are accurate and precise, and that testing conducted by multiple vendors of the same category of technology are employing the same test method. The QA/QC measures include the use of certified laboratories, established test methods, calibration of equipment, tolerance limits for results variation, data checks during testing, and stringent documentation requirements.

Table 4 provides a summary of the acceptance criteria for particle size distribution, solids concentration in test water, water temperature, flow measurement equipment, flow rate variation, sediment feed, sediment moisture content, and sample analysis.

QC Parameter	Acceptance Criteria
Particle Size Distribution	Analyzed by a certified laboratory in accordance with ASTM D422-63(2007)e1. Percentages for size ranges vary by <6%, median < 75 um. PSD in water determined by ASTM D422-63(2007)e1 upon prior drying in designated pre-weighed nonferrous trays in compliance with ASTM D4959-07.
Solids concentration in test water	Suspended solids concentration (SSC) concentration of test water of less than 20 mg/L.
Water temperature	Temperature of water less than 25ºC.
Flow measurement equipment	Equipment calibration reports submitted to confirm that reported flow rate match actual flow rate. Flow rates from calibrated flow instruments recorded at no longer than 30 second intervals over the duration of the test.
Flow rate variation	Flow rates have COV < 0.04; maintained with ±10% of target flow rate.
Sediment feed	TSS concentration target = 200 mg/L with a tolerance limit of ±25 mg/L. Injection location is 5 pipe diameters upstream of the inlet to the device, as per the *Procedure*. Six calibration samples taken over duration of each test run. The allowed Coefficient of Variance (COV) for the measured samples was 0.10.
Sediment moisture content	Determined by ASTM D4959-07 "Standard Test Method for Determination of Water (Moisture) Content of Soil By Direct Heating".
Sample analysis	Conducted by qualified laboratories using standard methods and meeting the requirements of ISO.

Table 4. Validation of QA/QC procedures

Summary of Verification Results and Verified Performance Claim for Hydroworks HydroDome HD3 Oil-Grit Separator (OGS)

In summary, the HydroDome HD3 Oil Grit Separator is designed to remove oil, sediment, trash and debris from stormwater and snowmelt runoff as well as other pollutants that attach to sediment particles, such as nutrients and metals. Verification of performance claims for the Hydroworks HydroDome HD3 Oil Grit Separator was conducted by CAWT based on independent third-party performance test results provided by Alden Research Laboratory, as well as additional information provided by Hydroworks.

Table 5 summarizes the verification results in relation to the technology performance parameters that were identified to determine the efficacy of the HydroDome HD3 Oil Grit Separator. The claims stated in Table 5 were verified using the modified mass balance method for sediment removal by measuring the total mass of sediment entering the unit and retained by the unit at prescribed surface loading rates. Effluent sampling was conducted every minute over a 30-minute duration for the scour test, using approved sampling methods as per the verification procedure. The light liquid re-entrainment test was conducted using a mass balance methodology which accounted for all the beads input, captured, and scoured from the separator.

Parameters	Verified Claims	Accuracy
Sediment Removal	During the sediment removal test, the Hydroworks HydroDome HD3 OGS device, with a false floor set to 50% of the manufacturer's recommended maximum sediment storage depth and a constant influent test sediment concentration of 200 mg/L and particle size distribution of 1-1000 µm, removed 83.9, 77.6, 68.4, 66.9, 59.4, 52.4, and 46.0 percent of influent sediment by mass at surface loading rates of 40, 80, 200, 400, 600, 1000, and 1400 L/min/m^2 respectively	The sediment removal characteristics were quantified at various surface loading rates (SLRs), including particle size fractions, using a modified mass balance methodology. Performance results are presented as the true values.
Sediment Scour	During the scour test, the Hydroworks HydroDome HD3 OGS device with 15.2 cm (6 inch) of test sediment preloaded onto a false floor reaching 50% of the manufacturer's recommended maximum sediment sump storage depth, generated corrected effluent sediment concentrations on average of 0.54, 0.70, 0.0, 0.0, and 0.11 mg/L at 5-min duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/m2, respectively.	5 samples analyzed for sediment (n=5) at each flow rate There was negligible scour once corrected for background concentrations.
Light Liquid Re-entrainment	During the light-liquid re-entrainment test, the Hydroworks HydroDome HD3 OGS with surrogate low-density polyethylene beads preloaded within the inner chamber, representing a floating light-liquid volume equal to a depth of 50.8 mm (2 inch) over the sedimentation area, retained 100, 100, 100, 100, and 99.7 percent of loaded beads by mass during the 5-minute duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/m^2, respectively.	Performance results are presented as the true values. Under the "Procedure for Laboratory Testing of Oil-Grit Separators" (TRCA, 2014), the light-liquid re-entrainment test is also not amenable to statistical analysis as the tests were only conducted once at various flow rates following a mass balance procedure.

Table 5. Verified performance claims

What is ISO 14034?

The purpose of environmental technology verification is to provide a credible and impartial account of the performance of environmental technologies. Environmental technology verification is based on a number of principles to ensure that verifications are performed and reported accurately, clearly, unambiguously and objectively. The International Organization for Standardization (ISO) standard for environmental technology verification (ETV) is ISO 14034, which was published in November 2016.

Benefits of ETV

ETV contributes to protection and conservation of the environment by promoting and facilitating market uptake of innovative environmental technologies, especially those that perform better than relevant alternatives. ETV is particularly applicable to those environmental technologies whose innovative features or performance cannot be fully assessed using existing standards. Through the provision of objective evidence, ETV provides an independent and impartial confirmation of the performance of an environmental technology based on reliable test data. ETV aims to strengthen the credibility of new, innovative technologies by supporting informed decision-making among interested parties.

For more information on the HydroDome Oil Grit Separator, contact:	For more information on VerifiGlobal, contact:
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Signed for Hydroworks: Graham Bryant Owner	Signed for VerifiGlobal: Thomas Bruun Managing Director John Neate Managing Director

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