S. LLEWELLYN & ASSOCIATES LIMITED
CONSULTING ENGINEERS

Functional Servicing & Stormwater Management Report

OAKWOOD DRIVE DEVELOPMENT

BRANTHAVEN BELMONT OAKWOOD INC.

CITY OF NIAGARA FALLS

JULY 2022
REVISED OCTOBER 2022
SLA File: 21077

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1.0 INTRODUCTION AND BACKGROUND

1.1 OVERVIEW

S. Llewellyn & Associates Limited has been retained by Branthaven Belmont Oakwood Inc. to provide Consulting Engineering services for the proposed development on Oakwood Drive in the City of Niagara Falls (see Figure 1.0 for location plan). This report will outline the functional servicing strategy for the proposed development.

The proposed development consists of constructing 12 2-storey townhouse blocks containing 69 units and 21 3-storey townhouse blocks containing approximately 167 units. The proposed site will also include asphalt parking/driveways, concrete curbing/sidewalk and landscaped areas.

This report will provide detailed information of the proposed servicing and stormwater management scheme for this development. Please refer to the preliminary engineering plans prepared by S. Llewellyn and Associates Limited and the site plan prepared by Orchard Design Studio Inc. for additional information.

1.2 BACKGROUND INFORMATION

The following documents were referenced in the preparation of this report:

Ref. 1: MOE Stormwater Management Practices Planning and Design Manual (Ministry of Environment, March 2003)

Ref. 2: Engineering Design Guidelines Manual (City of Niagara Falls, April 2016)

Ref. 3: MOE Design Guidelines for Drinking-Water Systems (Ministry of Environment, 2008)

Ref. 4: Stormwater Management Guidelines (Niagara Peninsula Conservation Authority, (March 17, 2010)

Ref. 5: Erosion & Sediment Control Guidelines for Urban Construction (December 2006)

Figure 1.0 – Location Plan

2.0 STORMWATER MANAGEMENT

The following stormwater management (SWM) criteria will be applied to the site, in accordance with the City of Niagara Falls, Region of Niagara and Niagara Peninsula Conservation Authority:

Quantity Control

Stormwater quantity controls have not been implemented for the development due to the close proximity between the proposed development and the storm sewer outlet to the Hydro Canal.

Quality Control

The stormwater runoff from the proposed site must meet Level 2 (Normal) stormwater quality control (70% TSS removal, 80% average annual runoff treatment).

Erosion Control

Erosion and sediment control measures will be implemented in accordance with the standards of the City of Niagara Falls and Niagara Peninsula Conservation Authority.

2.1 EXISTING CONDITIONS

In the existing conditions, the 5.45-hectare site is a vacant lot, which is entirely covered by tall grass and existing trees. The site is bound by Oakwood Drive to the north and west, the Hydro Canal to the east and existing commercial lands to the south. An existing 1650mmø storm sewer is located within the existing easement located along the south limits of the property.

The topography of the existing site generally slopes inward with the majority of the property sheet draining to the existing catchbasin at the northeast corner of the property. The remainder of the site sheet drains to the west and south onto the Oakwood Drive right-of-way and adjacent lands.

One catchment area, Catchment 101, has been identified in the existing condition. Catchment 101 represents the drainage area for the entire site which ultimately discharges to the Hydro Canal east of the subject lands. See Table 2.1 below and the Pre-Development Storm Drainage Area Plan in Appendix A for details.

Table 2.1 – Existing Condition Catchment Areas

Catchment ID	Description	Area (ha)	Percent Impervious	Run-off Coefficient
101	Entire Site	5.45	0	0.25

The existing conditions discharge from the development was calculated using the Rational Method based on the above runoff coefficient (C) and the City of Hamilton storm intensities at a time of concentration of 10 minutes (Tc=10min). An example of the 2-year calculation for Catchment 101 is shown below and a summary can be found in Table 2.2.

$Q_{2\text{-yr (Catchment 101)}}$ = 2.78 C i A
= 2.78 (0.25) (65.94 mm/hr) (5.45 ha)
= ***249.6 l/s (0.2496 m^3/s)***

Table 2.2 – Existing Conditions Stormwater Discharge

Storm Event	Catchment 101 (m^3/s)
2-Yr Event	0.2496
5-Yr Event	0.3180
10-Yr Event	0.4041
25-Yr Event	0.4195
100-Yr Event	0.5063

2.2 PROPOSED CONDITIONS

The proposed development consists of constructing 19 2-storey townhouse blocks containing 12 2-storey townhouse blocks containing 69 units and 21 3-storey townhouse blocks containing approximately 167 units. The proposed site will also include asphalt parking/driveways, concrete curbing/sidewalk and landscaped areas. It is proposed to service the site with a private storm sewer system designed and constructed in

accordance with the standards and specifications of the City of Niagara Falls and Niagara Region.

Two catchment areas, Catchment 201 and 202, have been identified in the proposed condition. Catchment 201 represent the drainage area for the majority of the site which will be captured by the private storm sewer system connected to the existing 1650mmø storm sewer within the easement along the south property limits ultimately discharging approximately 160m east to the Hydro Canal. Catchment 202 represents the drainage area for the remainder of the site which will sheet drain to the Oakwood Drive right-of-way. Refer to Table 2.3 below and the Post-Development Storm Drainage Area Plan in Appendix A for details.

Table 2.3 – Proposed Condition Catchment Areas

Catchment ID	Description	Area (ha)	Percent Impervious	Run-off Coefficient
201	To 1650mmø Storm Sewer	5.33	70	0.70
202	To Oakwood Drive Right-of-Way	0.12	70	0.70

The maximum discharge rates for Catchments 201 and 202 were calculated using the Rational Method based on the proposed condition runoff coefficients for the 2-year to 100-year storm events. The proposed discharge rates are summarized in Table 2.4 below.

Table 2.4 – Proposed Condition Stormwater Discharge

Storm Event	Catchment 201 Discharge (m^3/s)	Catchment 202 Discharge (m^3/s)	Total Discharge (m^3/s)
2-Yr Event	0.6834	0.0154	0.6988
5-Yr Event	0.8708	0.0196	0.8904
10-Yr Event	1.1065	0.0249	1.1314
25-Yr Event	1.1486	0.0259	1.1745
100-Yr Event	1.3865	0.0312	1.4177

Water Quantity Control

It is proposed that stormwater quantity controls not be implemented for this development due to the close proximity of the site to the Hydro Canal (approximately 160m). Given the size and capacity of the existing municipal storm sewers within the existing easement which is being used to service the site, post development peak storm flows will discharge the site, enter and be conveyed through the adjacent storm sewers to the Hydro Canal prior to the overall watershed peak flows reaching the point of confluence.

Water Quality Control

The proposed development is required to achieve a “Normal” (70% TSS removal) level of water quality protection. To achieve this criteria, discharge from Catchment 201 will be subject to treatment from a HydroStorm oil/grit separator before ultimately discharging to the existing 1650mmø storm sewer. The HydroStorm sizing software was used to determine the required size of oil/grit separator unit for the site. It was determined that a

HydroStorm HS8 will provide 71% TSS removal and 95% average annual runoff treatment. See HydroStorm unit sizing procedures in Appendix B for details.

HydroStorm units require regular inspection and maintenance as per the manufacture's specifications to ensure the units operate properly. See HydroStorm maintenance manuals in Appendix B for details.

2.3 SEDIMENT AND EROSION CONTROL

In order to minimize erosion during the grading and site servicing period of construction, the following measures will be implemented:

- Install silt fencing along the outer boundary of the site to ensure that sediment does not migrate to the adjacent properties;
- Install sediment control (silt sacks) in the proposed catchbasins as well as the nearby existing catchbasins to ensure that no untreated runoff enters the existing conveyance system
- Stabilize all disturbed or landscaped areas with hydro seeding/sodding to minimize the opportunity for erosion.

To ensure and document the effectiveness of the erosion and sediment control structures, an appropriate inspection and maintenance program is necessary. The program will include the following activities:

- Inspection of the erosion and sediment controls (e.g. silt fences, sediment traps, outlets, vegetation, etc.) with follow up reports to the governing municipality; and
- The developer and/or their contractor shall be responsible for any costs incurred during the remediation of problem areas.

For details on the proposed erosion and sediment control for the proposed site, see the Erosion & Sediment Control Plan included in the engineering drawings.

3.0 SANITARY SEWER SERVICING

3.1 EXISTING CONDITIONS

The site is located on Oakwood Drive, south of McLeod Road. An existing 300mmø sanitary sewer and a 1350mmø trunk sanitary sewer is located within the existing easements along the east and south limits of the property.

3.2 SANITARY DEMAND

Wastewater generation for the site was estimated in accordance with the City of Niagara Falls Engineering Design Guidelines. Table 3.1 summarizes the sanitary sewer discharge rate from the propose site.

Table 3.1 – Proposed Sanitary Sewer Discharge					
RDII[1] (l/s)	DWF[2] (l/s)	**Peak DWF[3] (l/s)**	WWF Beg.[4] (l/s)	WWF End[5] (l/s)	**Peak WWF[6] (l/s)**
1.56	5.22	**26.1**	5.29	6.78	**27.7**

Population = 236 units x 3 persons/unit = 708 persons
Peaking Factor = ($5/P^{0.2}$) with P expressed in thousands = 5.0
Dry Weather Infiltration = Area x Infiltration Rate = 5.45 ha x 0.28 l/ha/s = 1.53 l/s
[1]RDII (Rain Derived Inflow and Infiltration) = Area x 0.286 l/ha/s = 5.45 ha x 0.286 l/s = 1.56 l/s
[2]DWF (Dry Weather Flow) = Average Sanitary Flow + Dry Weather Infiltration = (average daily per capita flow x population) + Dry Weather Infiltration = (450 l/cap/day x 708 persons) + 1.53 l/s = 5.22 l/s
[3]Peak DWF = DWF x Peaking Factor = 5.22 l/s x 5.0 = 26.1 l/s
[4]WWF (Wet Weather Flow) Beginning of Sewer Lifecycle = DWF + Allowable Leakage (0.075 L/mm/100m of sewer per hour) = 5.22 l/s + (((0.075 x 250 x (1290/100))/60)/60) = 5.22 l/s + 0.067 l/s = 5.29 l/s
[5]WWF (Wet Weather Flow) End of Sewer Lifecycle = DWF + Inflow and All Infiltration (Dry Weather and Rain Derived) = 5.22 l/s + 1.56 l/s = 6.78 l/s
[6]Peak WWF = Peak DWF + RDII = 26.1 l/s + 1.56 l/s = 27.7 l/s

3.3 PROPOSED SANITARY SERVICING AND CAPACITY ANALYSIS

The proposed townhouse development will be serviced by a private 250mmø sanitary sewer, designed and constructed in accordance with the standards and specifications of the City of Niagara Falls and Niagara Region. Discharge from this sewer will ultimately discharge to the existing 1350mmø sanitary trunk sewer within the existing easement along the south limits of the property.

The minimum grade of the proposed 250mmø sanitary sewer will be 0.5%. At this minimum grade, the proposed sanitary sewer will have a capacity of 0.042 m^3/s (42 l/s). Therefore, the proposed 250mmø sanitary sewer at 0.5% grade is adequately sized to service the proposed development.

4.0 DOMESTIC AND FIRE WATER SUPPLY SERVICING

4.1 EXISTING CONDITIONS

The existing municipal water distribution system consists of a 300mmø watermain located along Oakwood Drive. Three existing fire hydrants in close proximity to the property are also located along Oakwood Drive fronting the subject lands.

4.2 DOMESTIC WATER DEMAND

The following is an estimate of the water usage for the proposed development. Water usage for the site was estimated in accordance with the Ministry of the Environment Design Guidelines for Drinking-Water Systems. Table 4.1 below summarizes the domestic water demand requirements for the Average Daily, Maximum Daily and Peaking Hourly demand scenarios.

Table 4.1 – Proposed Domestic Water Demand					
Population[1]	Average Daily Demand[2] (l/s)	Max. Daily Peaking Factor[3]	Max. Hourly Peaking Factor[4]	**Max Daily Demand[5] (l/s)**	**Max Hourly Demand[6] (l/s)**
708	2.95	2.75	4.13	**8.11**	**12.2**

[1]Population = 236 units x 3 persons/unit = 708 persons
[2]Average Daily Demand = (270 l/cap/day + 450 l/cap/day)/2 = 360 l/cap/day x population
[3]Max. Daily Peaking Factor = 2.75 (refer to Table 3-1 from MOE Manual)
[4]Max. Hourly Peaking Factor = 4.13 (refer to Table 3-1 from MOE Manual)
[5]Max. Daily Demand = Average Daily Demand x Max. Daily Peaking Factor
[6]Max. Hourly Demand = Average Daily Demand x Max. Hourly Peaking Factor

4.3 FIRE FLOW DEMAND

Fire flow demands for development are governed by a number of guidelines and criteria, such as the Water Supply for Public Fire Protection (Fire Underwriters Survey, 2020), Ontario Building Code (OBC), various codes and standards published by the National Fire Protection Association (NFPA). The required fire flow is for the proposed development is based on the "worst-case scenario", in terms of required fire flow.

At this stage of development, it was assumed that the proposed townhouse blocks will be constructed of wood frame construction (C=1.5), with limited combustible occupancy (-15% correction).

It was determined that the required fire flow for the "worst-case scenario" is **20000 l/min (333 l/s).** See Fire Flow Demand Requirements in Appendix C for calculations and details.

There are currently no hydrant flow tests available for the existing municipal hydrants. Flow tests will be completed upon detailed design to determine if the existing municipal distribution system has sufficient capacity to service the proposed development.

In the event the required fire flow exceeds the flow that are provided from the existing municipal system, it is recommended that fire walls be constructed within the proposed townhouse blocks.

Additional private fire hydrants will be required to meet the required 90m separation to the building face of the proposed townhouse blocks (as per Sentence 3.2.5.7 of the 2012 Ontario Building Code).

4.4 PROPOSED WATER SERVICING AND ANALYSIS

Proposed water servicing for the site consists of looping a 300mmø watermain through the proposed development and connecting to the existing 300mmø watermain adjacent to the site on Oakwood Drive. The proposed 300mmø watermain will provide domestic and fire water service for the proposed townhouse development. Water services for the site are to be designed and constructed in accordance with City of Niagara Falls and Niagara Region standards.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the information provided herein, it is concluded that the proposed development on Oakwood Drive can be constructed to meet the requirements of the City of Niagara Falls, Niagara Region and Niagara Peninsula Conservation Authority. Therefore, it is recommended that:

- The development be graded and serviced in accordance with the Preliminary Grading Plan and the Preliminary Servicing Plan prepared by S. Llewellyn & Associates Limited;

- Erosion and sediment controls be installed as described in this report and as per the Erosion & Sediment Control Plan to meet City of Niagara Falls and Niagara Peninsula Conservation Authority requirements;

- HydroStorm HS8 oil/grit separators be installed as per the Preliminary Servicing Plan and this report to provide efficient stormwater quality control;

- The proposed sanitary and water servicing system be installed as per the Preliminary Servicing Plan and this report to adequately service the proposed development;

We trust the information enclosed herein is satisfactory. Should you have any questions please do not hesitate to contact our office.

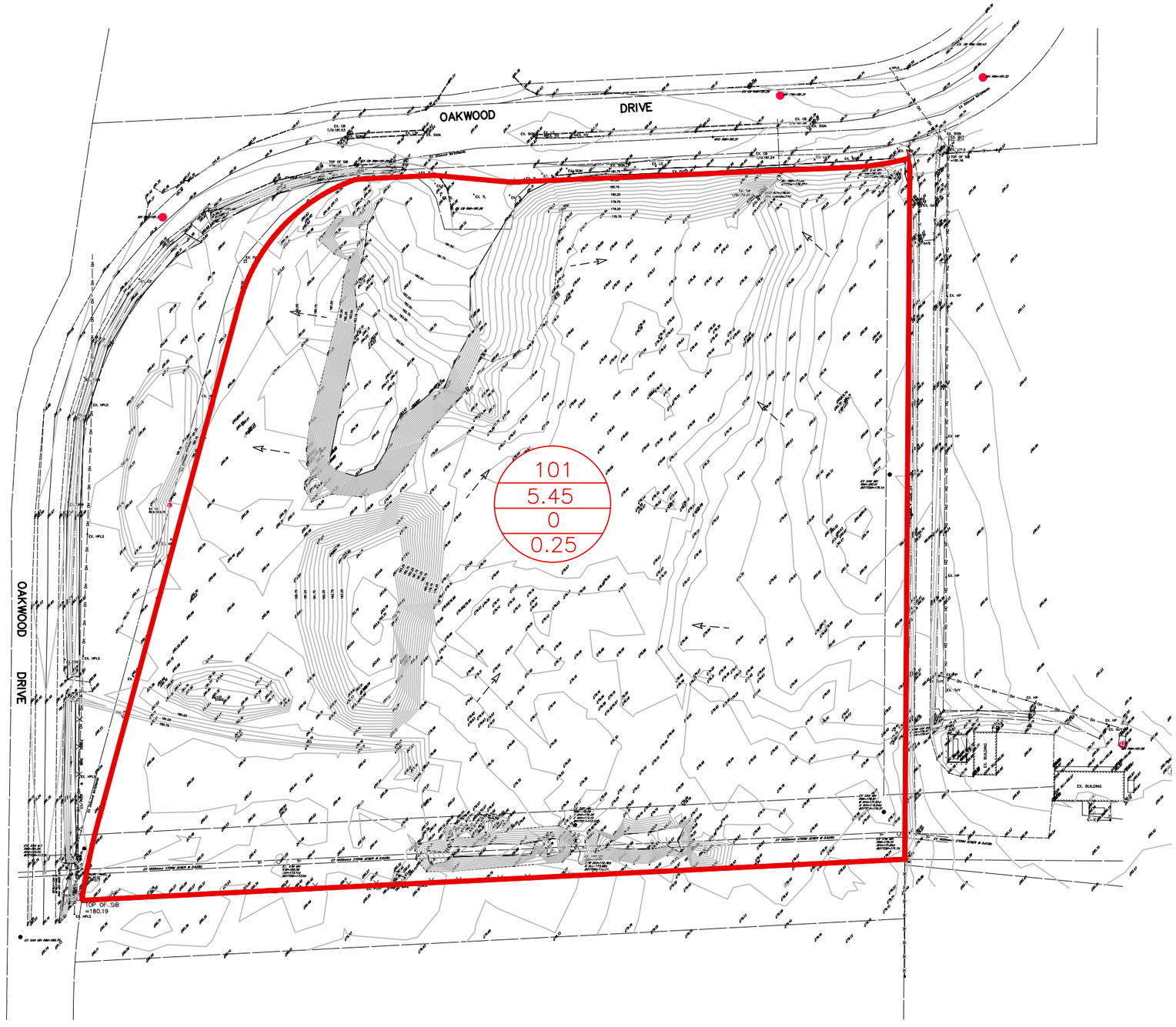
Prepared by:
S. LLEWELLYN & ASSOCIATES LIMITED

M. Colosimo, Dipl. T.

S. Frankovich, P.Eng.

APPENDIX A

STORMWATER MANAGEMENT INFORMATION



LEGEND

101	DRAINAGE AREA I.D.
5.45	DRAINAGE AREA (ha)
0	PERCENT IMPERVIOUS
0.25	RUNOFF COEFFICENT

→ DIRECTION OF SHEET FLOW

FIGURE 1.0
PRE-DEVELOPMENT STORM DRAINAGE AREA PLAN

SCALE: 1:1500

PROJECT: OAKWOOD DRIVE DEVELOPMENT
PROJECT No.: 21077

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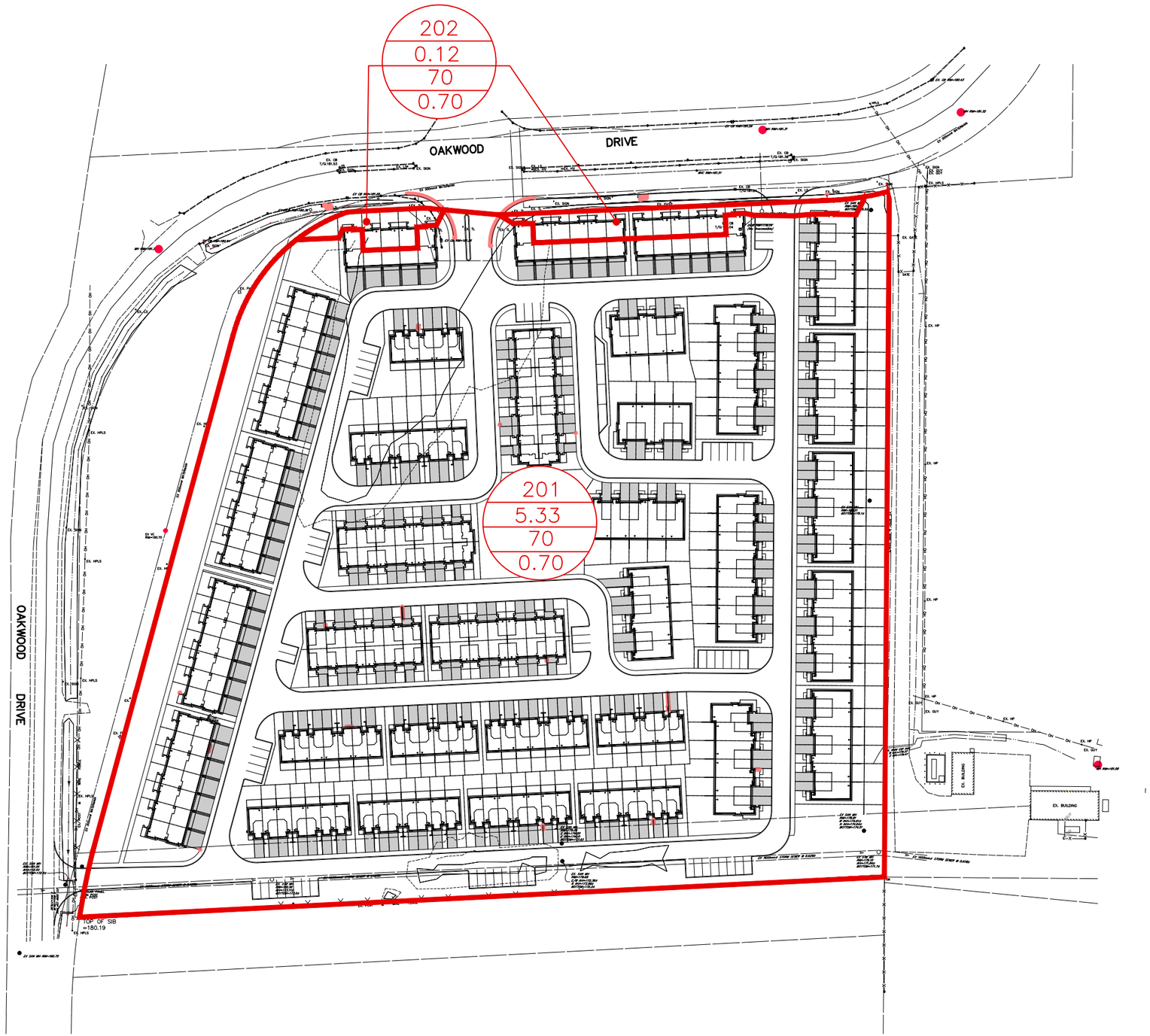

N

LEGEND

201
5.45
0
0.25

DRAINAGE AREA I.D.
DRAINAGE AREA (ha)
PERCENT IMPERVIOUS
RUNOFF COEFFICENT

DIRECTION OF SHEET FLOW

FIGURE 2.0
POST-DEVELOPMENT STORM DRAINAGE AREA PLAN

SCALE: 1:1500

PROJECT: OAKWOOD DRIVE DEVELOPMENT
PROJECT No.: 21077

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APPENDIX B

QUALITY CONTROL INFORMATION

Hydroworks Sizing Summary

Oakwood Drive
Niagara Falls

06-30-2022

Recommended Size: HS 8

A HydroStorm HS 8 is recommended to provide 70 % annual TSS removal based on a drainage area of 5.33 (ha) with an imperviousness of 70 % and St. Catherines A, Ontario rainfall for the 20 um to 2000 um particle size distribution.

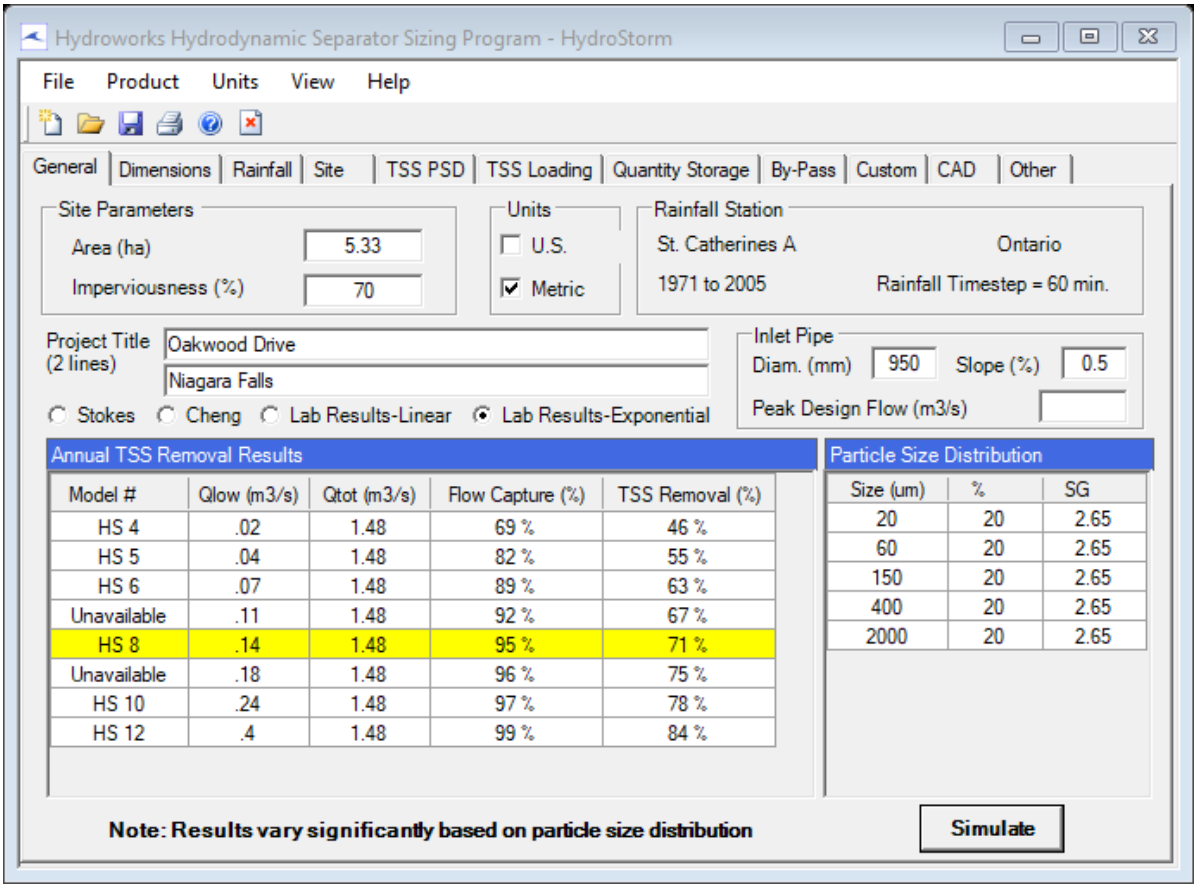
The recommended HydroStorm HS 8 treats 95 % of the annual runoff and provides 71 % annual TSS removal for the St. Catherines A rainfall records and 20 um to 2000 um particle size distribution.

The HydroStorm has a headloss coefficient (K) of 1.04. Since a peak flow was not specified, headloss was calculated using the full pipe flow of 1.48 (m3/s) for the given 950 (mm) pipe diameter at .5% slope. The headloss was calculated to be 231 (mm) based on a flow depth of 950 (mm) (full pipe flow).

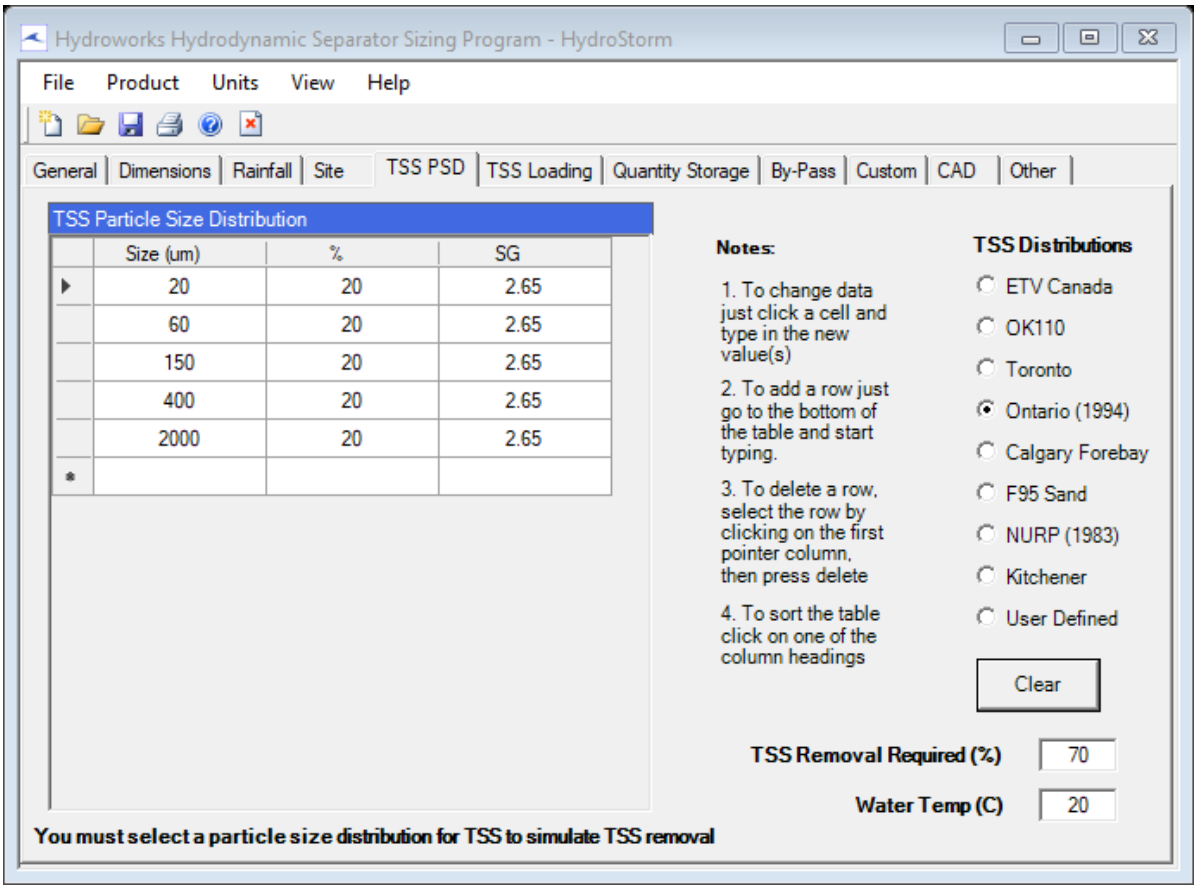
This summary report provides the main parameters that were used for sizing. These parameters are shown on the summary tables and graphs provided in this report.

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.

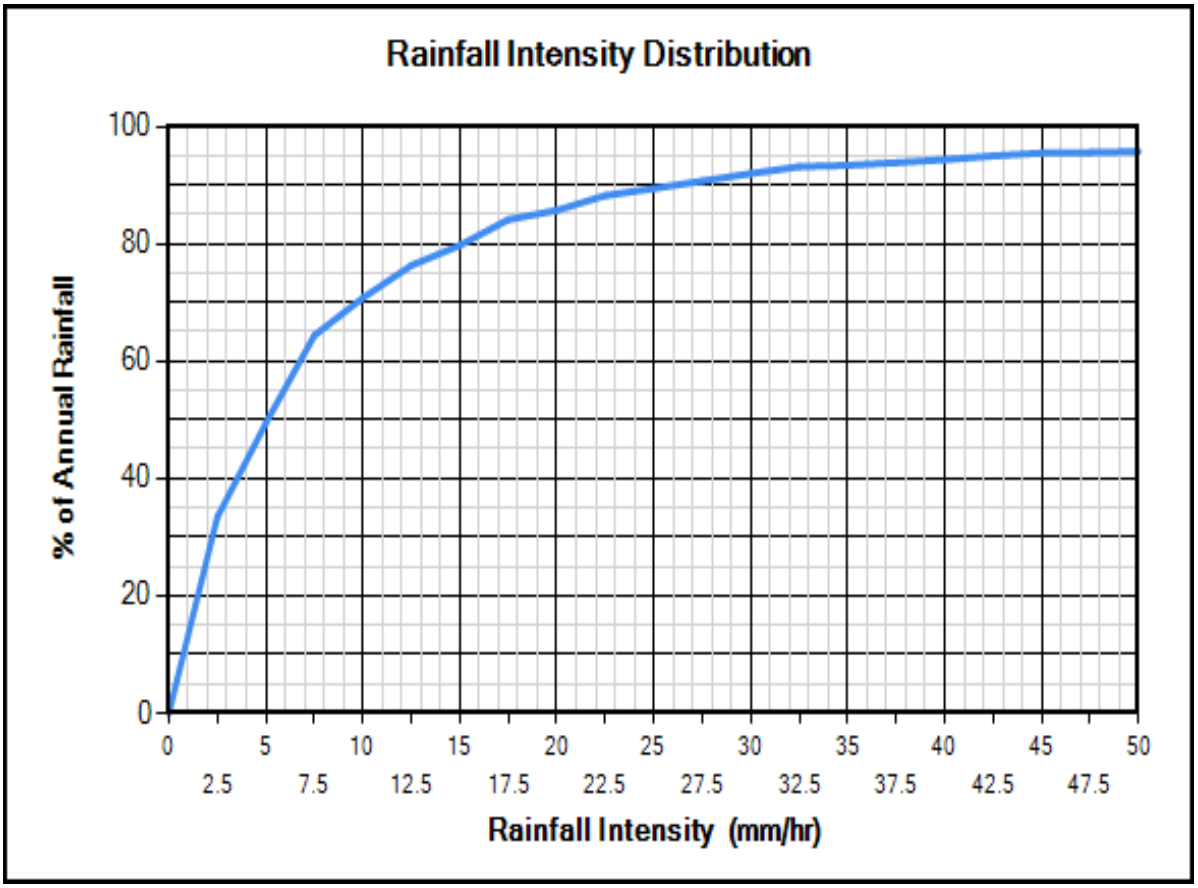
TSS Removal Sizing Summary



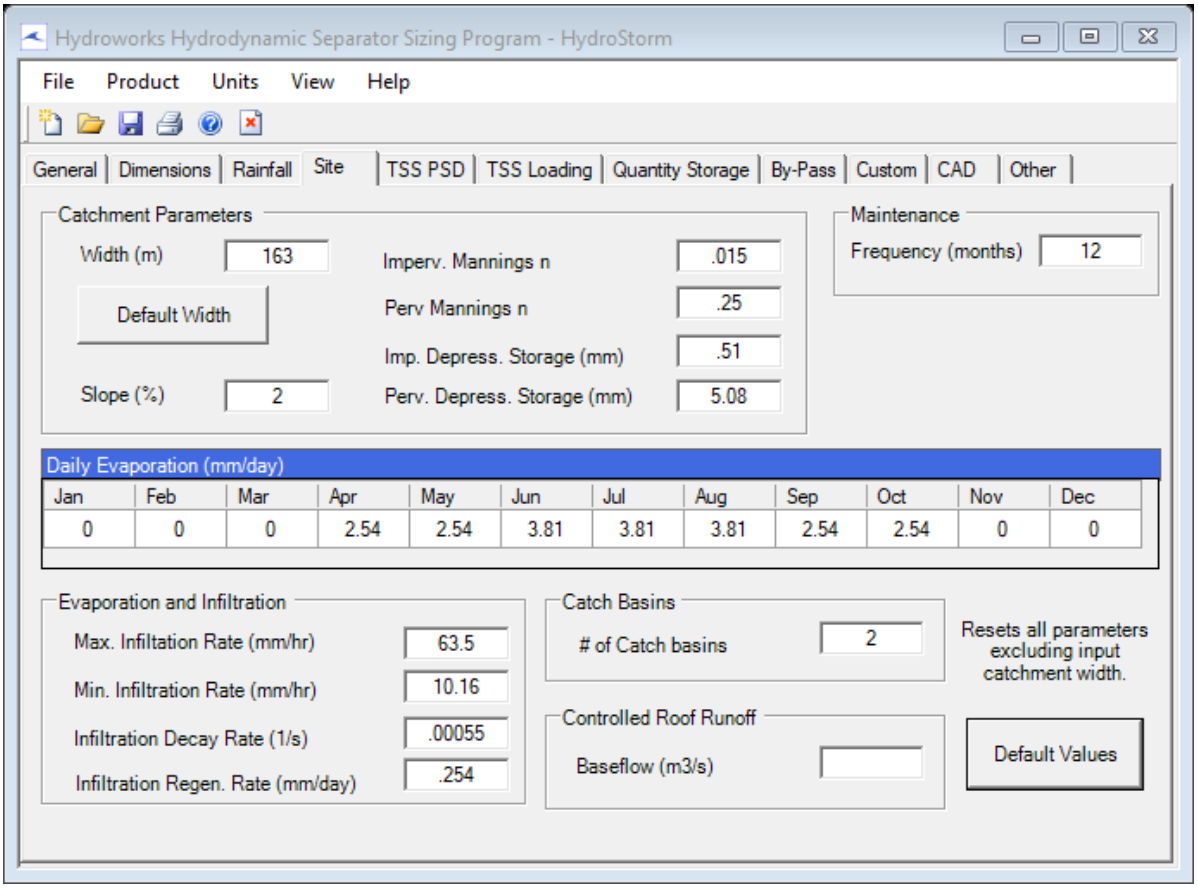
TSS Particle Size Distribution



Rainfall Station - St. Catherines A, Ontario(1971 to 2005)



Site Physical Characteristics



Dimensions And Capacities

Hydroworks Hydrodynamic Separator Sizing Program - HydroStorm

File Product Units View Help

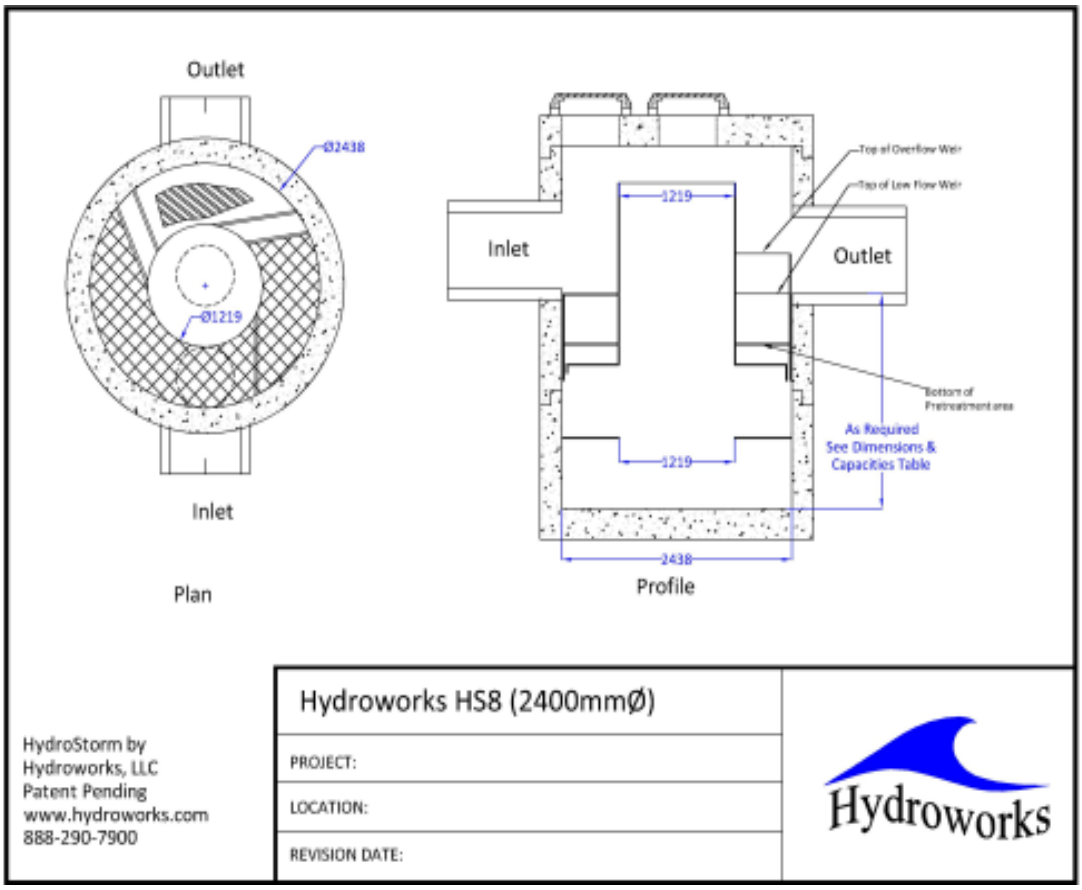
General | Dimensions | Rainfall | Site | TSS PSD | TSS Loading | Quantity Storage | By-Pass | Custom | CAD | Other

Dimensions and Capacities

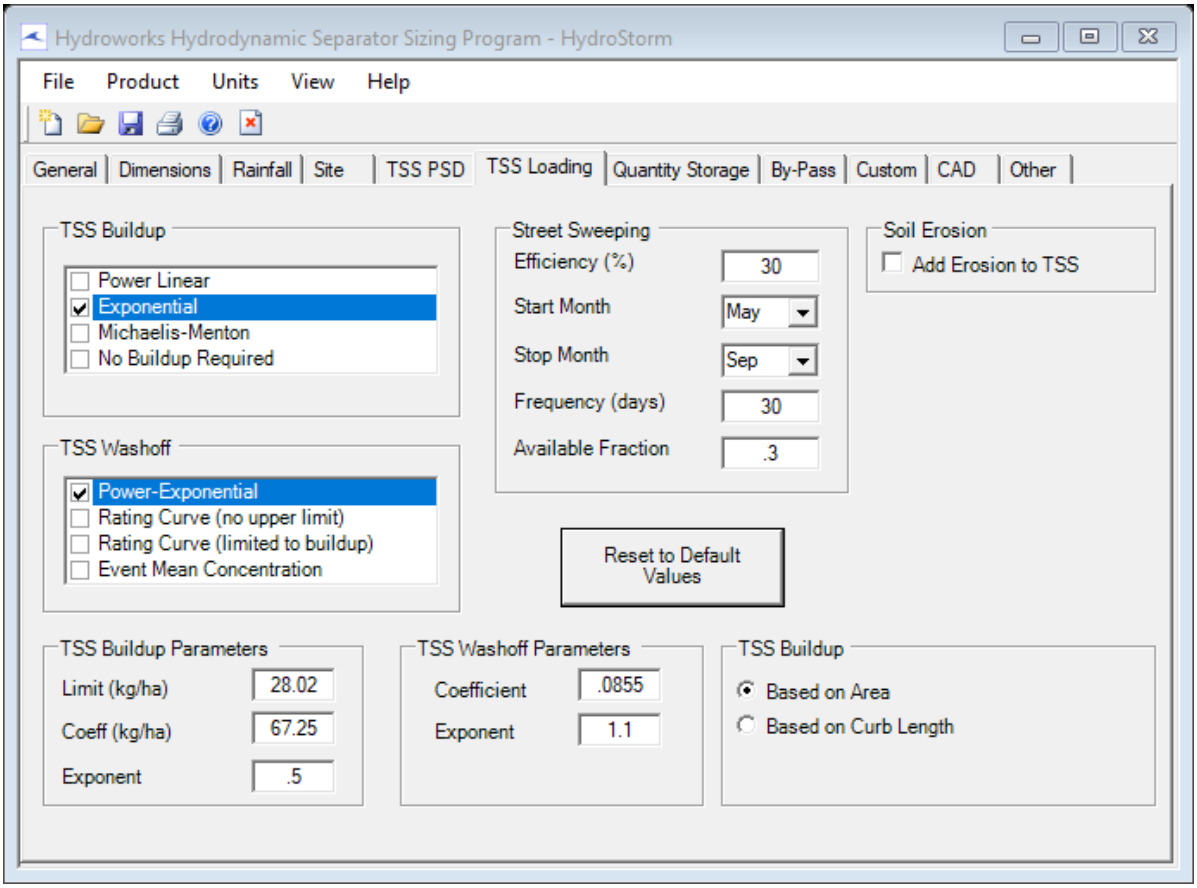
Model	Diam. (m)	Depth (m)	Float. Vol. (L)	Sediment Vol. (m3)	Total Vol. (m3)
HS 4	1.22	1.22	381	0.9	1.4
HS 5	1.52	1.52	642	1.8	2.8
HS 6	1.83	1.83	1041	3.2	4.8
HS 7	2.13	1.98	1575	4.6	7.1
HS 8	2.44	2.13	2354	6.3	10
HS 9	2.74	2.44	3242	9.3	14.4
HS 10	3.05	2.74	4327	13.2	20
HS 12	3.66	3.35	7164	23.8	35.2

Depth = Depth from outlet invert to inside bottom of tank

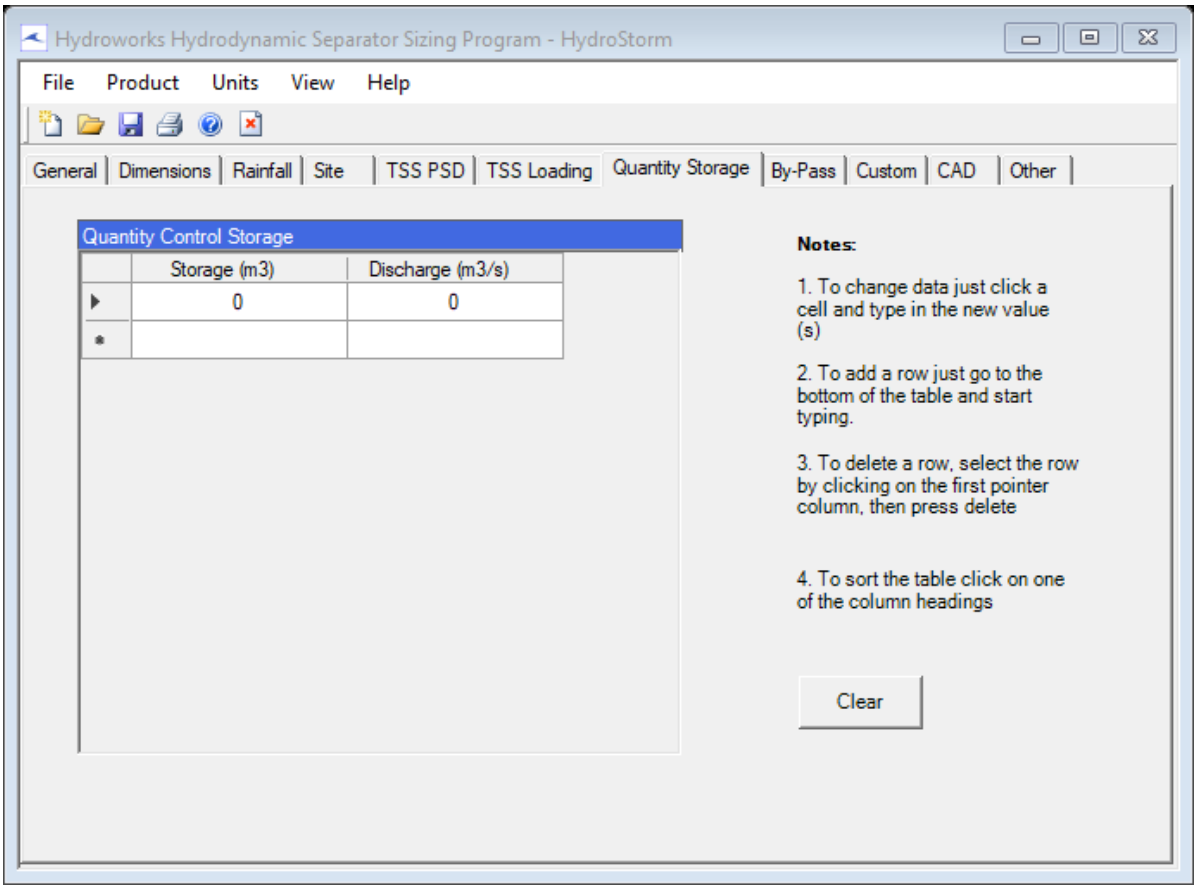
Generic HS 8 CAD Drawing



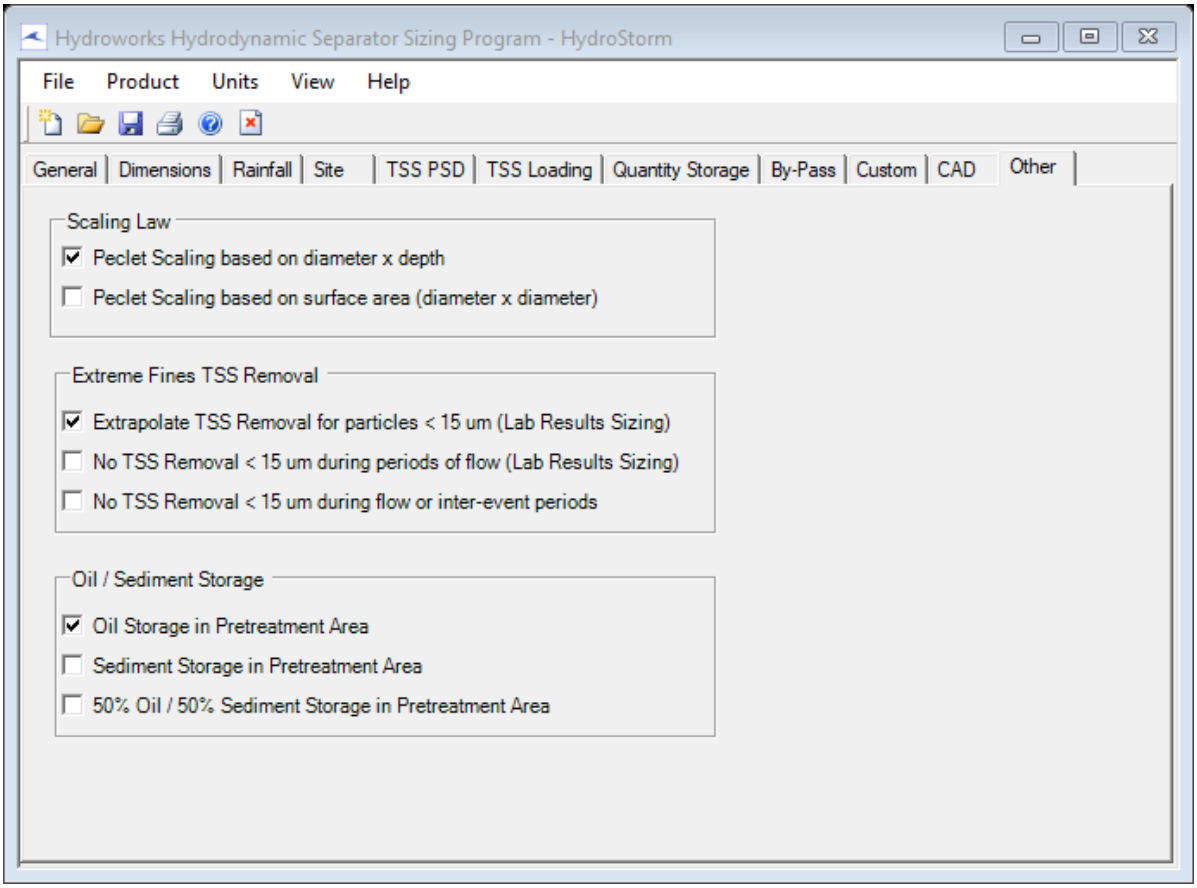
TSS Buildup And Washoff



Upstream Quantity Storage



Other Parameters



Hydroworks Sizing Program - Version 4.9

Hydroworks® HydroStorm

Operations & Maintenance Manual

Version 1.0

Please call Hydroworks at 888-290-7900 or email us at support@hydroworks.com if you have any questions regarding the Inspection Checklist. Please fax a copy of the completed checklist to Hydroworks at 888-783-7271 for our records.

Introduction

The HydroStorm is a state of the art hydrodynamic separator. Hydrodynamic separators remove solids, debris and lighter than water (oil, trash, floating debris) pollutants from stormwater. Hydrodynamic separators and other water quality measures are mandated by regulatory agencies (Town/City, State, Federal Government) to protect storm water quality from pollution generated by urban development (traffic, people) as part of new development permitting requirements.

As storm water treatment structures fill up with pollutants they become less and less effective in removing new pollution. Therefore, it is important that storm water treatment structures be maintained on a regular basis to ensure that they are operating at optimum performance. The HydroStorm is no different in this regard and this manual has been assembled to provide the owner/operator with the necessary information to inspect and coordinate maintenance of their HydroStorm.

Hydroworks® HydroStorm Operation

The Hydroworks HydroStorm (HS) separator is a unique hydrodynamic by-pass separator. It incorporates a protected submerged pretreatment zone to collect larger solids, a treatment tank to remove finer solids, and a dual set of weirs to create a high flow bypass. High flows are conveyed directly to the outlet and do not enter the treatment area, however, the submerged pretreatment area still allows removal of coarse solids during high flows.

Under normal or low flows, water enters an inlet area with a horizontal grate. The area underneath the grate is submerged with openings to the main treatment area of the separator. Coarse solids fall through the grate and are either trapped in the pretreatment area or conveyed into the main treatment area depending on the flow rate. Fines are transported into the main treatment area. Openings and weirs in the pretreatment area allow entry of water and solids into the main treatment area and cause water to rotate in the main treatment area creating a vortex motion. Water in the main treatment area is forced to rise along the walls of the separator to discharge from the treatment area to the downstream pipe.

The vortex motion forces solids and floatables to the middle of the inner chamber. Floatables are trapped since the inlet to the treatment area is submerged. The design maximizes the retention of settled solids since solids are forced to the center of the inner chamber by the vortex motion of water while water must flow up the walls of the separator to discharge into the downstream pipe.

A set of high flow weirs near the outlet pipe create a high flow bypass over both the pretreatment area and main treatment chamber. The rate of flow into the treatment area is regulated by the number and size of openings into the treatment chamber and the height of by-pass weirs. High flows flow over the weirs directly to the outlet pipe preventing the scour and resuspension of any fines collected in the treatment chamber.

A central access tube is located in the structure to provide access for cleaning. The arrangement of the inlet area and bypass weirs near the outlet pipe facilitate the use of multiple inlet pipes.

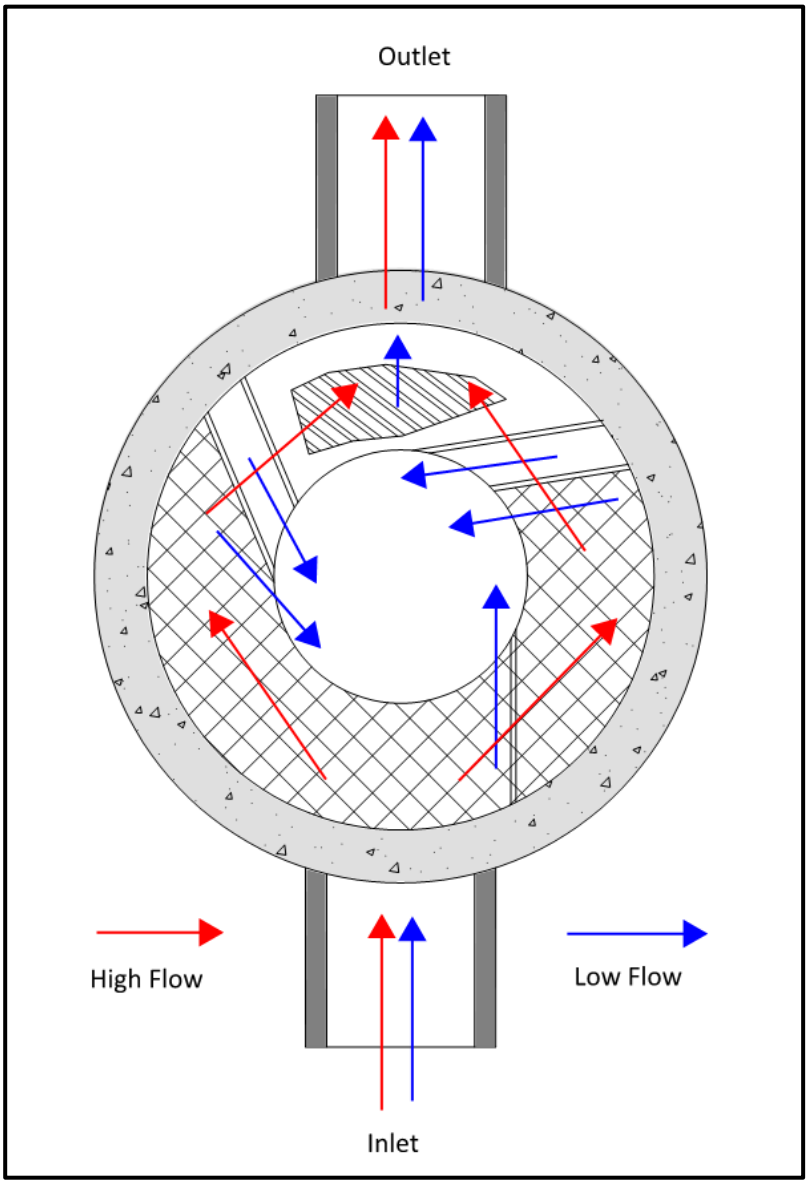


Figure 1. Hydroworks HydroStorm Operation – Plan View

Figure 2 is a profile view of the HydroStorm separator showing the flow patterns for low and high flows.

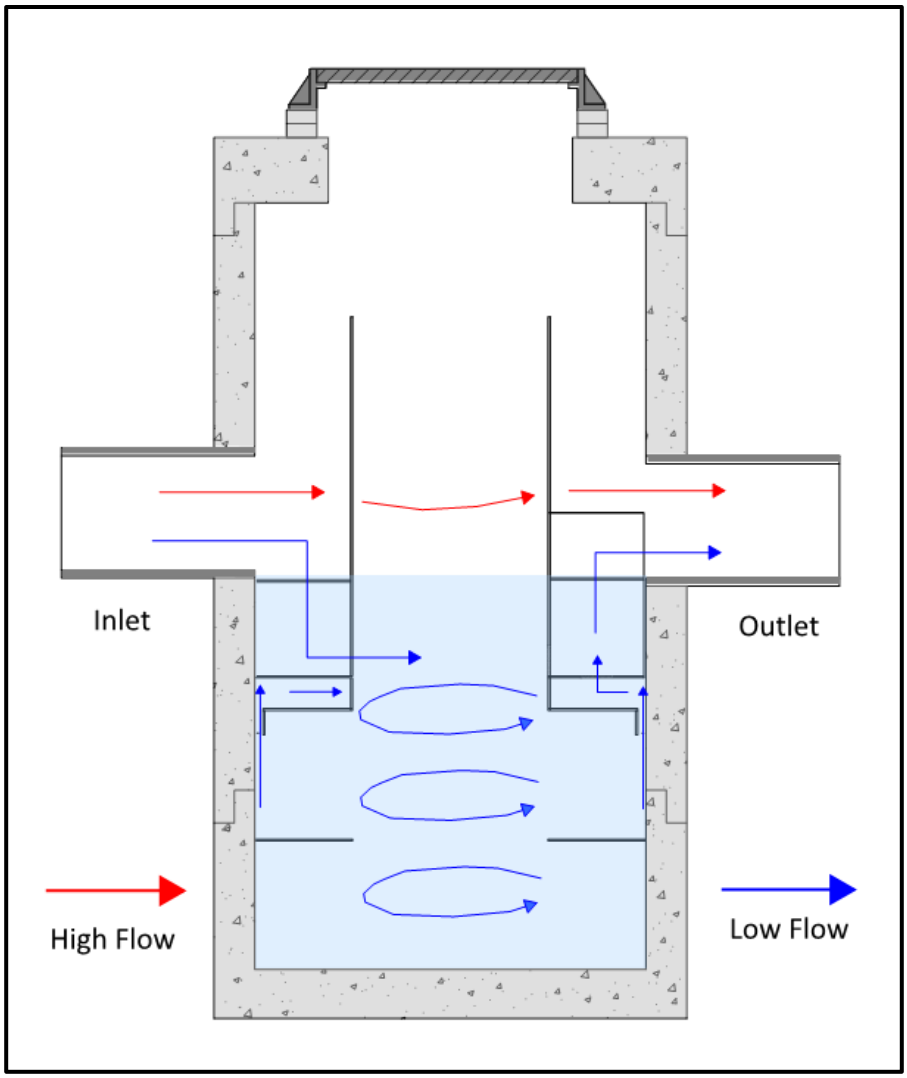


Figure 2. Hydroworks HydroStorm Operation – Profile View

The HS 4i is an inlet version of the HS 4 separator. There is a catch-basin grate on top of the HS 4i. A funnel sits sits underneath the grate on the frame and directs the water to the inlet side of the separator to ensure all lows flows are properly treated. The whole funnel is removed for inspection and cleaning.

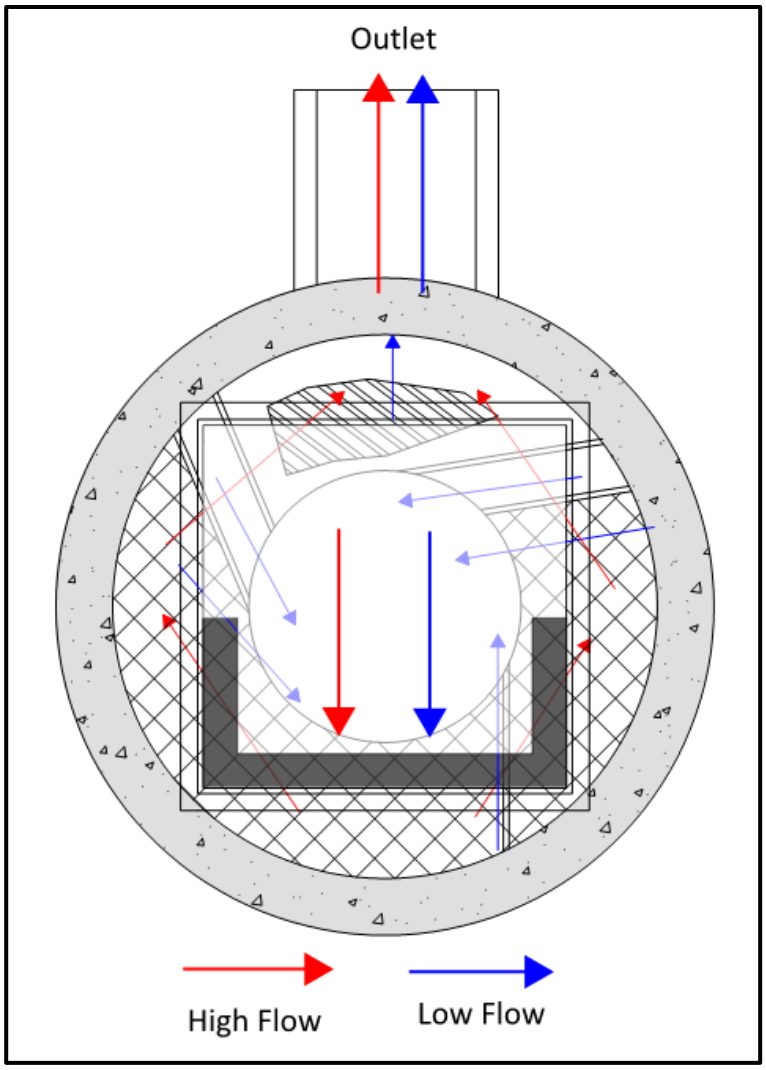


Figure 3. Hydroworks HS 4i Funnel

Inspection

Procedure

Floatables

A visual inspection can be conducted for floatables by removing the covers and looking down into the center access tube of the separator. Separators with an inlet grate (HS 4i or custom separator) will have a plastic funnel located under the grate that must be removed from the frame prior to inspection or maintenance. If you are missing a funnel please contact Hydroworks at the numbers provided at the end of this document.

Hydroworks

TSS/Sediment

Inspection for TSS build-up can be conducted using a Sludge Judge®, Core Pro®, AccuSludge® or equivalent sampling device that allows the measurement of the depth of TSS/sediment in the unit. These devices typically have a ball valve at the bottom of the tube that allows water and TSS to flow into the tube when lowering the tube into the unit. Once the unit touches the bottom of the device, it is quickly pulled upward such that the water and TSS in the tube forces the ball valve closed allowing the user to see a full core of water/TSS in the unit. The unit should be inspected for TSS through each of the access covers. Several readings (2 or 3) should be made at each access cover to ensure that an accurate TSS depth measurement is recorded.

Frequency

Construction Period

The HydroStorm separator should be inspected every four weeks and after every large storm (over 0.5" (12.5 mm) of rain) during the construction period.

Post-Construction Period

The Hydroworks HydroStorm separator should be inspected during the first year of operation for normal stabilized sites (grassed or paved areas). If the unit is subject to oil spills or runoff from unstabilized (storage piles, exposed soils) areas the HydroStorm separator should be inspected more frequently (4 times per year). The initial annual inspection will indicate the required future frequency of inspection and maintenance if the unit was maintained after the construction period.

Reporting

Reports should be prepared as part of each inspection and include the following information:

1. Date of inspection
2. GPS coordinates of Hydroworks unit
3. Time since last rainfall
4. Date of last inspection
5. Installation deficiencies (missing parts, incorrect installation of parts)
6. Structural deficiencies (concrete cracks, broken parts)
7. Operational deficiencies (leaks, blockages)
8. Presence of oil sheen or depth of oil layer
9. Estimate of depth/volume of floatables (trash, leaves) captured
10. Sediment depth measured
11. Recommendations for any repairs and/or maintenance for the unit
12. Estimation of time before maintenance is required if not required at time of inspection

A sample inspection checklist is provided at the end of this manual.

Maintenance

Procedure

The Hydroworks HydroStorm unit is typically maintained using a vacuum truck. There are numerous companies that can maintain the HydroStorm separator. Maintenance with a vacuum truck involves removing all of the water and sediment together. The water is then separated from the sediment on the truck or at the disposal facility.

A central access opening (24” or greater) is provided to the gain access to the lower treatment tank of the unit. This is the primary location to maintain by vacuum truck. The pretreatment area can also be vacuumed and/or flushed into the lower treatment tank of the separator for cleaning via the central access once the water level is lowered below the pretreatment floor.

In instances where a vacuum truck is not available other maintenance methods (i.e. clamshell bucket) can be used, but they will be less effective. If a clamshell bucket is used the water must be decanted prior to cleaning since the sediment is under water and typically fine in nature. Disposal of the water will depend on local requirements. Disposal options for the decanted water may include:

1. Discharge into a nearby sanitary sewer manhole
2. Discharge into a nearby LID practice (grassed swale, bioretention)
3. Discharge through a filter bag into a downstream storm drain connection

The local municipality should be consulted for the allowable disposal options for both water and sediments prior to any maintenance operation. Once the water is decanted the sediment can be removed with the clamshell bucket.

Disposal of the contents of the separator depend on local requirements. Maintenance of a Hydroworks HydroStorm unit will typically take 1 to 2 hours based on a vacuum truck and longer for other cleaning methods (i.e. clamshell bucket).

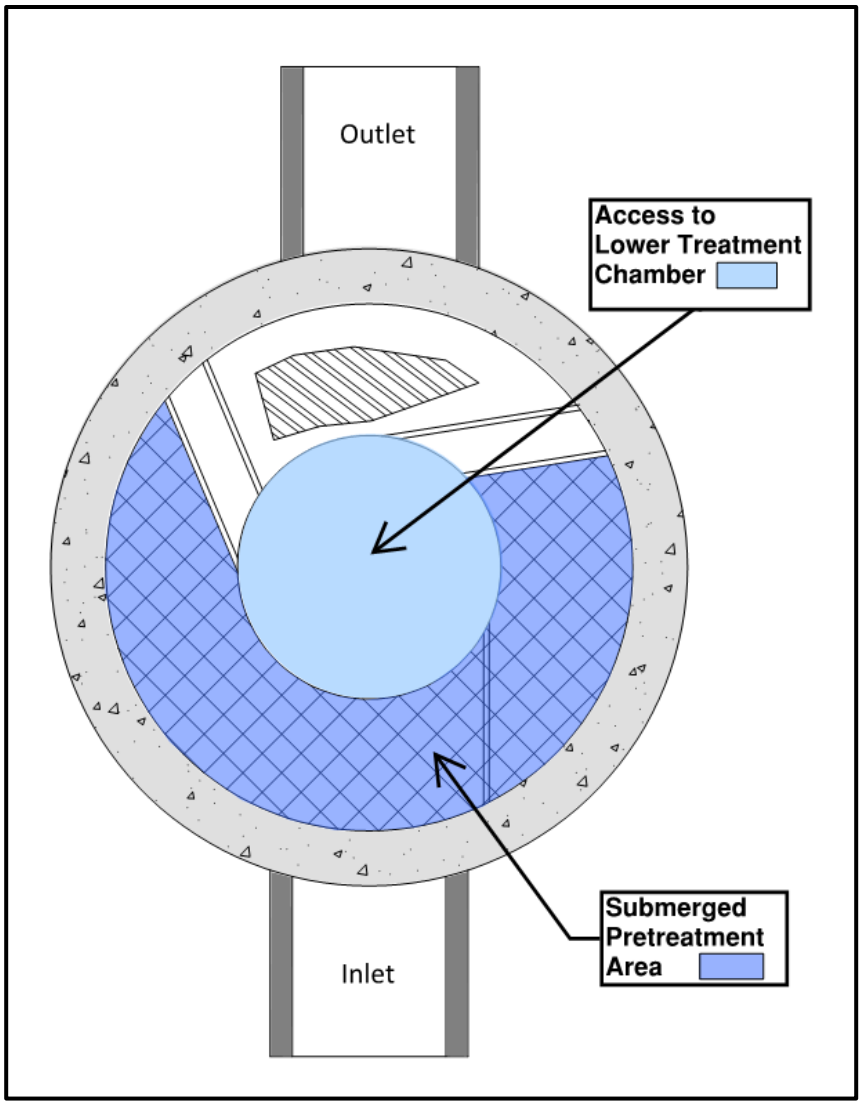


Figure 3. Maintenance Access

Frequency

Construction Period

A HydroStorm separator can fill with construction sediment quickly during the construction period. The HydroStorm must be maintained during the construction period when the depth of TSS/sediment reaches 24” (600 mm). It must also be maintained during the construction period if there is an appreciable depth of oil in the unit (more than a sheen) or if floatables other than oil cover over 50% of the area of the separator

The HydroStorm separator should be maintained at the end of the construction period, prior to operation for the post-construction period.

Post-Construction Period

The HydroStorm was independently tested by Alden Research Laboratory in 2017. A HydroStorm HS 4 was tested for scour with a 50% sediment depth of 0.5 ft. Therefore, maintenance for sediment accumulation is required if the depth of sediment is 1 ft or greater in separators with standard water (sump) depths (Table 1).

There will be designs with increased sediment storage based on specifications or site-specific criteria. A measurement of the total water depth in the separator through the central access tube should be taken and compared to water depth given in Table 1. The standard water depth from Table 1 should be subtracted from the measured water depth and the resulting extra depth should be added to the 1 ft to determine the site-specific sediment maintenance depth for that separator.

For example, if the measured water depth in the HS-7 is 7 feet, then the sediment maintenance depth for that HS-7 is 2 ft (= 1 + 7 – 6) and the separator does not need to be cleaned for sediment accumulation until the measure sediment depth is 2 ft.

The HydroStorm separator must also be maintained if there is an appreciable depth of oil in the unit (more than a sheen) or if floatables other than oil cover over 50% of the water surface of the separator.

Table 1 Standard Dimensions for Hydroworks HydroStorm Models

Model	Diameter (ft)	Total Water Depth (ft)	Sediment Maintenance Depth for Table 1 Total Water Depth(ft)
HS-3	3	3	1
HS-4	4	4	1
HS-5	5	4	1
HS-6	6	4	1
HS-7	7	6	1
HS-8	8	7	1
HS-9	9	7.5	1
HS-10	10	8	1
HS-11	11	9	1
HS-12	12	9.5	1

HYDROSTORM INSPECTION SHEET

Date _____
Date of Last Inspection _____

Site _____
City _____
State _____
Owner _____

GPS Coordinates _____

Date of last rainfall _____

Site Characteristics	**Yes**	**No**
Soil erosion evident	☐	☐
Exposed material storage on site	☐	☐
Large exposure to leaf litter (lots of trees)	☐	☐
High traffic (vehicle) area	☐	☐

HydroStorm	**Yes**	**No**
Obstructions in the inlet or outlet	☐ *	☐
Missing internal components	☐ **	☐
Improperly installed inlet or outlet pipes	☐ ***	☐
Internal component damage (cracked, broken, loose pieces)	☐ **	☐
Floating debris in the separator (oil, leaves, trash)	☐	☐
Large debris visible in the separator	☐ *	☐
Concrete cracks/deficiencies	☐ ***	☐
Exposed rebar	☐ **	☐
Water seepage (water level not at outlet pipe invert)	☐ ***	☐

Water level depth below outlet pipe invert _____“

Routine Measurements

Floating debris depth	**< 0.5” (13mm)**	☐	**>0.5” 13mm)**	☐ *
Floating debris coverage	**< 50% of surface area**	☐	**> 50% surface area**	☐ *
Sludge depth	**< 12” (300mm)**	☐	**> 12” (300mm)**	☐ ****

* Maintenance required
** Repairs required
*** Further investigation is required

Hydroworks

Other Comments:

Hydroworks

Hydroworks® HydroStorm

One Year Limited Warranty

Hydroworks, LLC warrants, to the purchaser and subsequent owner(s) during the warranty period subject to the terms and conditions hereof, the Hydroworks HydroStorm to be free from defects in material and workmanship under normal use and service, when properly installed, used, inspected and maintained in accordance with Hydroworks written instructions, for the period of the warranty. The standard warranty period is 1 year.

The warranty period begins once the separator has been manufactured and is available for delivery. Any components determined to be defective, either by failure or by inspection, in material and workmanship will be repaired, replaced or remanufactured at Hydroworks' option provided, however, that by doing so Hydroworks, LLC will not be obligated to replace an entire insert or concrete section, or the complete unit. This warranty does not cover shipping charges, damages, labor, any costs incurred to obtain access to the unit, any costs to repair/replace any surface treatment/cover after repair/replacement, or other charges that may occur due to product failure, repair or replacement.

This warranty does not apply to any material that has been disassembled or modified without prior approval of Hydroworks, LLC, that has been subjected to misuse, misapplication, neglect, alteration, accident or act of God, or that has not been installed, inspected, operated or maintained in accordance with Hydroworks, LLC instructions and is in lieu of all other warranties expressed or implied. Hydroworks, LLC does not authorize any representative or other person to expand or otherwise modify this limited warranty.

The owner shall provide Hydroworks, LLC with written notice of any alleged defect in material or workmanship including a detailed description of the alleged defect upon discovery of the defect. Hydroworks, LLC should be contacted at 136 Central Ave., Clark, NJ 07066 or any other address as supplied by Hydroworks, LLC. (888-290-7900).

This limited warranty is exclusive. There are no other warranties, express or implied, or merchantability or fitness for a particular purpose and none shall be created whether under the uniform commercial code, custom or usage in the industry or the course of dealings between the parties. Hydroworks, LLC will replace any goods that are defective under this warranty as the sole and exclusive remedy for breach of this warranty.

Subject to the foregoing, all conditions, warranties, terms, undertakings or liabilities (including liability as to negligence), expressed or implied, and howsoever arising, as to the condition, suitability, fitness, safety, or title to the Hydroworks HydroStorm are hereby negated and excluded and Hydroworks, LLC gives and makes no such representation, warranty or undertaking except as expressly set forth herein. Under no circumstances shall Hydroworks, LLC be liable to the Purchaser or to any third party for product liability claims; claims arising from the design, shipment, or installation of the HydroStorm, or the cost of other goods or services related to the purchase and installation of the HydroStorm. For this Limited Warranty to apply, the HydroStorm must be installed in accordance with all site conditions required by state and local codes; all other applicable laws; and Hydroworks' written installation instructions.

Hydroworks, LLC expressly disclaims liability for special, consequential or incidental damages (even if it has been advised of the possibility of the same) or breach of expressed or implied warranty. Hydroworks, LLC 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 damages to the HydroStorm arising from ordinary wear and tear; alteration, accident, misuse, abuse or neglect; improper maintenance, failure of the product due to improper installation of the concrete sections or improper sizing; or any other event not caused by Hydroworks, LLC. This limited warranty represents Hydroworks' sole liability to the purchaser for claims related to the HydroStorm, whether the claim is based upon contract, tort, or other legal basis.

APPENDIX C

WATER ANALYSIS INFORMATION

FIRE FLOW DEMAND REQUIREMENTS - FIRE UNDERWRITERS SURVEY (FUS GUIDELINES)

Project Number: 21077
Project Name: Oakwood Drive
Date: 30-Jun-22

Fire flow demands for the FUS method is based on information and guidance provided in "Water Supply for Public Protection" (Fire Underwriters Survey, 2020).

An estimate of the fire flow required is given by the following formula:

$$F = 220\,C\sqrt{A} \qquad (1)$$

where:

F = the required fire flow in litres per minute
C = coefficient related to the type of construction
= 1.5 for Type V wood frame construction (structure essentially all combustible)
= 0.8 for Type IV-A mass timber construction (encapsulated mass timber)
= 0.9 for Type IV-B mass timber construction (rated mass timber)
= 1.0 for Type IV-C mass timber construction (ordinary mass timber)
= 1.5 for Type IV-D mass timber construction (un-rated mass timber)
= 1.0 for ordinary construction (brick or other masonry walls, combustible floor and interior)
= 0.8 for non-combustible construction (unprotected metal structural components, masonry or metal walls)
= 0.6 for fire-resistive construction (fully protected frame, floors, roof)
A = Total floor area in square metres

	Building Area				(1)		(2)			(3)		(4)		Final Adjusted Fire Flow	
Building / Location	Footprint Area (m^2)	# of Storeys	**Total GFA (m^2)**	Type of Construction	***Fire Flow "F"*** (l/min)	***Fire Flow "F"*** (l/s)	***Occupancy*** %	***Occupancy*** Adjustment (l/min)	**Adjusted Fire Flow (l/min)**	***Sprinkler*** %	***Sprinkler*** Adjustment (l/min)	***Exposure*** %	***Exposure*** Adjustment (l/min)	**(l/min)**	**(l/s)**
Building 9	**655.0**	**2**	**1310**	**1.5**	12000	200.0	**-15**	-1800.0	**10200.0**	**0**	0.0	55	5610.0	**16000**	**267**
Building 19	**608.0**	**3**	**1824**	**1.5**	14000	233.3	**-15**	-2100.0	**11900.0**	**0**	0.0	65	7735.0	**20000**	**333**
Building 22	**352.0**	**3**	**1056**	**1.5**	11000	183.3	**-15**	-1650.0	**9350.0**	**0**	0.0	75	7012.5	**16000**	**267**
Building 31	**550.0**	**3**	**1650**	**1.5**	13000	216.7	**-15**	-1950.0	**11050.0**	**0**	0.0	60	6630.0	**18000**	**300**

(2) Occupancy

Non-Combustible	-25%
Limited Combustible	-15%
Combustible	No charge
Free Burning	15%
Rapid Burning	25%

(3) Sprinkler

Minimum credit for systems designed to NFPA 13 is 30%.

If the domestic and fire services are supplied by the same municipal water system, then take an additional 10%.

If the sprinkler system is fully supervised (ie. annunciator panel that alerts the Fire Dept., such as a school), then an additional 10% can be taken. Maximum credit = 50%.

(4) Exposure

0 to 3m	25%	
3.1 to 10m	20%	Calculate for all
10.1 to 20m	15%	sides. Maximum
20.1 to 30m	10%	charge shall not
30.1 to 45m	5%	exceed 75%

Side	Exposure (m)	Charge (%)
North =	**45+**	**0**
South =	**	**0**
East =	**	**0**
West =	**45+**	**0**
Total Exposure =		***0***

*exposed building is fully protected with an automatic sprinkler system = 50% of total exposure
**subject and exposed buildings are fully protected with an automatic sprinkler system = no adjustment
***subject building and the area between the buildings are fully protected with an automatic sprinkler system = no adjustment
****exposed building face of a Type V building has an exterior cladding with min. 1 hour FRR, than the exposure charge may be treated as a Type III/IV building

Building 9

Side	Exposure (m)	Charge (%)
North =	**10.1 to 20m**	**15**
South =	**20.1 to 30m**	**10**
East =	**10.1 to 20m**	**15**
West =	**10.1 to 20m**	**15**
Total Exposure =		***55***

Building 19

Side	Exposure (m)	Charge (%)
North =	**10.1 to 20m**	**15**
South =	**10.1 to 20m**	**15**
East =	**20.1 to 30m**	**10**
West =	**0 to 3m**	**25**
Total Exposure =		***65***

Building 22

Side	Exposure (m)	Charge (%)
North =	**10.1 to 20m**	**15**
South =	**10.1 to 20m**	**15**
East =	**0 to 3m**	**252**
West =	**0 to 3m**	**25**
Total Exposure =		***75***

Building 31

Side	Exposure (m)	Charge (%)
North =	**0 to 3m**	**25**
South =	**0 to 3m**	**25**
East =	**20.1 to 30m**	**10**
West =	**45m+**	**0**
Total Exposure =		***60***