



Hydroworks® HydroStorm

Operations & Maintenance Manual

Version 1.2

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

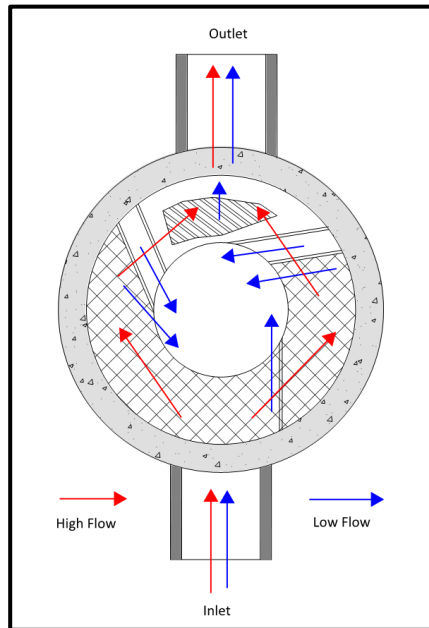


Figure 1. Hydroworks HydroStorm Operation – Plan View

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

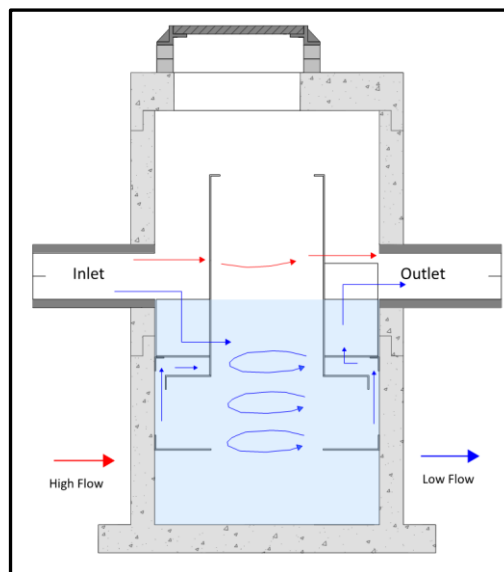


Figure 2. Hydroworks HydroStorm Operation – Profile View



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 underneath the grate on the frame and directs the water to the inlet side of the separator to ensure all low flows are properly treated. The whole funnel is removed for inspection and cleaning.

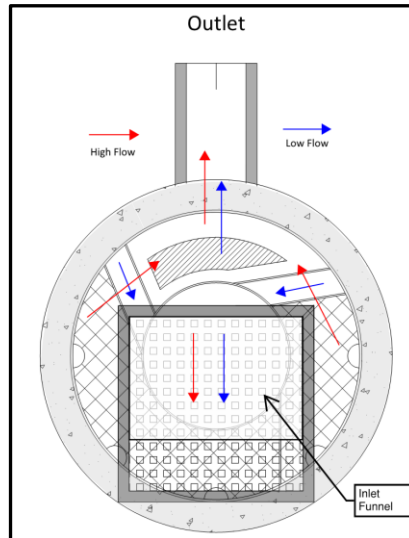


Figure 3. Hydroworks HS 4i Funnel

Construction Materials

The inner chamber and outlet baffle are made out of a copolymer plastic. The shell of the structure is pre-cast concrete. Pre-cast concrete is readily accepted by all municipalities since it has the following advantages:

- long service life
- ease of installation (less dependent on backfill (contractor proficiency) for structural integrity)
- concrete structures are designed for both anti-buoyancy and traffic loading without any field requirements (such as structural loading slabs in traffic areas and anti-buoyancy slabs to prevent groundwater uplift).
- low maintenance requirements

Hydroworks HS Separator Dimensions and Capacities

The HS separator is manufactured in a variety of sizes from 4 ft inside diameter to 12 ft inside diameter as shown in Table 1. Larger sizes may not be available in all areas. Please check with Hydroworks to ensure availability of the larger model sizes.



| Model | Structure Inside Diam. (SID) (mm) | Structure Depth (mm)* | Sediment/ Sinking Trash Volume (L) | Oil/Floating Trash Volume (L) | Permanent Pool Wet Volume (L) |
|-------|-----------------------------------|-----------------------|------------------------------------|-------------------------------|-------------------------------|
| HS 3 | 900 | 1050 | 420 | 150 | 700 |
| HS 4 | 1200 | 1200 | 845 | 355 | 1420 |
| HS 5 | 1500 | 1500 | 1695 | 620 | 2775 |
| HS 6 | 1800 | 1800 | 3110 | 1020 | 4800 |
| HS 7 | 2100 | 1950 | 4530 | 1550 | 7080 |
| HS 8 | 2400 | 2100 | 6225 | 2325 | 9960 |
| HS 9 | 2700 | 2400 | 9200 | 3195 | 14410 |
| HS 10 | 3000 | 2700 | 13025 | 4275 | 20015 |
| HS 12 | 3600 | 3000 | 20525 | 7095 | 30535 |

*Dimensions vary with project requirements

The volumes provided in Table 1 for oil and sediment are to full capacity and not indicative of recommended depths/volumes for maintenance.

Headloss

Any water quality system implemented in a storm drain network will create headloss in the system. In general, depending on the configuration of the by-pass, systems designed to treat high flows or all of the flow will have a higher headloss impact on the storm drain network than systems that by-pass high flows.

The headloss created by the HS separator was measured in an independent laboratory (Alden Research Laboratory) for a full-scale HS 4. The K value ($h = K v^2/(2g)$) for headloss calculations was determined to be 1.04 as shown in Figure 3.

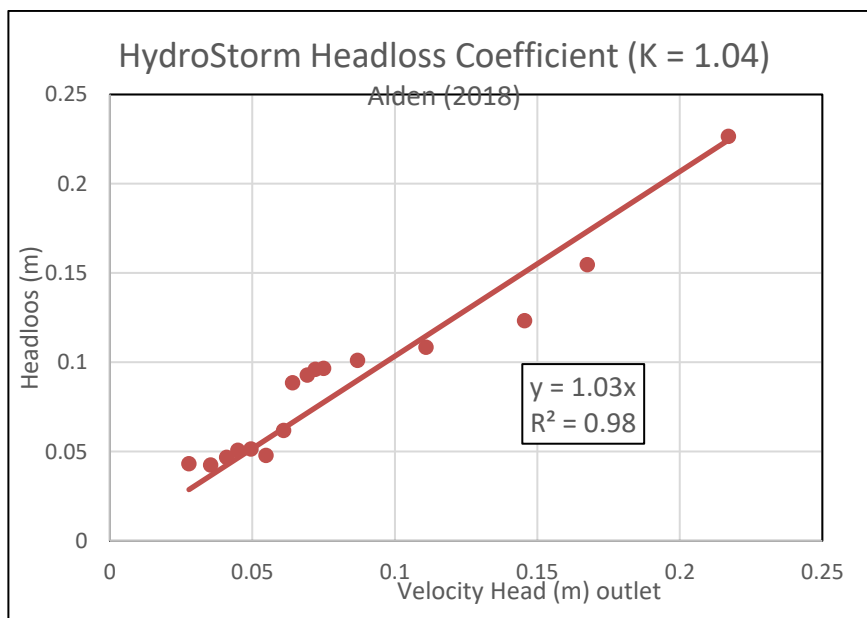


Figure 3. HydroStorm Headloss K Factor (1.04)



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.

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" (600 mm) 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.

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).



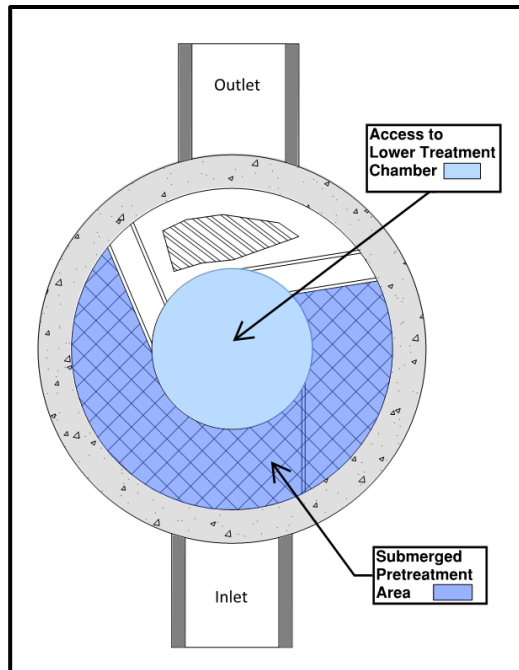


Figure 3. Maintenance Access

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.(150 mm). The sump depths given in Table 1 are scaled larger than required based on standard scaling requirements (NJDEP, ETV Canada). Accordingly maintenance depths for units larger than the HS 4 will be larger than 300 mm.

There will be designs with increased sediment storage based on specifications or site-specific criteria. A measurement of the total depth in the separator through the central access tube should be taken and compared to sump depth given in Table 1.

The standard sump depth from Table 1 should be subtracted from the measured depth and the resulting extra depth should be added to the values given in Table 2 to determine the site-specific sediment maintenance depth for that separator.

For example, if the measured sump depth in the HS-7 is 7.5 feet, then the sediment maintenance depth for that HS-7 is 2.25 ft (= 0.5 + 1.75) and the separator does not need to be cleaned for sediment accumulation until the measure sediment depth is 2.25 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 2 Standard Maintenance Depths for HydroStorm Models

| Model | Diameter ft (mm) | Sediment Maintenance Depth for Total Water Depth ft (mm)* |
|--------------|-----------------------------|--|
| HS-3 | 3 (900) | 1 (300) |
| HS-4 | 4 (1200) | 1 (300) |
| HS-5 | 5 (1500) | 1.75 (530) |
| HS-6 | 6 (1800) | 2 (610) |
| HS-7 | 7 (2100) | 1.75 (535) |
| HS-8 | 8 (2400) | 1.5 (465) |
| HS-9 | 9 (2700) | 1.75 (540) |
| HS-10 | 10 (3000) | 2 (615) |
| HS-12 | 12 (3600) | 1.5 (470) |

*based on standard sump depths in Table 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 | <input type="checkbox"/> | <input type="checkbox"/> |
| Exposed material storage on site | <input type="checkbox"/> | <input type="checkbox"/> |
| Large exposure to leaf litter (lots of trees) | <input type="checkbox"/> | <input type="checkbox"/> |
| High traffic (vehicle) area | <input type="checkbox"/> | <input type="checkbox"/> |

| HydroStorm | Yes | No |
|---|------------------------------|--------------------------|
| Obstructions in the inlet or outlet | <input type="checkbox"/> * | <input type="checkbox"/> |
| Missing internal components | <input type="checkbox"/> ** | <input type="checkbox"/> |
| Improperly installed inlet or outlet pipes | <input type="checkbox"/> *** | <input type="checkbox"/> |
| Internal component damage (cracked, broken, loose pieces) | <input type="checkbox"/> ** | <input type="checkbox"/> |
| Floating debris in the separator (oil, leaves, trash) | <input type="checkbox"/> | <input type="checkbox"/> |
| Large debris visible in the separator | <input type="checkbox"/> * | <input type="checkbox"/> |
| Concrete cracks/deficiencies | <input type="checkbox"/> *** | <input type="checkbox"/> |
| Exposed rebar | <input type="checkbox"/> ** | <input type="checkbox"/> |
| Water seepage (water level not at outlet pipe invert) | <input type="checkbox"/> *** | <input type="checkbox"/> |
| Water level depth below outlet pipe invert _____" | | |

| Routine Measurements | | | |
|-----------------------------|---------------------------------|--------------------------|---|
| Floating debris depth | < 0.5" (13mm) | <input type="checkbox"/> | >0.5" 13mm) <input type="checkbox"/> * |
| Floating debris coverage | < 50% of surface area | <input type="checkbox"/> | > 50% surface area <input type="checkbox"/> * |
| Sludge depth | < 12" (300mm) | <input type="checkbox"/> | > 12" (300mm) <input type="checkbox"/> * |

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





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.