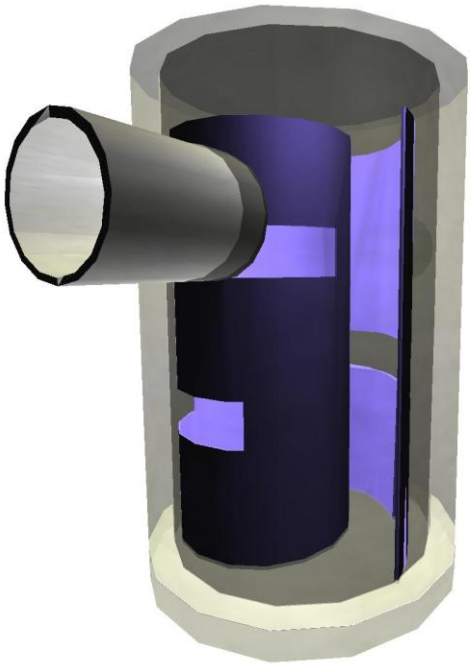


HYDROWORKS® HG

TECHNICAL MANUAL

Version 2.3

Hydroworks

U.S. Patent No. 6,951,619

Introduction

The Hydroworks® HG (Hydroguard) separator is a structural stormwater quality Best Management Practice (BMP) designed to treat impervious areas such as parking lots and roads. The implementation of BMPs is one of the six measures (number 5) identified by the Environmental Protection Agency (EPA) that should be taken to protect and maintain water quality under the National Pollution Discharge Elimination System (NPDES) program:

1. Public Education and Outreach
2. Public Participation/Involvement
3. Illicit Discharge Detection/Elimination
4. Construction Site Runoff Control
5. Post-Construction Runoff Control
6. Pollution Prevention/Good Housekeeping

In addition, BMPs that treat high flow rates, such as Hydroworks HG separator, help to satisfy the construction site runoff control requirements (number 4).

Most urban communities must obtain NPDES permits from the EPA to be in compliance with the Clean Water Act. All urban development must conform to the requirements of the NPDES permit.

There are several other manufactured BMPs in the marketplace. All of these BMPs are designed to either:

- Treat a first flush and by-pass higher flows without treatment
- Treat all flows through the same flow path

Designs that by-pass high flows are premised on all of the pollution being conveyed during the first flush. There is mounting evidence to suggest that the loading of some pollutants is a function of storm volume and that not all of the pollution is conveyed during the first flush. In fact the term first flush is ambiguous and means something different to each person (first ½" of rainfall, first 1" of runoff, first 15 minutes of a storm, etc.). Many agencies now insist on some treatment for higher flows (trash removal, etc.).

Designs that treat all flows through the same path may scour fines during periods of high flow. These scoured fines are conveying downstream into the receiving waters negating the positive effects of the BMP during periods of low flow.

Hydroworks HG Operation

The Hydroworks HG separator is unique since it treats both high and low flows in one device, but maintains separate flow paths for low and high flows. Accordingly, high flows do not scour out the fines that are settled in the low flow path since they are treated in a separate area of the device as shown in Figure 1.

The HG separator consists of three chambers:

1. an inner chamber that treats low or normal flows
2. a middle chamber that treats high flows
3. an outlet chamber where water is discharged to the downstream storm system

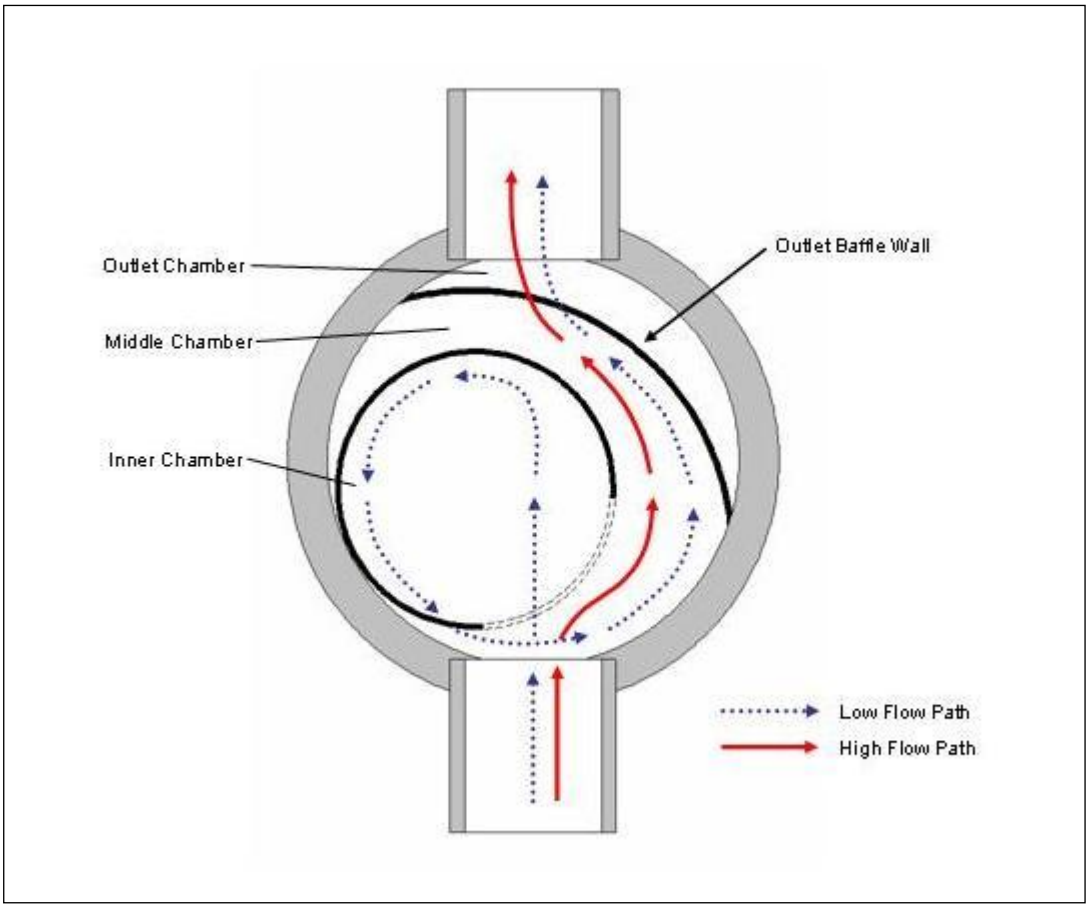


Figure 1. Hydroworks HG Operation – Plan View

Under normal or low flows, water enters the middle chamber and is conveyed into the inner chamber by momentum. Since the inner chamber is offset to one side of the structure the water strikes the wall of the inner chamber at a tangent creating a vortex within the inner chamber. The vortex motion forces solids and floatables to the middle of the inner chamber. The water spirals down the inner chamber to the outlet of the inner chamber which is located below the inlet of the inner chamber and adjacent to the wall of the structure but above the floor of the structure. Floatables are trapped since the outlet of the inner chamber is submerged. The design maximizes the retention of settle able solids since solids are forced to the center of the inner chamber by the vortex motion of water while the outlet of the inner chamber draws water from the wall of the inner chamber.

The water leaving the inner chamber continues into the middle chamber, again at a tangent to the wall of the structure. The water is then conveyed through an outlet

baffle wall (high and low baffle). This enhances the collection of any floatables or suspended solids not removed by the inner chamber. Water flowing through the baffles then enters the outlet chamber and is discharged into the downstream storm drain.

During high flows, the flow rate entering the inner chamber is restricted by the size of the inlet opening to the inner chamber. This restriction of flow rate into the inner chamber prevents scour and re-suspension of solids from the inner chamber during periods of high flow. The excess flow is conveyed directly into the middle chamber where it receives treatment for floatables and suspended solids via the baffle system. This treatment of the higher flow rates is important since trash and heavier solids are typically conveyed during periods of higher flow rates. The Hydroworks HG separator is revolutionary since it incorporates low and high flow treatment in one device while maintaining separate low and high flow paths to prevent the scour and re-suspension of fines.

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

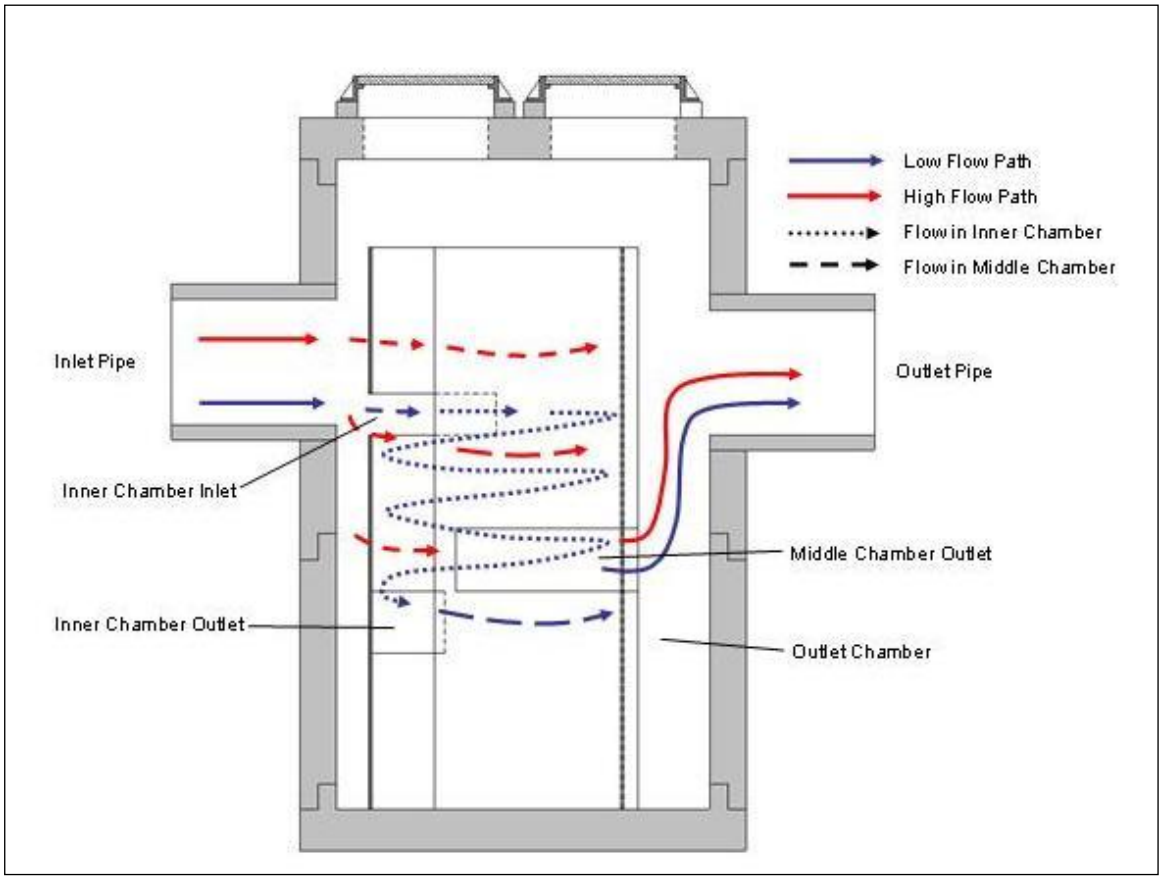
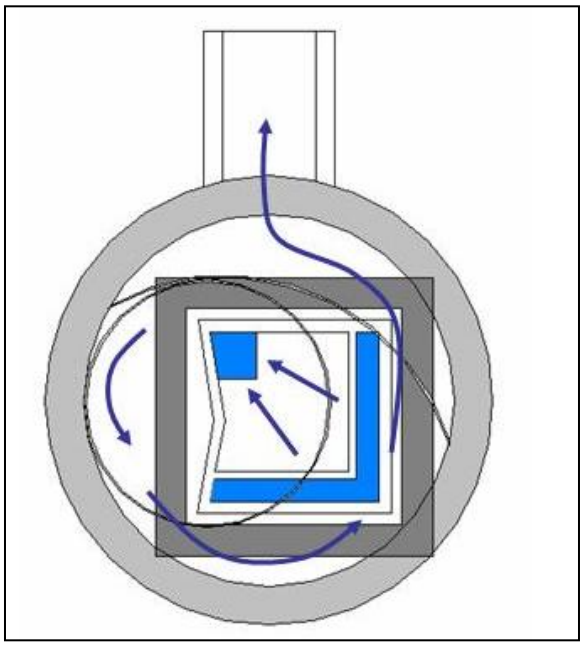


Figure 2. Hydroworks HG Operation – Profile View

The HG 4i is an inlet version of the HG 4 separator. There is a catch-basin grate on top of the HG 4i. Water flows directly into the inner chamber of the HG 4i through the catch-basin grate on top of the structure. The grate is oversized to allow maintenance

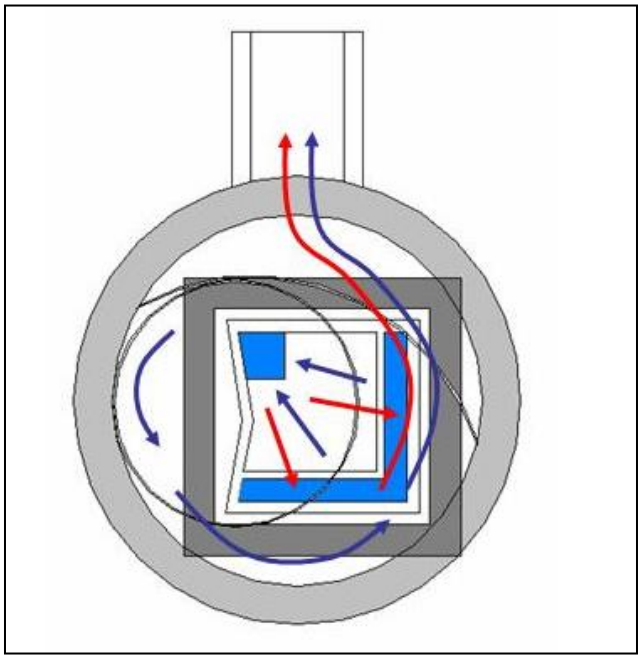
of the entire structure. A funnel that sits underneath the grate on the top cap of the concrete itself directs the water into the inner chamber during normal flows and the middle chamber during high flows. Figures 3 and 4 show the flow paths for the HG 4i separator.



The inlet funnel is sloped towards the corner inlet and hence the wall of the inner chamber. Water moves in a circular direction in the inner chamber since water enters tangentially along the wall of the inner chamber due to the sloping funnel.

Water continues moving in a circular motion (vortex) through the rest of the structure (through the middle chamber and baffle wall) until it is discharged from the separator.

Figure 3. Hydroworks Hydroguard HG 4i Normal Flow Path



During periods of peak flow the water will back up from the corner inlet and overflow into two side overflow troughs which discharge directly into the middle chamber. These overflow troughs are covered from the surface such that water cannot directly fall through them (i.e. water must back up to enter the overflow troughs).

Accordingly this funnel provides the same separate flow paths for low and high flow as the other Hydroguard separators.

The whole funnel is removed for inspection and cleaning providing.

Figure 4. Hydroworks Hydroguard HG 4i Peak Flow Path

Construction Materials

The inner chamber and outlet baffle are made out of a copolymer polypropylene. 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 HG Separator Dimensions and Capacities

The HG separator is manufactured in a variety of sizes from 4 ft (1.2 m) inside diameter to 12 ft (3.6 m) 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.

Table 1. Hydroworks HG Separator Dimensions*

Model	Structure Inside Diam. ft (m)	Structure Depth ft (m)	Sediment Volume ft^3 (m^3)	Oil/Floating Trash Volume US gal (L)	Permanent Pool Wet Volume US gal (L)
HG 4	4 (1.2)	5.0 (1.5)	38 (1.1)	76 (288)	470 (1779)
HG 5	5 (1.5)	5.5 (1.65)	64 (1.8)	123 (465)	808 (3059)
HG 6	6 (1.8)	6.0 (1.8)	92 (2.6)	203 (768)	1269 (4803)
HG 7	7 (2.1)	6.3 (1.9)	125 (3.5)	313 (1185)	1823 (6901)
HG 8	8 (2.4)	6.7 (2.0)	163 (4.6)	457 (1730)	2507 (9490)
HG 9	9 (2.7)	7.1 (2.1)	207 (5.9)	754 (2854)	3371 (12761)
HG 10	10 (3.0)	7.6 (2.3)	268 (7.6)	893 (3380)	4455 (16864)
HG 12	12 (3.6)	8.5 (2.6)	386 (10.9)	1389 (5258)	7191 (27221)

* Typical dimensions – dimensions will vary based on project requirements/specifics

Although the inlet and outlet pipe diameters are only limited by the structural integrity of the outer structure itself, typical inlet pipe diameters are given in Table 2.

Table 2. Typical Inlet Pipe Diameter	
Model	Inlet Pipe Diameter in (mm)
HG 4	12 – 15 (300 – 375)
HG 5	15 – 18 (375 – 450)
HG 6	15 – 24 (375 – 600)
HG 7	18 – 24 (450 - 600)
HG 8	18 – 30 (450 – 750)
HG 9	24 – 30 (600 – 750)
HG 10	24 – 36 (600 – 900)
HG 12	30 – 48 (750 – 1200)

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 HG separator was measured in an independent laboratory (Alden Research Laboratory) for a full scale HG6. The K value ($h = K\ v2/(2g)$) for headloss calculations was determined to be 1.09 for flows up to the top of the inner chamber / outlet baffle.

TSS Removal Performance

Independent lab testing was conducted on a full scale HG6 separator at Alden Research Laboratory in Holden, MA in 2008. The test results are shown in Figure 5.

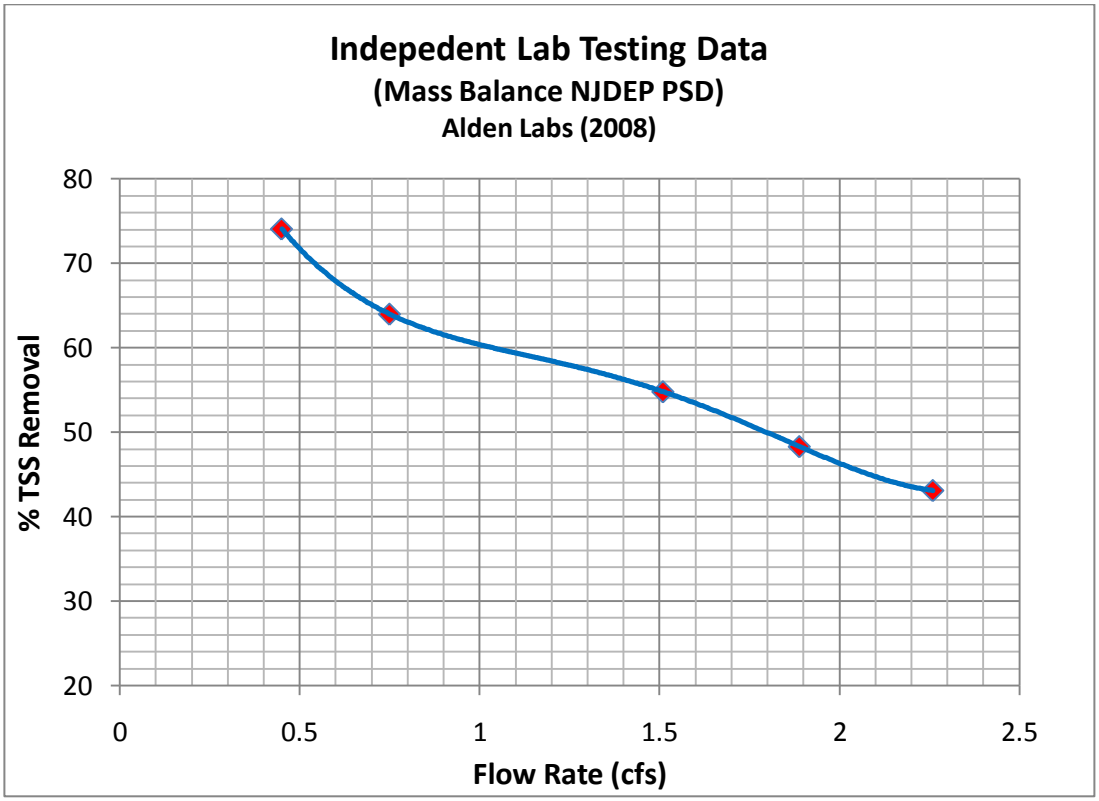


Figure 5. Independent Laboratory Testing (Alden, 2008)

The Hydroguard HG 6 has a 100% treatment flow rate of 1.8 cfs (0.05 cms) based on the Alden testing for the NJDEP particle size distribution (Figure 6).

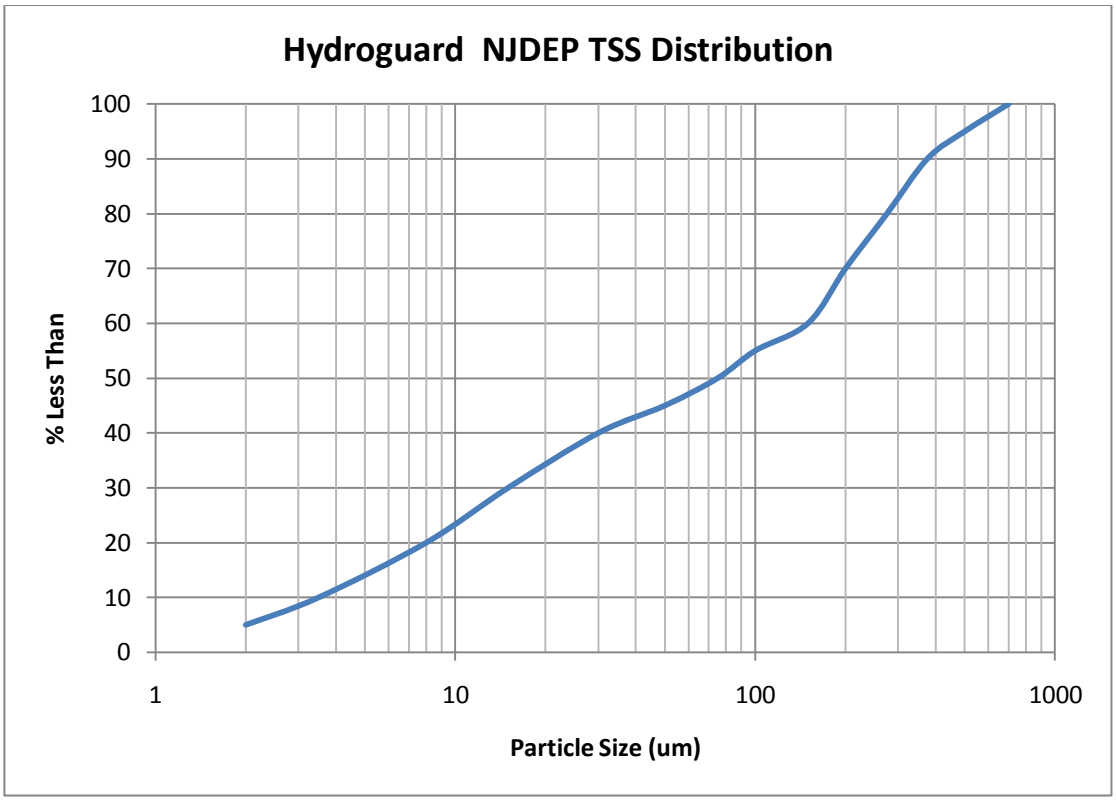


Figure 6. Hydroguard Testing TSS Distribution (NJDEP)

The particle size distribution shown in Figure 6 (40% < 40 um) directly affects the treatment flow rate (HG 6 = 1.8 cfs). Although there are numerous separators that are NJDEP certified, very few of the certified separators have tested with TSS smaller than 40 um even though NJDEP requires that 40% of the TSS tested be smaller than 40 um. Hydroworks tested TSS that had 43% of the material smaller than 40 um.

The lack of fines in TSS used by other companies makes comparison of treatment flow rates impossible. For example one company tested both TSS conforming to the NJDEP particle size distribution and TSS consisting of OK110 sand. The treatment flow rate using OK110 sand was 59% higher than the treatment flow rate using the NJDEP TSS distribution for the exact same unit.

Hydroworks HG Sizing

Hydroworks has developed a sizing program based on EPA SWMM 4.4. The sizing program can be used to size the Hydroguard based on either the independent laboratory sizing results or theoretical settling equations (Stoke's Law, Cheng's Equation) in conjunction with a user input particle size distribution and local rainfall records. The sizing program calculates TSS removal during every time step of the simulation and then aggregates the results to determine the long-term TSS removal performance. A copy of the software is included on the Hydroguard CD. For a copy of the software email us (info@hydroworks.com) or call us at 1-888-290-7900.

A comparison of laboratory performance versus theoretical settling (Stokes law, Figure 7) demonstrates that the Hydroguard is much more effective than an ordinary settling tank with the same storage volume.

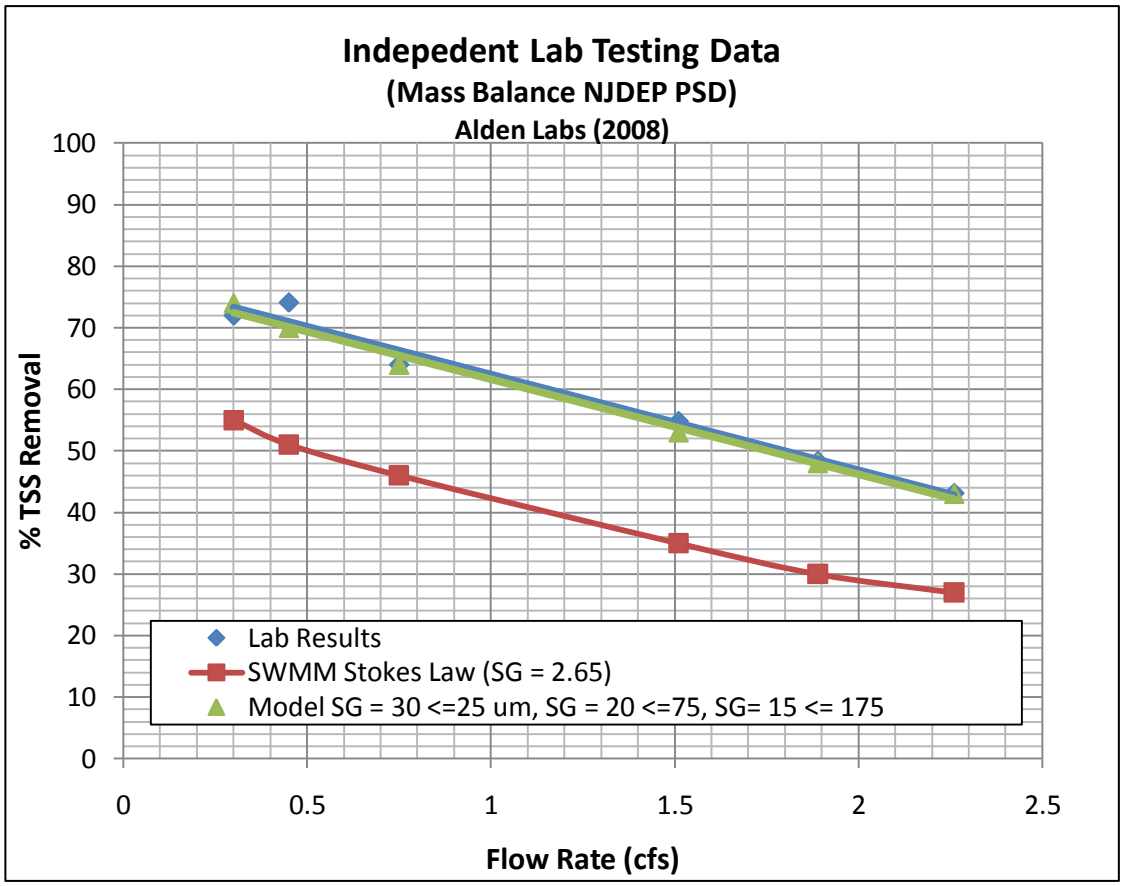


Figure 7. Hydroguard Laboratory TSS Removal versus Stokes Law

The independent laboratory TSS removal results are based on only one particle size distribution (NJDEP). In order to use the laboratory TSS removal results for sizing in the SWMM program with any user input particle size distribution, critical Peclet numbers for the removal of each particle size tested in the NJDEP distribution were determined from the laboratory testing results.

The Peclet number has been used as a dimensionless scaling number for sediment deposition in lakes (Dhamotharan, et. Al. 1981). Others have suggested its use for scaling of TSS removal results for hydrodynamic separators (Dhanak, 2008, Gulliver, Guo and Wu, 2008). The Peclet number is the ratio of convection (convective settling) to diffusion (turbulence keeping particles in suspension). The Peclet number (Equation 1) varies with the size of separator, particle size of TSS, and flow rate.

$$Pe = Vs\ h\ d\ /Q \qquad \text{Equation 1}$$

Where Pe = Peclet number
Vs = settling velocity
h = depth of separator sump
d = separator diameter
Q = flow rate

A particle will be removed in the separator if the Peclet number is equal to, or greater than, the Peclet number calculated for removal of that particle based on the independent laboratory results.

The TSS removal value at each flow rate during the independent laboratory testing provides an indication of the smallest particle removed at each flow rate based on the influent particle size distribution (Figure 6). The Peclet number was calculated for the smallest particle removed at each flow rate to generate a relationship between Peclet number and particle size removed in the Hydroguard.

The Peclet number is based on the settling velocity of the TSS particle. Settling velocities were calculated using Cheng (1997) (Equation 2) instead of Stoke's law since previous research (Cheng, 1997) has indicated that it provides better correlation with sedimentation rates measured in the field.

$$Vs = \nu/d_p\ [(25+1.2(d_1)^2)^{0.5} -5]^{1.5} \qquad \text{Equation 2}$$

$$d_1 = d_p\ [(g\ (\rho_s-\rho)/\ \rho)/\nu^2\ ]^{0.33}$$

Where Vs = settling velocity
ν = kinematic viscosity of water
d_p = particle diameter
ρ_s = particle density
ρ = water density

Cheng settling velocities provide values smaller than Stoke's law for particles smaller than 120 µm and settling velocities larger than Stoke's law for particles greater than 120 µm.

Figures 7 and 9 indicates that the relationship between TSS removal performance and flow rate can be estimated using a linear relationship for the flow rates tested in the laboratory ($r^2 = 0.98$). The linear regression equation from Figure 9 (Equation 3) was used to determine TSS removal results at various flow rates. Figure 6 was used with the resulting TSS removal results to determine the smallest particle size removed at each flow rate.

$$TSS\ Removal = -15.155\ Q + 77.267 \qquad \text{Equation 3}$$

Where Q = flow rate in ft^3/s

Table 3 provides a range of Peclet Numbers corresponding to TSS removals calculated using Equation 3 based on the independent laboratory results.

Table 3. Peclet Number for TSS Particle Size Removed			
Flow Rate (cfs)	TSS Removal (%)	Particle Removed (µm)	Peclet Number
0.48	70	18	0.053
1.14	60	35	0.085
1.47	55	55	0.163
1.80	50	110	0.532
2.46	40	170	0.928
3.12	30	210	1.114
3.78	20	290	1.745
4.44	10	430	3.231
4.77	5	655	6.797

Figure 8 shows the relationship between Peclet Number and Particle Size removed.

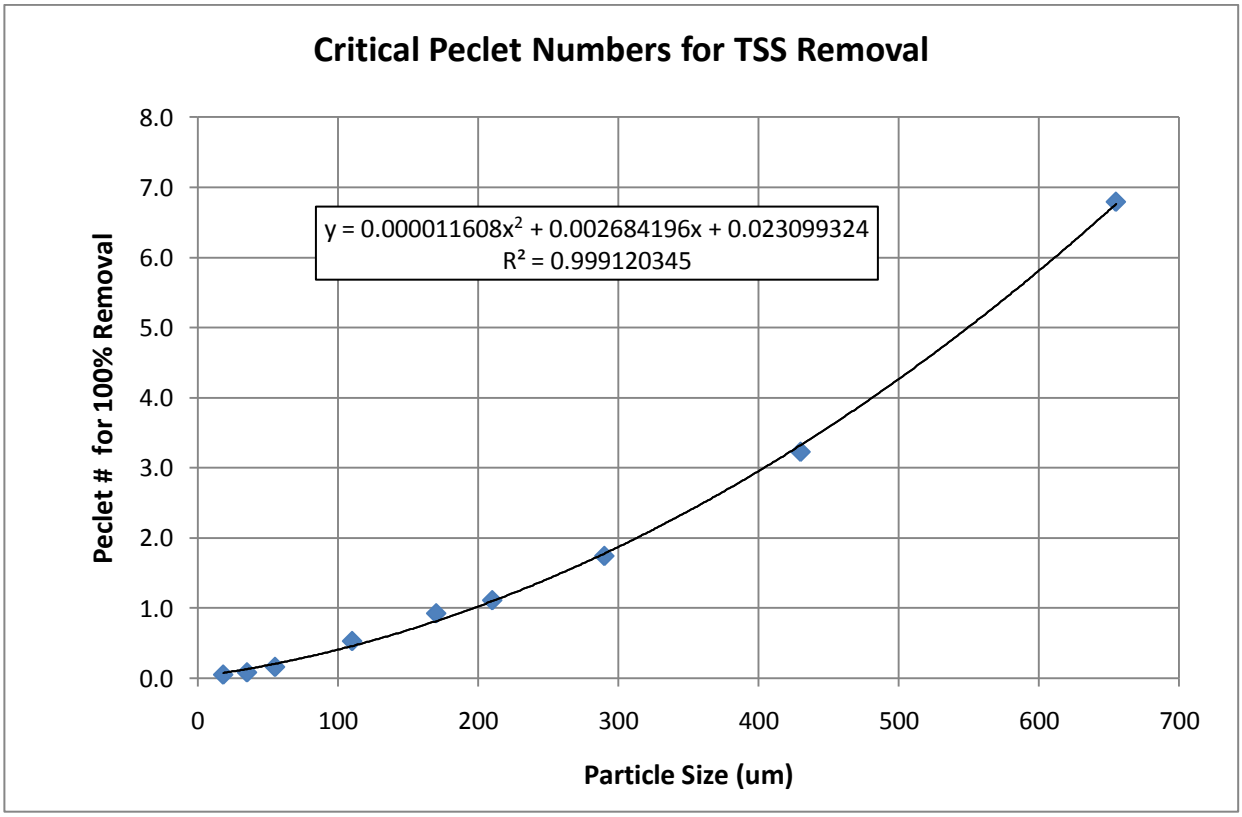


Figure 8. Critical Peclet Numbers for Particle Removal

Figure 8 indicates that a critical Peclet Number associated with the removal of a specific particle size can be calculated using equation 4 ($r^2 = 0.99$).

Critical Peclet Number = $0.0000116\ d^2 + 0.002684\ d + 0.023$ Equation 4

Where d= Particle Diameter (µm)

and Critical Peclet Number ≥ 0.050

Equation 3 was used to determine TSS removal in Table 3 instead of the actual testing results since the lowest TSS removal rate measured during the independent laboratory testing was 43 % which corresponds to a removed particle size of 151 µm. Equation 3 was used to allow the construction of a relationship between Peclet Number and settled particle size for particles between 150 µm and 655 µm. Table 4 provides the relationship between Peclet number and TSS removal rate based on the actual independent laboratory testing results.

Table 4. Peclet Number for TSS Particle Size Removed

Flow Rate (cfs)	TSS Removal (%)	Particle Removed (µm)	Peclet Number
0.15	73.8	14	0.106
0.30	72.0	16	0.068
0.45	74.1	14	0.034
0.75	64.0	27	0.079
1.51	54.8	57	0.172
1.89	48.3	120	0.605
2.26	43.1	151	0.801

Table 4 shows that the Peclet numbers are inconsistent at the lower flow rates due to the fluctuations in TSS removal results at the low flow rates. The results indicate that the smallest particle able to be effectively removed by the separator tested (Hydroguard HG6) during flow periods is 15 µm. Indeed the removal of particles smaller than 15 µm by hydrodynamic separators during flow through periods is not considered realistic due to the potential for these small particles to stay suspended in the water column. Accordingly the fluctuation in TSS removal rates with fine particles is expected at low flow rates due to experimental error and fluctuations in settling velocity for very fine particles. In order to properly account for this phenomenon, a minimum Critical Peclet number of 0.050 was established for any particle to be removed during flow conditions in the separator regardless of flow rate, separator size, and particle size diameter.

Equation 4 was used in the settling model to establish a critical Peclet Number for each particle size simulated in the model. For each size of separator and flow rate at any given timestep the Peclet number was calculated for each particle size in the distribution and compared to the critical Peclet number for that particle size. If the Peclet number calculated at the particular timestep exceeded the critical Peclet number the TSS associated with that particle size for that timestep was considered removed (settled). This calculation occurs for each timestep/flow rate and each particle size such that an overall TSS removal result for the simulation period can be determined.

Figure 9 shows the results from the sizing model simulated for constant flow rates to replicate the independent laboratory tests. The calculations of TSS removal using the Peclet Number methodology match the laboratory results (using Figure 6 for the particle size distribution) with a correlation coefficient of 0.96 (r^2 = 0.91).

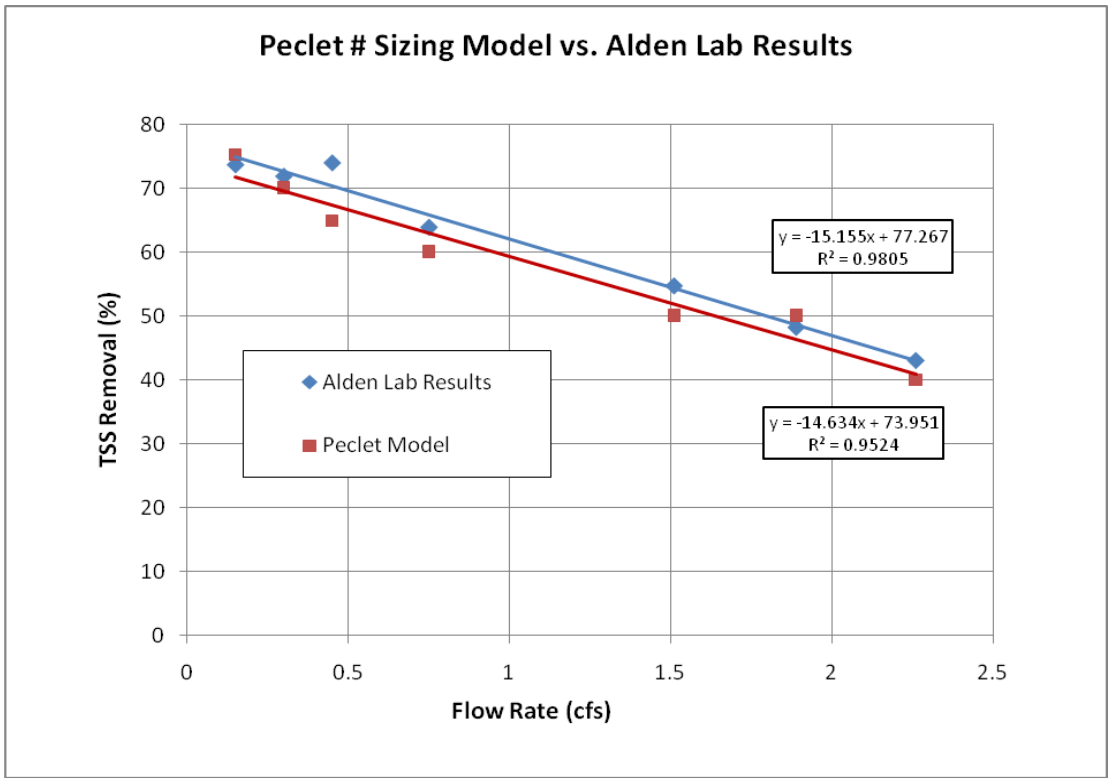


Figure 9. Independent Laboratory TSS Removal versus Peclet Sizing Model

Hydroworks added a Peclet routine to the USEPA SWMM model to determine TSS removal based on the Peclet number calibrated to the independent laboratory testing completed by Alden Research Laboratory in Holden, MA in 2008. A paper describing the Peclet sizing model is provided on the Hydroguard CD as well as the independent laboratory testing completed by Alden Labs.

Each stormwater infrastructure manufacturer designs their system differently. Comparisons between devices should be made using the same parameters (rainfall distribution/hydrology or flow rate, particle size distribution) to ensure that the comparisons are accurate.

Hydroworks will be pleased to size a HG separator for your application. Please call (888-290-7900) or e-mail us (support@hydroworks.com) for design support. We will require the following information to size a HG separator:

1. Upstream drainage area
2. Imperviousness
3. Geographic location (town/city, state) or rainfall station

4. Particle Size Distribution
5. Percent TSS removal required

A form is provided in Appendix A for design purposes. Please fax (888-783-7271) or email (support@hydroworks.com) the form to us and we will provide you with a recommended size of HG separator for your application.

If the Hydroworks HG unit is being sized against competitive products, please ask for a competitive sizing and provide the names of the competitors in addition to the information listed above.

Hydroguard Installation Instructions

For most units, the inner chamber and outlet baffle wall are installed at the pre-cast concrete manufacturing facility. This minimizes the potential for any installation errors.

Generally delivery of a Hydroguard separator is within 4 weeks of an approved drawing and signed order. If this timeframe does not conform to the timeframe of the project, Hydroworks can field install the internal components. Field installation of the internal components expedites the installation of the structure itself since the precast components of the structure can be delivered and installed typically within 1 week of an approved drawing and signed order. There is an additional charge for the field installation of the internal separator components. In addition, the top cap of the precast structure cannot be permanently installed until the internal components have been installed since the top cap of the structure must be removed to install the internal separator components.

During the handling of all pieces, the contractor shall ensure the pieces are not damaged by any lifting device. The use of straps, spreader bars, wooden blocks or other devices shall be used to prevent damage to the joint areas. If damaged (cracked, chipped) the damaged areas must be repaired with non-shrink grout prior to the installation.

Installation of the Hydroguard includes the following steps:

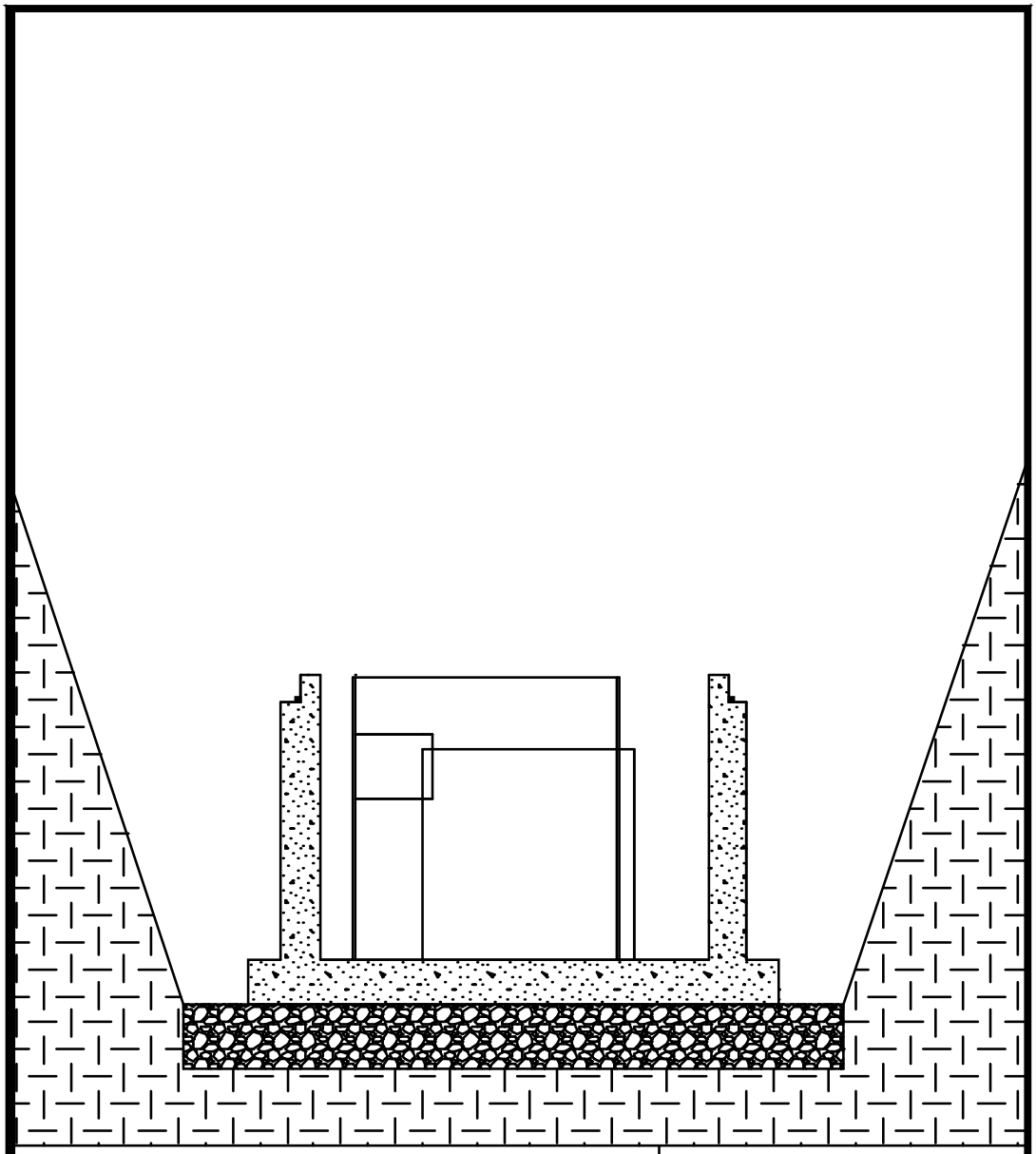
1. Excavation of the hole
   Excavation must conform to all local, state or federal requirements relating to open cut, sheeting, and trench box installations
2. Preparation of the bedding
   Prepare 12” (300 mm) of granular bedding. The bedding should conform to local or state standards and be free draining. In areas with high groundwater, de-watering shall be used to ensure the structure is installed in the dry.
3. Preparation of the joint surfaces
   Clean all joint surfaces (remove soil, sand, debris, etc) prior to applying the joint gasket
4. Application of the joint sealant/gasket
   Apply the supplied joint sealant/gasket around the shoulder of the joint making sure the gasket meets and there are no gaps that would compromise water tightness.

5. Install the base section
6. Check for level and alignment of the base section.
   If the base section is not level or is not aligned with the incoming and outgoing storm pipes, the base must be removed. If the base is not level the granular base shall be re-leveled prior to the base section being reset. The base section will have a vertical alignment mark(s) for the centerline of the inlet and/or outlet pipe. This line must be aligned with the appropriate pipe to ensure that the internal components of the separator are properly oriented.
7. Install the next riser section which contains the internal baffle pieces
   Apply the supplied gasket on the joint as per the base on the first riser section and install the next riser which will have the incoming and outgoing pipe holes as well as internal components. This section will have a vertical alignment mark that must line up with the alignment mark on the base
8. Install the remaining concrete riser sections to grade
   Install the other riser sections in accordance with the methodology for the first riser.
9. Fill all lifting holes (if present)
   All lifting holes shall be filled with concrete plugs and sealed with non-shrink grout
10. Backfill the structure up to the inlet and outlet pipes
    The unit must be backfilled with material acceptable to the engineer, local and state authorities. The backfill should be placed in 12” (300 mm) lifts and compacted after each lift to the standards set forth by the engineer or local/state authorities.
11. Install the inlet and outlet pipes
    The inlet and outlet pipes should be installed in the pipe holes provided. The pipes must be laid concentric within the holes. The pipes can be connected to the concrete structure using either flexible rubber boots or non shrink mortar or grout. If grout is to be used, the annular space between the wall and the pipes shall be plugged with non-shrinking mortar or grout. The mortar or grout is to be applied and cured as per the manufacturer’s recommendations such that there is zero leakage through the annular space. The mortar shall be finished smooth and flush with the interior and exterior concrete wall surfaces. The inlet pipe may protrude several inches into the structure but the outlet pipe should be installed such that the edges of the pipe are flush with the interior wall surface.
12. Connect the internal components
    The inner chamber is split between the mono-base and first riser section. The upper chamber is connected to the concrete riser by stainless steel bolts through slots in the chamber. There is a horizontal flange where the two sections meet. Caulking (Pro-Seal 34) is first applied to the lower flange. The bolts in the upper chamber securing the upper inner chamber to the concrete riser are then loosened such that the chamber slides down until the flanges meet and compress the caulking. The joined flanges are then bolted together using 18-8 stainless steel bolts, nuts and washers. Bolts shall be evenly spaced every 8” (200 mm) to 10” (250 mm) along the entire circumference of the joined flange. The bolts holding the upper chamber to the concrete wall are then re-tightened and the exterior surface where the two flanges meet and the slots in the upper chamber shall be caulked with Pro-Seal 34.
13. Install the top cap on the riser sections

Install the supplied gasket material to the upper riser as per the other riser sections. There will be a vertical alignment mark on the top cap that lines up with the inlet /outlet pipe riser section. The cap must be installed with these marks aligned to ensure that the frame and covers are properly oriented.

14. Grade adjustment
    Concrete grade adjustment rings (minimum 2” (50 mm) thick) or other acceptable materials to the engineer and local or state agencies (ex. brick with 0.5” (12.5 mm) mortar layer on interior and exterior surfaces) shall be used to adjust the frame and covers to the grade shown on the drawings
15. Set the Frame and Cover(s)
    Frames and covers shall be set to conform accurately to the finished ground or pavement elevation established by the approved drawing unless otherwise directed by the Engineer. Frames should be set in a full bed of mortar such that the frame is watertight.
16. Backfill the structure
    The remaining portion of the structure that is exposed shall be backfilled to grade or the sub-grade of the road or pavement surface in 12” (300 mm) lifts that are compacted to the engineer’s specifications.

The following drawings illustrate the installation steps.



Hydroguard Installation Instructions

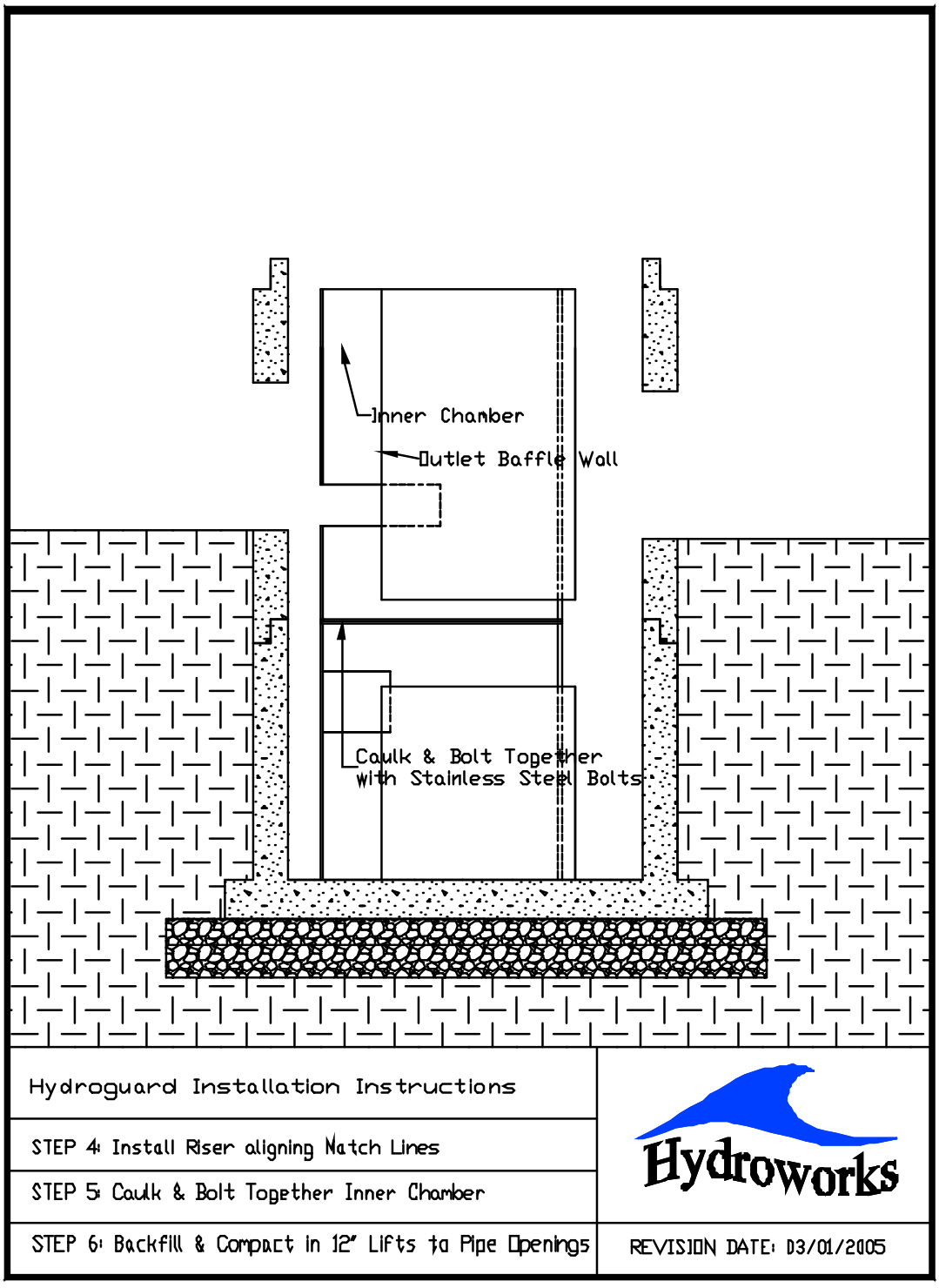
STEP 1: Prepare 12" Min. Compacted Gravel Base

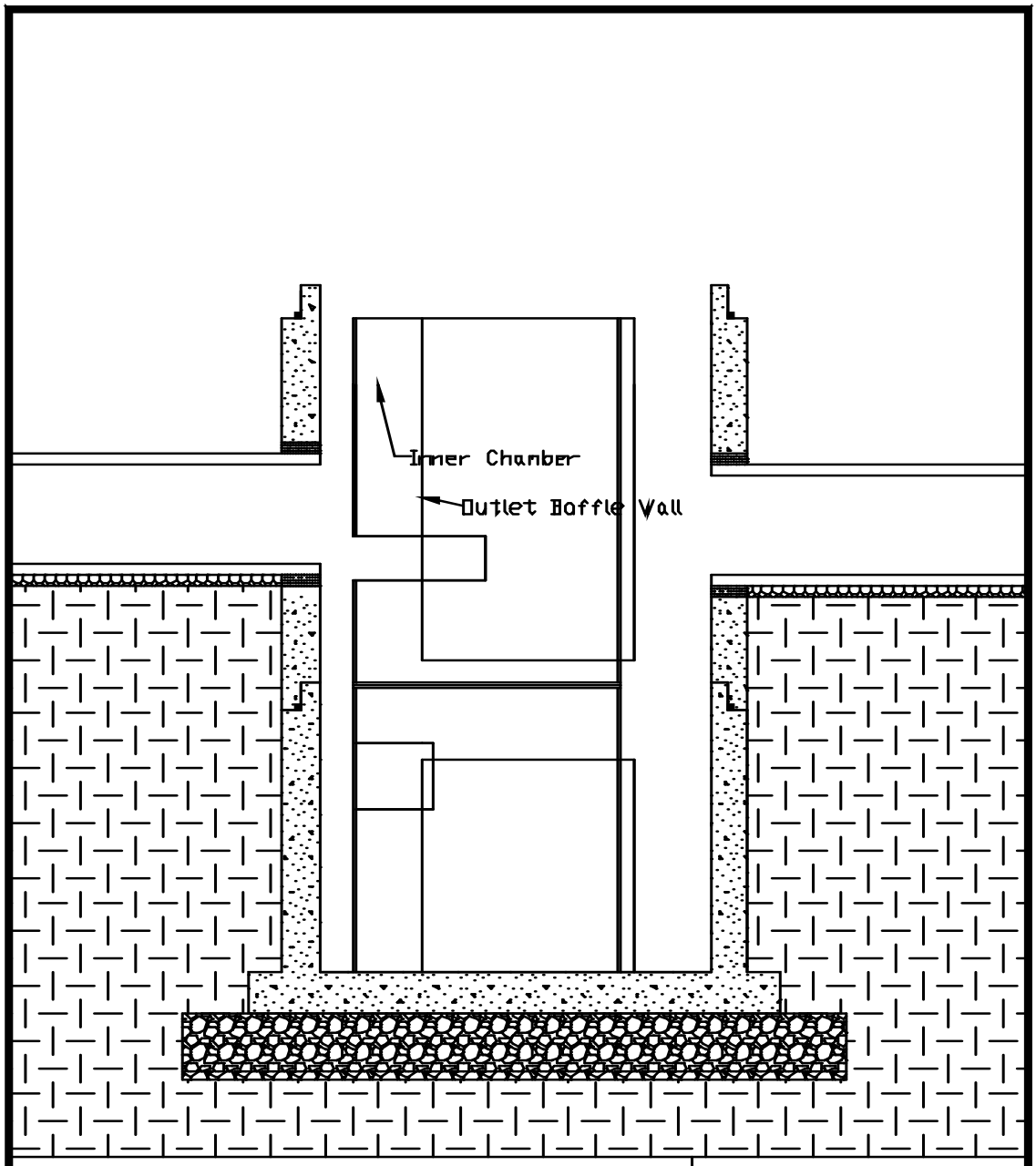
STEP 2: Install Manobase on Gravel Base

STEP 3: Clean Nonbase Joint and Install Gasket

Hydroworks

REVISION DATE: 03/01/2005


Inner Chamber
Outlet Baffle Wall
Caulk & Bolt Together
with Stainless Steel Bolts
Hydroguard Installation Instructions
STEP 4: Install Riser aligning Match Lines
STEP 5: Caulk & Bolt Together Inner Chamber
STEP 6: Backfill & Compact in 12" Lifts to Pipe Openings
Hydroworks
REVISION DATE: 03/01/2005



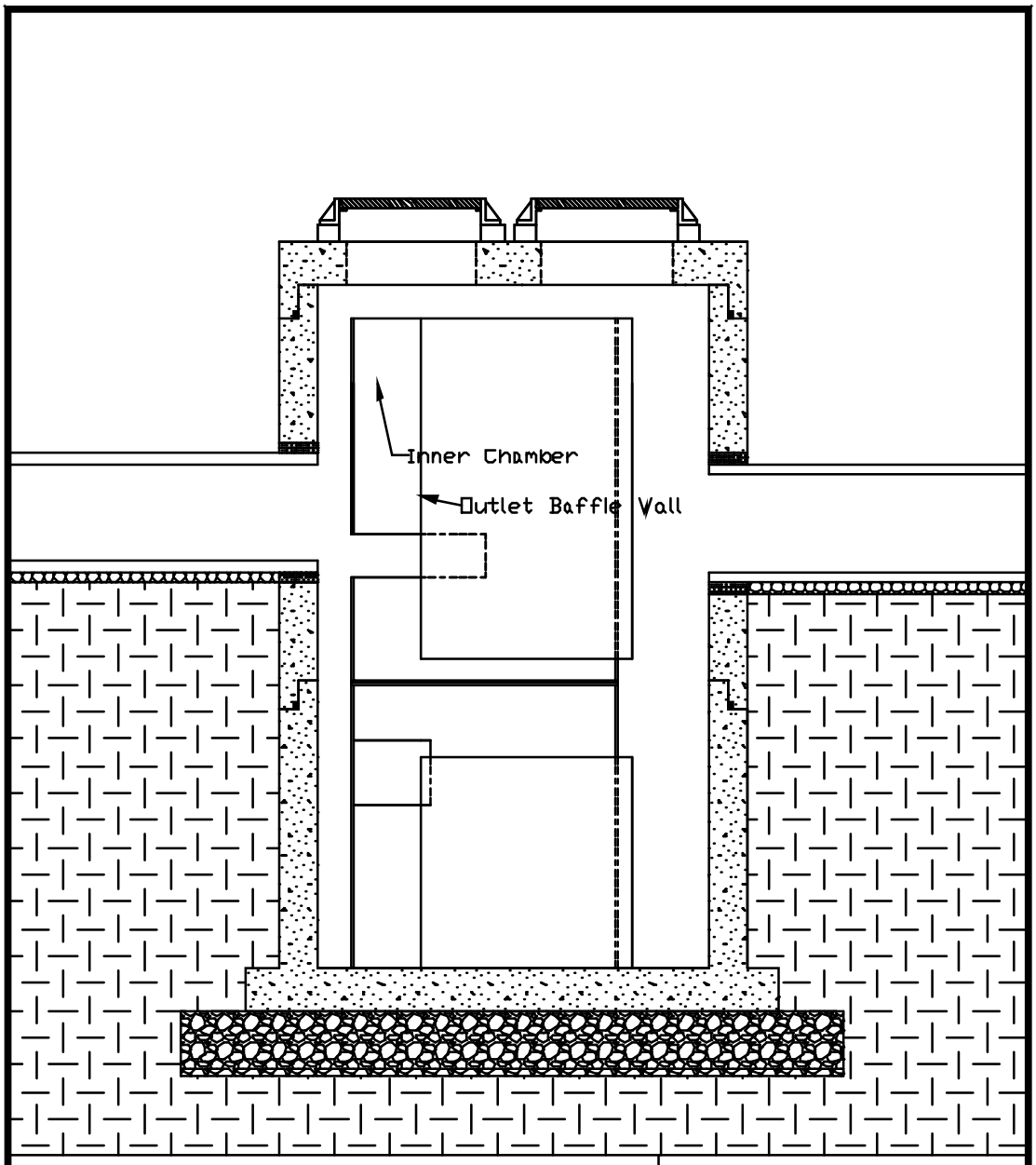
Hydroguard Installation Instructions

STEP 7: Connect Inlet and Outlet Pipes using flexible boots or non-shrink grout. Pipes must be centered in the pipe holes. Outlet pipe should be flush with concrete wall

STEP 8: Clean Riser Joint and Install Gasket

Hydroworks

REVISION DATE: 02/04/2006



Hydroguard Installation Instructions

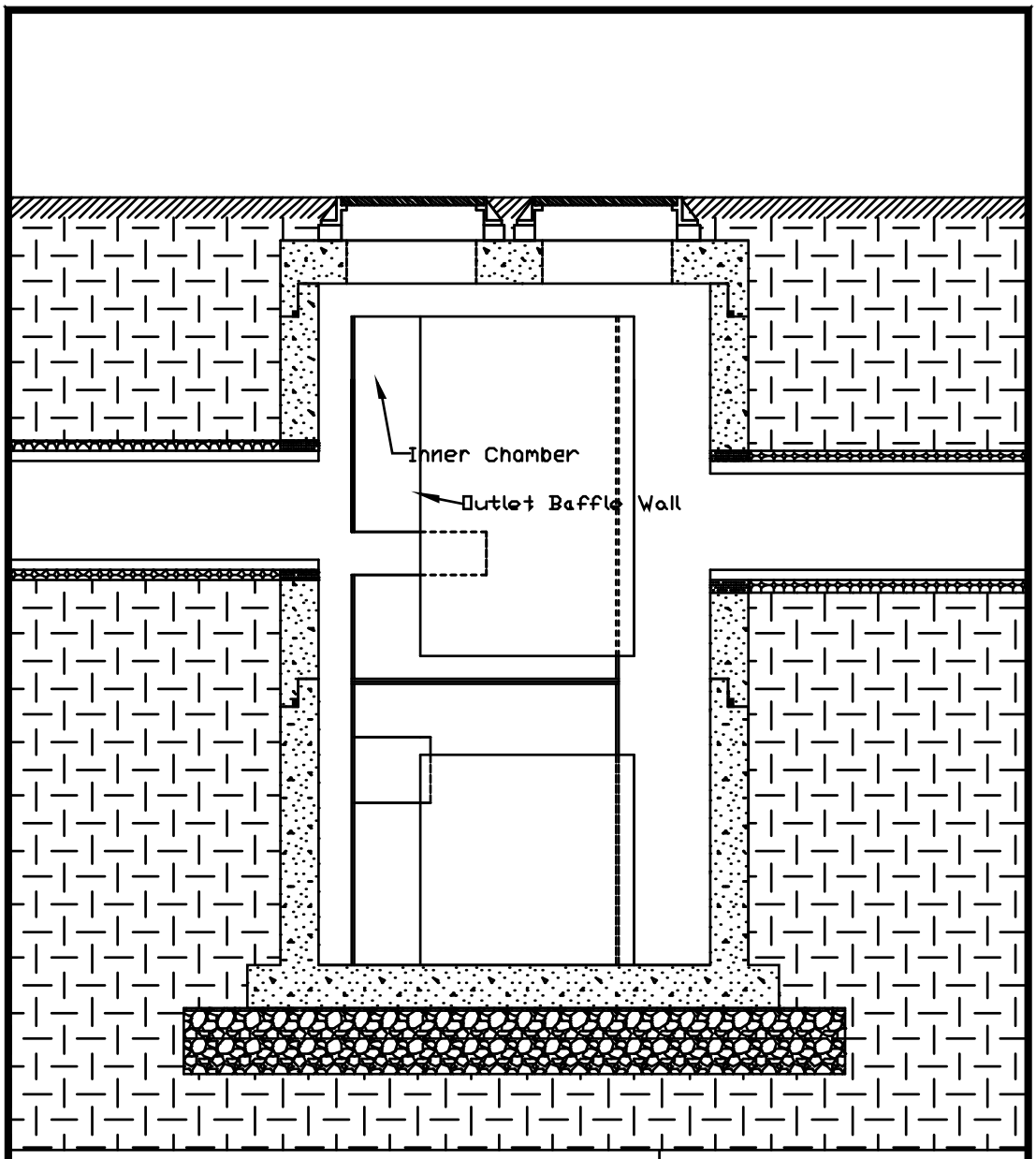
STEP 9: Install Flat Cap on top of Riser

STEP 10: Install Grade Adjusters as Required

STEP 11: Install Frame and Covers to meet Grade

Hydroworks

REVISION DATE: 03/01/2005



Hydroguard Installation Instructions

STEP 12: Backfill around Pipes with specified material

STEP 13: Backfill and compact with specified material to grade or pavement sub-grade as required

Hydroworks

REVISION DATE: 03/01/2005

Inspection and Maintenance

Inspection

Procedure

Floatables

A visual inspection can be conducted for floatables by removing the covers and looking down into the separator. Multiple covers are provided on Hydroworks HG units to access all areas of the separator (The HG 4 may have a single larger 32" (800 mm) cover due to the lack of space for multiple 24" (600 mm) covers)

TSS/Sediment

Inspection for TSS build-up can be conducted using a Sludge Judge® or Core Pro® 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 HG separator should be inspected every two weeks and after every large storm (over 0.5" (12.5 mm) of rain) during the construction period.

Post-Construction Period

The Hydroworks HG separator should be inspected once per year 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 HG separator should be inspected more frequently (4 times per year). The initial annual inspection will indicate the required future frequency of 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

Maintenance

Procedure

The Hydroworks HG unit is typically maintained using a vactor truck or clam shell bucket. There are numerous companies that can maintain the HG separator. Envirocalm, LLC, an affiliate company of Hydroworks offers inspection and maintenance services and can inspect and maintain the HG separator. (www.envirocalm.com).

Disposal of the contents of the separator depend on local requirements. Maintenance of a Hydroworks HG unit will typically take 1 to 2 hours.

Frequency

Construction Period

A HG separator can fill with sediment quickly during the construction period. It must be maintained when the depth of TSS/sediment reaches 27" (675 mm). It 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 open water surface on the inlet side of the outlet baffle wall.

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

Post-Construction Period

The HG separator must 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 open water surface on the inlet side of the outlet baffle wall. It should also be maintained once the accumulated TSS/sediment depths reach 14" (350 mm). For typical stabilized post-construction sites (parking lots, streets) it is anticipated that maintenance will be required annually or once every two years. More frequent or less frequent maintenance will be required depending on individual site conditions (traffic use, stabilization, storage piles, etc.). The long term maintenance frequency can be established based on the maintenance requirements during the first several years of operation if site conditions do not change.

Installation Personnel

Hydroworks sends out a field installation person to make some internal connections once the contractor has set the structure. The field installer reviews the installation and repairs any deficiencies relating to the installation that they can repair, or alternatively notifies the contractor of any installation errors that need to be corrected.

Over the past 15 years of dealing with proprietary storm water quality structures, it is our experience that many of the structures are installed with some deficiencies. These deficiencies result from a lack of contractor supervision. Most other vendors do not send anybody to the job site to assist the contractor or review the installation. This allows the contractor to bury their mistakes with the unit. Hydroworks sends a field installation person to review the installation for each separator that is installed in the ground. This is a major advantage over other competing products.

Approvals

Hydroguard has received interim verification from the New Jersey Center for Advanced Technology (NJCAT).

The Hydroworks Hydroguard is rated a 2 in the MASTEP database for MA. MASTEP rates stormwater products on a scale of 1 to 5 based on the quality of data supporting the vendor claims. The highest rating is 1 and the lowest rating is 5. The rating of 2 is the highest rating given to any hydrodynamic separator.

The Hydroworks Hydroguard is an approved product by the Massachusetts Plumbing Board.

Hydroworks is on the list of approved stormwater units for both ConnDOT and MDC (Metropolitan District of Connecticut – Hartford.

Hydroguard is certified by the New Jersey Department of Environmental Protection (NJDEP)

Hydroworks Hydroguard is approved by the Wisconsin Department of Commerce and the City of Virginia Beach.

Hydroguard has been used extensively throughout the United States. Over 1000 Hydroguard separators have been installed in RI, CT, MA, MD, NJ, NY, NH, PA, WI, IL, IN, IA, KY, OH, MN, CO, FL, VA and TX since 2004.

Technical Assistance

Hydroworks is available to assist you with the design and implementation of a HG separator for your development application. Please call (888-290-7900) or email (support@hydroworks.com) Hydroworks regarding design issues and applicability of the HG unit for your application.

Contact Information

Hydroworks HG Design and Manufacturing

Hydroworks	888-290-7900	Toll
	908-272-4411	Telephone
	888-783-7271	Fax
	www.hydroworks.com	Web site
	info@hydroworks.com	Promotional/technical literature
	support@hydroworks.com	Technical assistance

BMP Inspection and Maintenance

Envirocalm	888-290-7900	Toll
	908-272-4411	Telephone
	888-783-7271	Fax
	www.envirocalm.com	Web site
	info@envirocalm.com	Promotional/technical literature
	support@envirocalm.com	Technical Assistance

APPENDIX A

HYDROWORKS HG DESIGN FORM

HYDROGUARD DESIGN REQUEST SHEET

Required Information

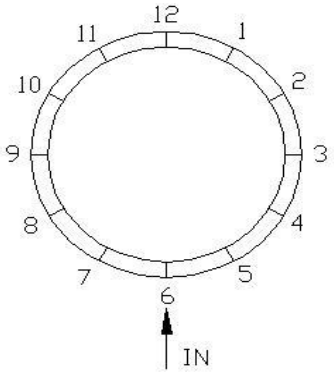
Units (Metric / US) _____

Project Name: _____

City _____ State / Province _____

Drainage Area (ac) _____ Imperviousness (%) _____

Required TSS Removal (%) _____ Inlet Pipe Slope (%) _____



Inlet Pipe

Please show the orientation of the outlet pipe and angle between the inlet and outlet pipe on the diagram on the left

Rim Elevation _____ ft / m

Inlet Pipe
In Elev. _____ft/m Diam. _____ in/mm Material _____

Outlet Pipe
Out Elev. _____ft/m Diam. _____ in/mm Material _____

WQF _____cfs/cms Water quality flow

Peak Pipe Flow _____ cfs/cms (i.e. 10 yr or 25 yr flow)

TSS Particle Size Distribution (Enter values of size (µm) and % **or** select a checkbox)

TSS Size (µm)	% of TSS by mass

- NJDEP (program default) ☐
- Fine Sand (150 µm) ☐
- Coarse Sand (1000 µm) ☐
- Silt (20 µm) ☐

Optional Information

Upstream Storage (i.e. upstream flood control pond) ☐
(If checked please fill out storage discharge table)

Storage (ft^3)	Discharge (ft^3/s)

Surface Slope (%) _____

Overland Flow Length (ft/m) _____

Maintenance Freq. (months) _____

Constant Baseflow (ft^3/s / m^3/s) _____

Tailwater (ft/m) _____

Please fax this sheet to Hydroworks® at (888-783-7271). If you have questions or need assistance please call 888-290-7900 or email support@hydroworks.com.

APPENDIX B

STANDARDS / SPECIFICATION

SECTION 01

STORM WATER QUALITY SEPARATOR

PART 1 - GENERAL

1.1 DESCRIPTION:

This section specifies construction of outside, underground storm water quality separators. The storm water quality separators shall include a vortex motion (centripetal force, swirl separator) that provides enhanced settling characteristics.

1.2 QUALITY ASSURANCE:

A. Products Criteria:

1. Multiple Units: When two or more separators are required on one project, these units shall be products of one manufacturer.
2. Identification: The separator manufacturer's name, or identifiable trademark, shall be cast into the frame and cover(s) /grate of each separator.

B. The separator must comply with the rules and regulations of the Public Utility having jurisdiction over the connection to public storm sewers and the extension, and/or modifications to Public Utility systems.

1.3 SUBMITTALS:

A. Submit SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Manufacturers' Literature and Data: Submit the following as one package:

1. Sizing Calculations including Particle Size Distribution.
2. Operations and Maintenance Manual.
3. Independent Laboratory or Field Testing Results.
4. Frames and Covers / Grates.
5. CAD Detail of Separator

1.4 APPLICABLE PUBLICATIONS:

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American Society for Testing and Materials (ASTM):

A48-03/A48M-03 ..... Gray Iron Castings

A536-84(2004) ..... Ductile Iron Castings

A615-05/A615M-05 ..... Deformed and Plain-Billet Steel Bars for Concrete Reinforcement

A655-04e1/A655M-04e1... Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe

C76-05a/C76M-05a ..... Reinforced Concrete Culvert, Storm Drain and Sewer Pipe

C139-03 ..... Concrete Masonry Units for Construction of Catch Basins and Manholes

C150-04ae1 ..... Portland Cement

C443-05/C443M-05 ..... Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

C478-03a/C478M-03a ..... Precast Reinforced Concrete Manhole Sections

C857-95(2001) ..... Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

C923-02/C923M-02 ..... Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes and Materials

C1103-03/C1103M-03 ..... Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines

D256 ..... Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

D570 ..... Standard Test Method for Water Absorption of Plastics

D638 ..... Standard Test Method for Tensile Properties of Plastics

D648 ..... Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position

D698-00ae1 ..... Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))

D785 ..... Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position

D790 ..... Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D792 ..... Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

D1056-00 ..... Flexible Cellular Materials-Sponge or Expanded Rubber

NOTE: ASTM test methods shall be the current version as of the date of advertisement of the project.

C. American Association of State Highway and Transportation Officials (AASHTO):

HB17 ..... Standard Specifications for Highway Bridges (AASHTO Standard H20-44)

PART 2 - MATERIAL

2.1 SEPARATOR EXTERIOR

A. The exterior shell of the separator shall be constructed of precast reinforced concrete rings, precast reinforced sections, or cast-in-place concrete. The following requirements must be adhered to for the concrete portion of the separator:

1. Precast Reinforced Concrete Rings: Rings or sections shall have an inside diameter as indicated on the drawings, and shall be not less than 1200 mm (48 inches) in diameter. Wall thickness shall conform to requirements of ASTM C76. Tops shall conform to ASTM C478. Top section shall be a flat top type.
2. Precast Reinforced Concrete Manhole Risers and Tops: Design, material and installation shall conform to requirements of ASTM C478. Top sections shall be flat.
3. Flat top manhole tops shall be reinforced concrete rated for AASHTO HS20-44 loading.
4. Concrete for precast sections shall have a minimum compressive strength of 35 MPa (5,000 psi) at 28 days, ASTM A615, Grade 60 reinforcing steel, rated for AASHTO HS20-44 loading with 30 percent impact, and conform to ASTM C-857.

5. Mortar mixture shall be by volume, 1 part of Portland cement and 2 parts sand. Water in mixture shall produce a stiff, workable mortar, but shall not exceed 21L (5-1/2 gallons) per sack of cement.
6. Flexible sealing compound shall be packaged in extruded preformed shape, sized to completely fill the joint between precast sections, and form permanently flexible watertight seal. The sealing compound shall be non-shrink and meet AASHTO M-198B.

2.2 CASTINGS:

1. Frames and covers shall be gray cast iron conforming to ASTM A48 or cast ductile iron conforming to ASTM A536. The frame and cover shall be rated for HS20-44 loading, and have the name of the separator manufacturer cast into the cover. The cover shall be a minimum of 600 mm (24 inches) in diameter. The bearing surface of the frame and cover shall be machine finished. The cover shall fit firmly on the frame without movement when subject to traffic.
2. Frame and Grates shall be cast gray iron conforming to ASTM A48 or cast ductile iron conforming to ASTM A536. The frame and grate shall be rated for HS20-44 loading, and have the name of the separator manufacturer cast into the grate. The grate shall be a minimum of 750 mm (30 inches) square or 800 mm (32”) in diameter. The bearing surface of the frame and cover shall be machine finished. The cover shall fit firmly on the frame without movement when subject to traffic.

2.3 CONCRETE:

Concrete shall be in accordance with local State Department of Transportation standards. For concrete not specified in above standards, concrete shall have a minimum compressive strength of 20 MPa (3000 psi) at 28 days. The cement shall be Type III conforming to ASTM C150.

2.4 REINFORCING STEEL:

Reinforcing steel shall be deformed bars, ASTM A615, Grade 40 unless otherwise noted.

2.5 RESILIENT CONNECTORS:

Resilient Connectors: Flexible, watertight connectors used for connecting pipe to manholes and inlets shall conform to ASTM C923.

2.6 INTERNAL BAFFLES:

Internal baffles are to be made of co-polymer polypropylene conforming to a tensile strength of 4000 psi (ASTM D-638),an Izod impact value of 2.5 (ASTM D-256), water absorption of 0.01% (ASTM D-570), a density of 0.91 (ASTM D-792), a flexural modulus of 195000 (ASTM D-790), a heat distortion temperature of 190 °F (ASTM D-648), and a Rockwell Hardness of 74 (ASTM D-785). Thickness of baffles will be ¼" for 48" diameter separators, 3/8" for separators between 60" and 96" in diameter and ½" for separators greater than 96" in diameter. Co-polymer polypropylene joints must be nitrogen welded.

2.7 FASTENERS:

Internal baffles are to be fastened to the precast concrete structure using stainless steel hardware Grade 304 or 316. Stainless steel wedge anchors used to fasten the internal baffles to the concrete wall are to be ½" in diameter and 4.5" long. Fender washers (2" diameter) are to be used with wedge anchors where the internal baffles are fastened to the concrete walls to disperse the anchor pressure over the baffle surface area.

PART 3 - EXECUTION

3.1 EXCAVATION FOR STORM WATER SEPARATORS:

Excavation and backfilling for storm water quality separators shall be in accordance with all other applicable portions of the EARTH MOVING section for the project.

3.2 SEPARATOR BEDDING:

The bedding surface of the separator shall provide a firm foundation of uniform density throughout the entire area of the separator. If not otherwise instructed by the engineer or local or state requirements, the separator should be set on 12" of granular bedding. The bedding should conform to local or state standards and be free draining. In areas with high groundwater,

de-watering shall be used to ensure the structure is installed in the dry.

3.3 SEPARATOR CONSTRUCTION:

A. General:

1. Precast Concrete Base and Risers/Rings:
   a. Precast reinforced concrete rings and base shall be installed true and plumb. The joints between rings and between rings and the base and top shall be sealed with a preformed flexible gasket material specifically manufactured for this type of application. Adjust the length of the rings so that the flat top section will be at the required elevation pursuant to any local or project specific grade adjustment requirements.
   b. Precast reinforced concrete manhole risers and tops. Install as specified for precast reinforced concrete rings.
2. Lifting Holes:
   a. All lifting holes shall be filled with concrete plugs and sealed with non-shrink grout.
3. Concrete Structure Joints:
   a. All joint surfaces must be clean prior to the application of the joint gasket. The gasket shall be applied according to the manufacturer’s specifications to ensure water tightness.
4. Inlet and Outlet Pipes:
   a. The inlet and outlet pipes should be installed concentric in the pipe holes provided. The pipes can be connected to the concrete structure using either flexible rubber boots or non shrink mortar or grout. If grout is to be used, the annular space between the wall and the pipes shall be plugged with non-shrinking mortar or grout. The mortar or grout is to be applied and cured as per the manufacturer’s recommendations such that there is zero leakage through the annular space. The mortar shall be finished smooth and flush with the interior and exterior concrete wall surfaces. The inlet pipe may protrude several inches into the structure but the outlet pipe

should be installed such that the edges of the pipe are flush with the interior wall surface.

5. Top Cap:
   a. The cap must be installed according to the approved drawings to ensure that the access openings are aligned properly for inspection and maintenance.
6. Frame and Covers / Grates:
   a. Install separator frames and covers/grates on a mortar bed, and flush with the finish pavement. Frames and covers/grates shall not move when subject to vehicular traffic. Install a concrete collar around the frame to protect the frame from moving until the adjacent pavement is placed. In unpaved areas, the rim elevation shall be 50 mm (2 inches) above the adjacent finish grade. Install a 100 mm (4 inches) thick, by 300 mm (12 inches) concrete collar around the perimeter of the frame. Slope the top of the collar away from the frame.
   b. Concrete grade adjustment rings (minimum 2” thick) or other acceptable materials to the engineer and local or state agencies shall be used to adjust the frame and covers/grates to the approved grade elevation.

3.4 BACKFILL:

The unit must be backfilled with material acceptable to the engineer, and local and state authorities. The backfill should be placed in 12” lifts and compacted after each lift to the standards set forth by the engineer or local/state authorities.

3.5 INSPECTION OF SEPARATORS:

Inspect and obtain the Resident Engineer's approval. Thoroughly clean out separator before inspection.

3.6 TESTING OF SEPARATOR WATER TIGHTNESS:

1. Exfiltration Test:
   a. Subject separator to hydrostatic pressure test produced by the head of water at the depth of the outgoing separator pipe invert (full tank). Maintain head of water for one hour for full absorption by concrete structure before testing. Leave separator for a 24 hour period without addition of water. Measure water loss in separator after 24 hour test by measuring water volume

needed to fill the separator back up to outgoing pipe invert. During the 24 hour test period, the measured maximum allowable water loss due to exfiltration shall be 0.5% of the original permanent pool (separator) storage volume.

b. If measurements indicate exfiltration is greater than maximum allowable leakage, take additional measurements until leaks are located. Repair and retest.

PART 4 – PERFORMANCE

1. Annual TSS Removal:

   The storm water separator will be designed to satisfy all site specific, local, and state regulatory requirements. If the separator is designed for total suspended solids (TSS) removal, the design should be based on using continuous analysis with local precipitation data. Designs based on TSS removal will be designed using the following particle size distribution and an annual load removal of 80% unless a different regulatory or site specific distribution and TSS removal rate are specified.

Design Particle Size Distribution	
Diameter (μm)	Percentage(%) by Mass
8	20
50	25
100	15
250	30
500	5
1000	5

2. Trash Removal:

   The separator will remove over 90% of floatable trash and sinking trash at all flow rates influent to the separator.

3. Treatment Flow Rate:

   The separator will fully treat the water quality flow rate without by-pass. The water quality flow rate will conform to local or state calculation requirements. In the absence of specific local or state calculation methods, the water

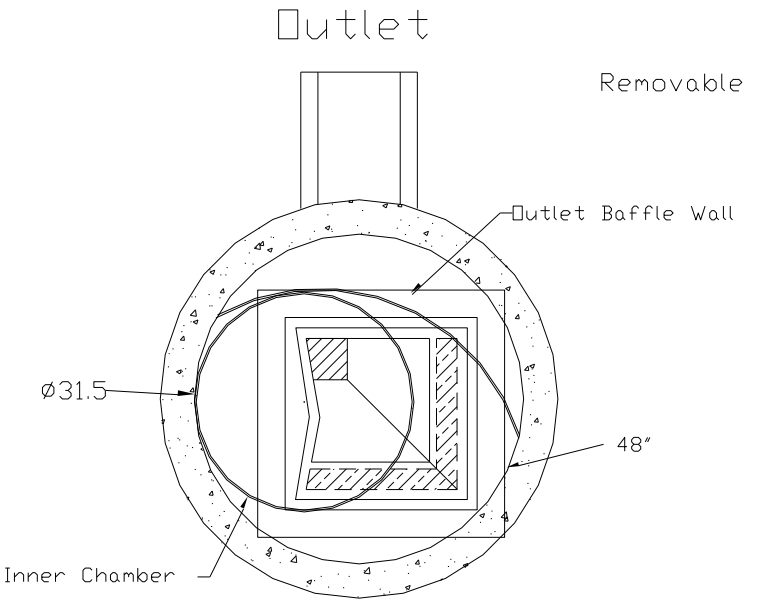
quality flow rate will be calculated based on a Rational Method calculation using 1 inch per hour as the rainfall intensity, the area draining to the separator, and the imperviousness of the drainage area.

4. Oil Removal:
   The separator will remove 95% of free oil spills during dry weather conditions. The separator will remove a minimum of 85% of the free oil influent to the separator up to the water quality flow rate during wet weather conditions.

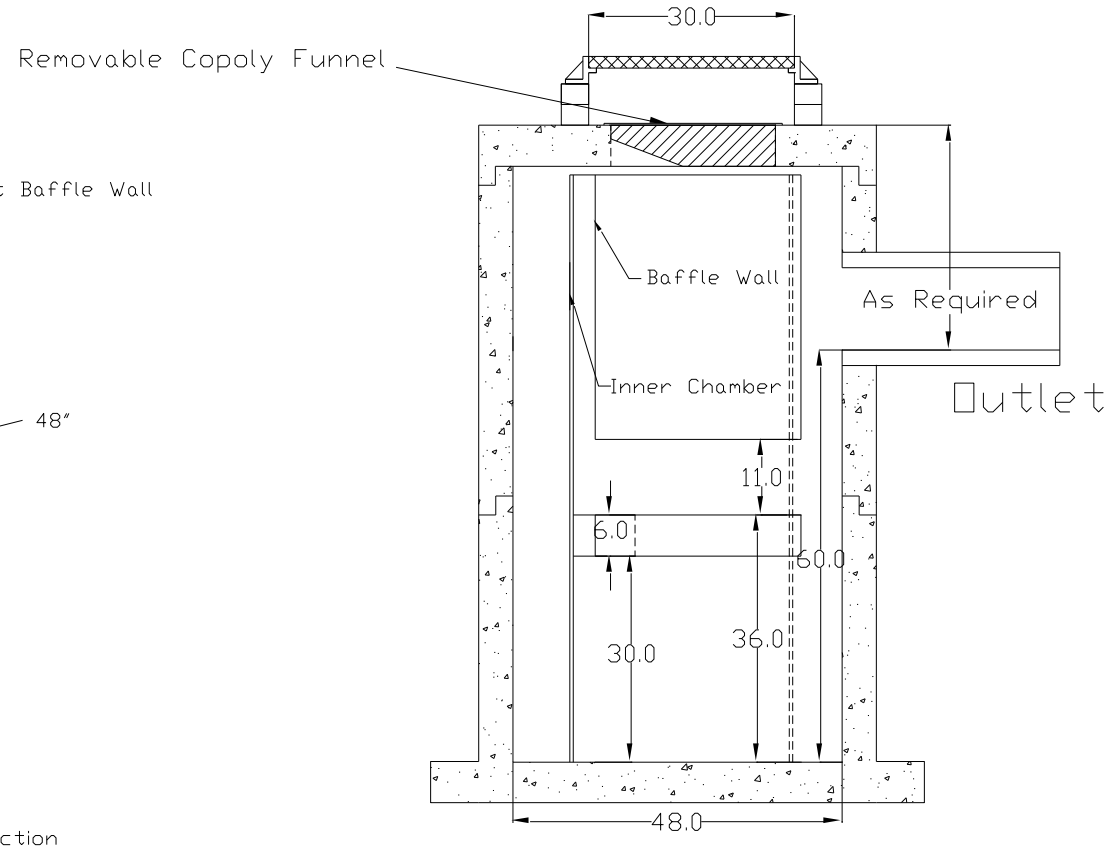
- - - E N D - - -

APPENDIX C

HYDROWORKS HG CAD DRAWINGS



Plan



Profile

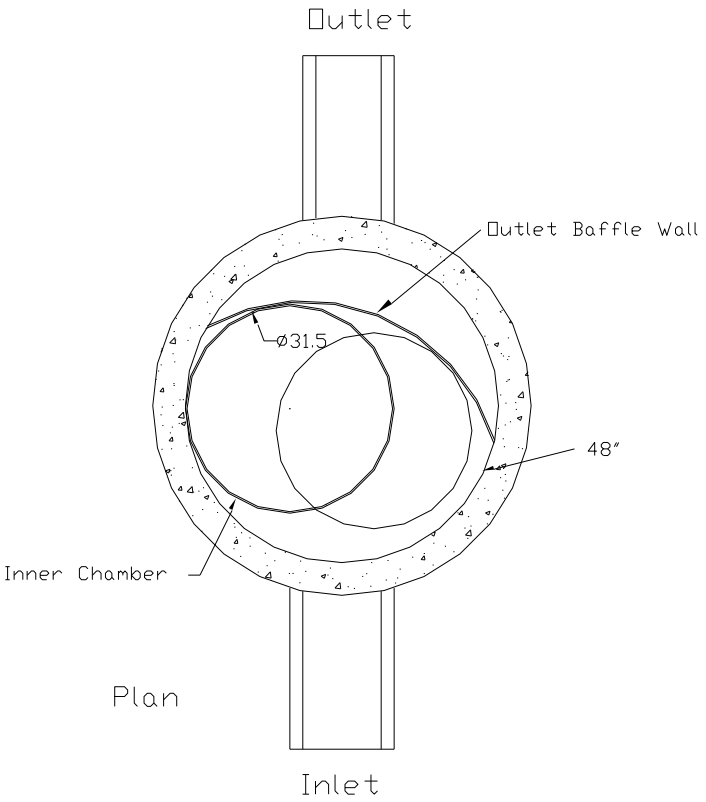
U.S. Patent No. 6,951,619

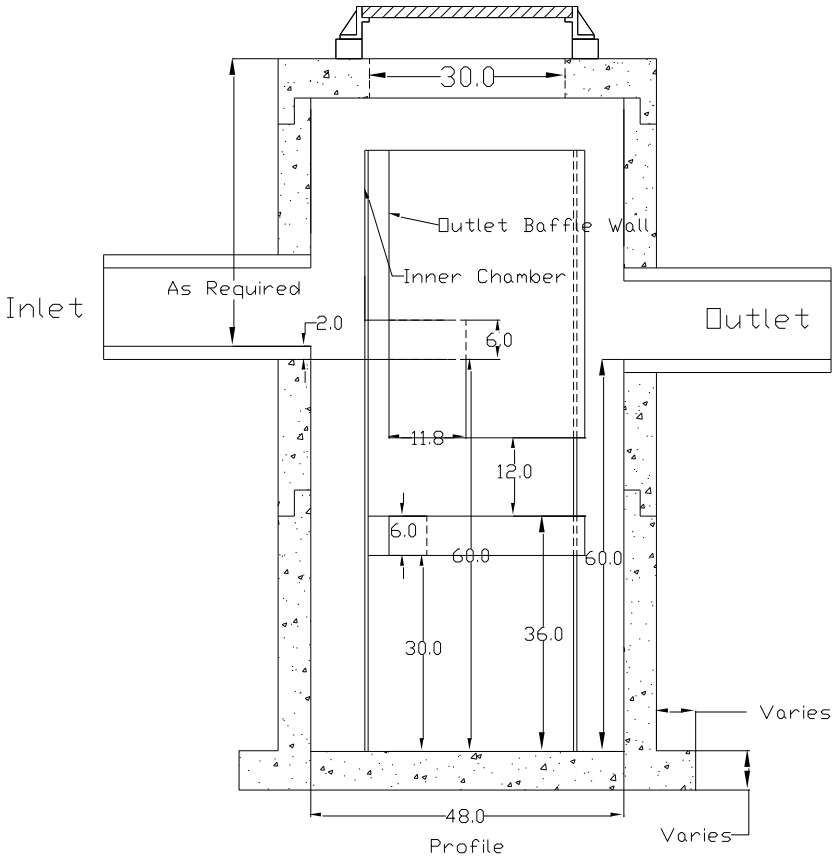
Dimensions in inches
Permanent Pool Volume = 450 US gallons
The Hydroguard must be cleaned after the construction period if it is used as a sediment and erosion control measure
The Hydroguard should be inspected once per year for stabilized sites
Inspection will determine the maintenance frequency (annual maintenance or once every two years typical for stabilized sites)
Sites with unstable conditions (exposed soil or materials storage) will require more frequent inspection and maintenance

Hydroworks, LLC
50 S. 21st St., Kenilworth, NJ 07033
Phone: 888-290-7900 Fax: 888-783-7271
Web: www.hydroworks.com

Hydroworks HG4i (48"Ø) Inlet
PROJECT:
LOCATION:
REVISION DATE: 01/09/2009

Hydroworks





U.S. Patent No. 6,951,619

Dimensions in inches
Permanent Pool Volume = 450 US gallons
The Hydroguard must be cleaned after the construction period if it is used as a sediment and erosion control measure
The Hydroguard should be inspected once per year for stabilized sites
Inspection will determine the maintenance frequency (annual maintenance or once every two years typical for stabilized sites)
Sites with unstable conditions (exposed soil or materials storage) will require more frequent inspection and maintenance

Hydroworks, LLC
50 S 21st St., Kenilworth, NJ 07033
Phone: 888-290-7900 Fax: 888-783-7271
Web: www.hydroworks.com

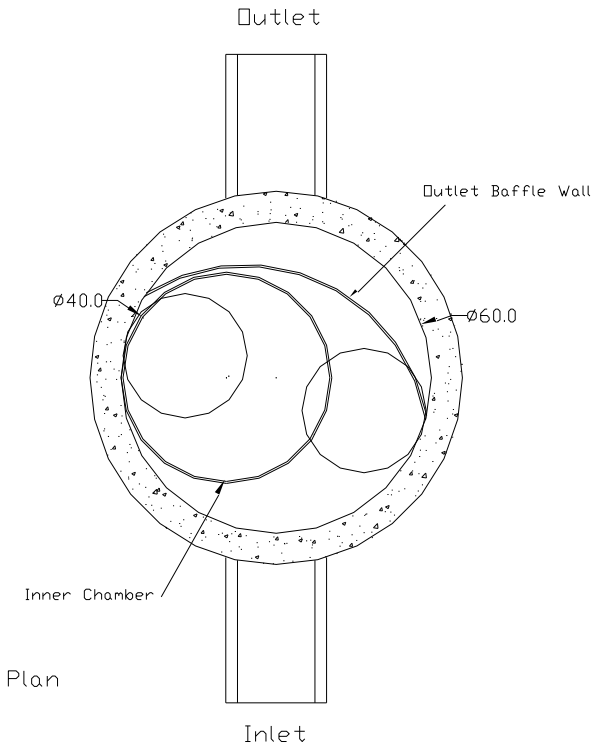
Hydroworks HG4 (48″Ø)

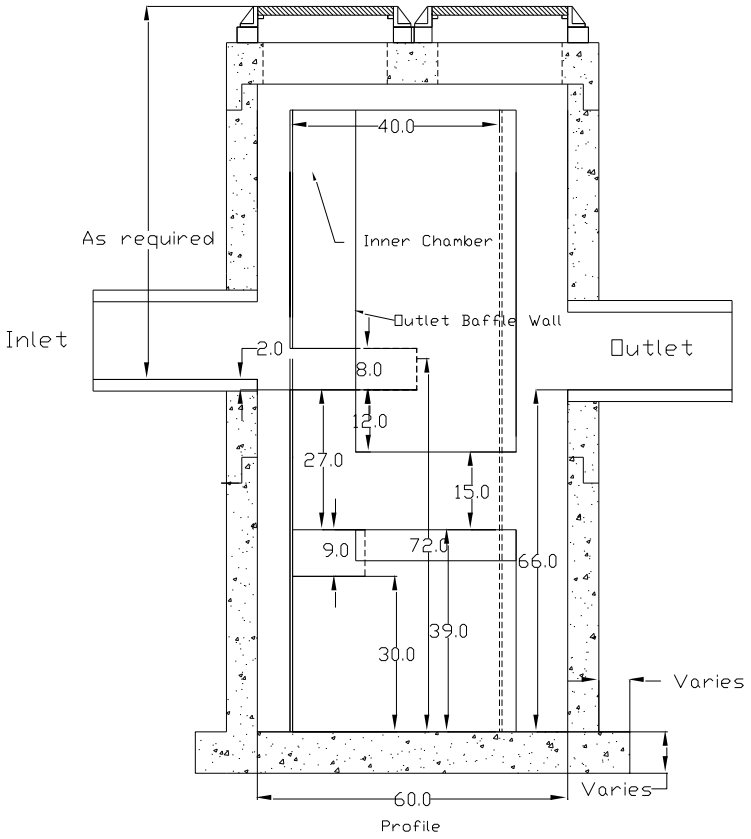
PROJECT:

LOCATION:

REVISION DATE: 01/09/2009

Hydroworks





U.S. Patent No. 6,951,619

Dimensions in inches
Permanent Pool Volume = 800 US gallons
The Hydroguard must be cleaned after the construction period if it is used as a sediment and erosion control measure
The Hydroguard should be inspected once per year for stabilized sites
Inspection will determine the maintenance frequency (annual maintenance or once every two years typical for stabilized sites)
Sites with unstable conditions (exposed soil or materials storage) will require more frequent inspection and maintenance

Hydroworks, LLC
50 S. 21st St., Kenilworth, NJ 07033
Phone: 888-290-7900 Fax: 888-783-7271
Web: www.hydroworks.com

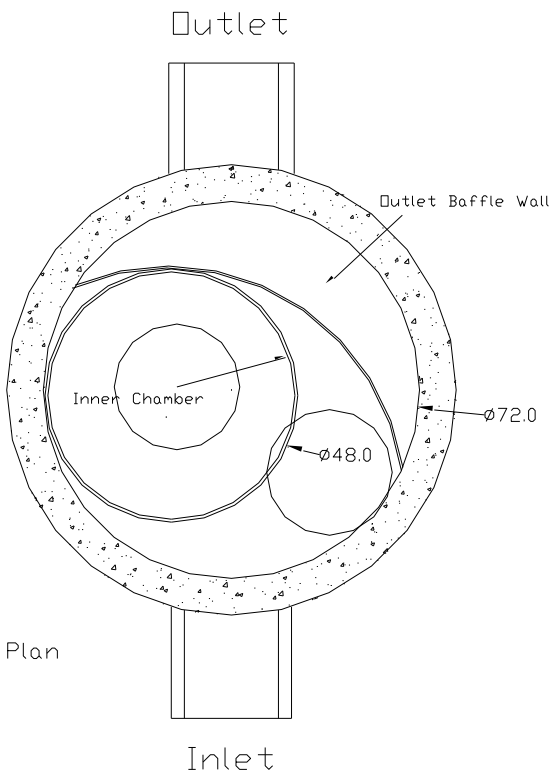
Hydroworks HG5 (60"ø)

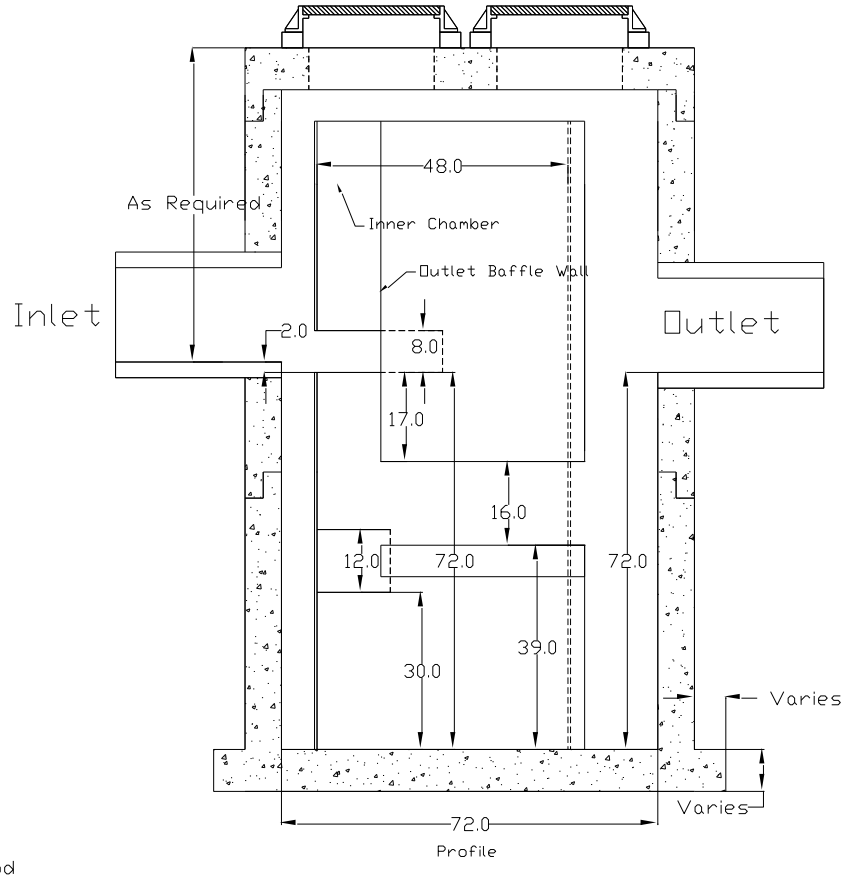
PROJECT:

LOCATION:

REVISION DATE: 01/09/2009

Hydroworks





U.S. Patent No. 6,951,619

Dimensions in inches
Permanent Pool Volume = 1250 US gallons
The Hydroguard must be cleaned after the construction period if it is used as a sediment and erosion control measure
The Hydroguard should be inspected once per year for stabilized sites
Inspection will determine the maintenance frequency (annual maintenance or once every two years typical for stabilized sites)
Sites with unstable conditions (exposed soil or materials storage) will require more frequent inspection and maintenance

Hydroworks, LLC
50 S. 21st St., Kenilworth, NJ 07033
Phone: 888-290-7900 Fax: 888-783-7271
Web: www.hydroworks.com

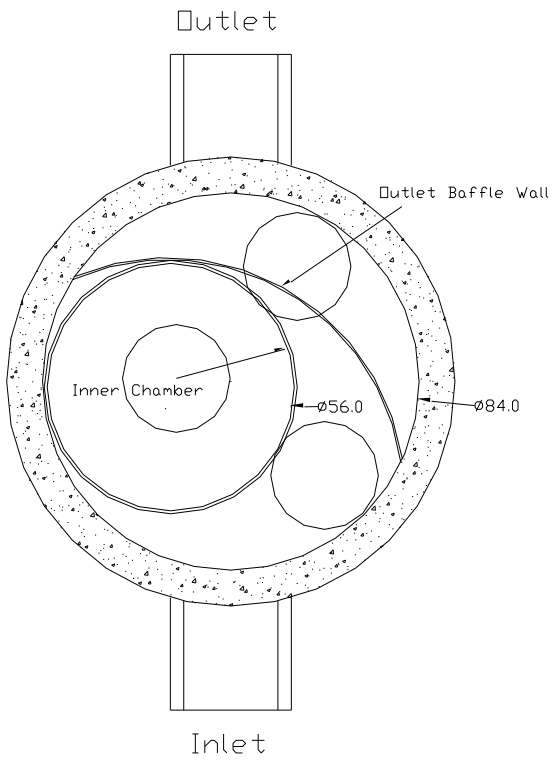
Hydroworks HG6 (72"ø)

PROJECT:

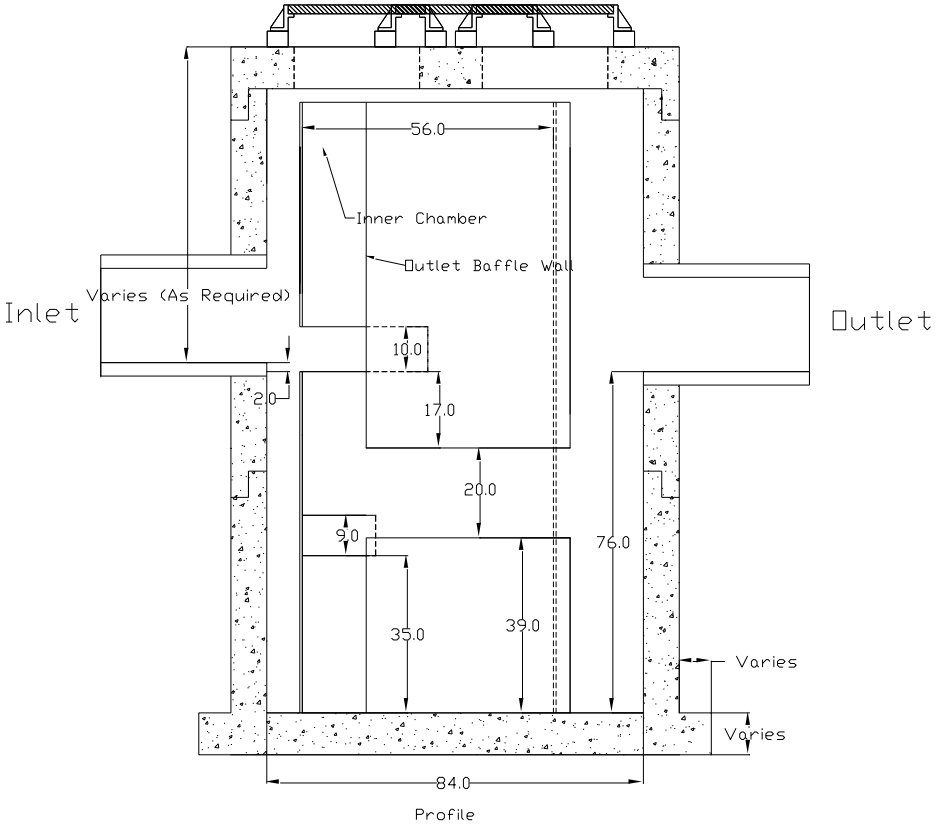
LOCATION:

REVISION DATE: 01/09/2009

Hydroworks



Plan



Profile

U.S. Patent No. 6,951,619

Dimensions in inches
Permanent Pool Volume = 1820 US gallons
The Hydroguard must be cleaned after the construction period if it is used as a sediment and erosion control measure
The Hydroguard should be inspected once per year for stabilized sites
Inspection will determine the maintenance frequency (annual maintenance or once every two years typical for stabilized sites)
Sites with unstable conditions (exposed soil or materials storage) will require more frequent inspection and maintenance

Hydroworks, LLC
50 S. 21st St., Kenilworth, NJ 07033
Phone: 888-290-7900 Fax: 888-783-7271
Web: www.hydroworks.com

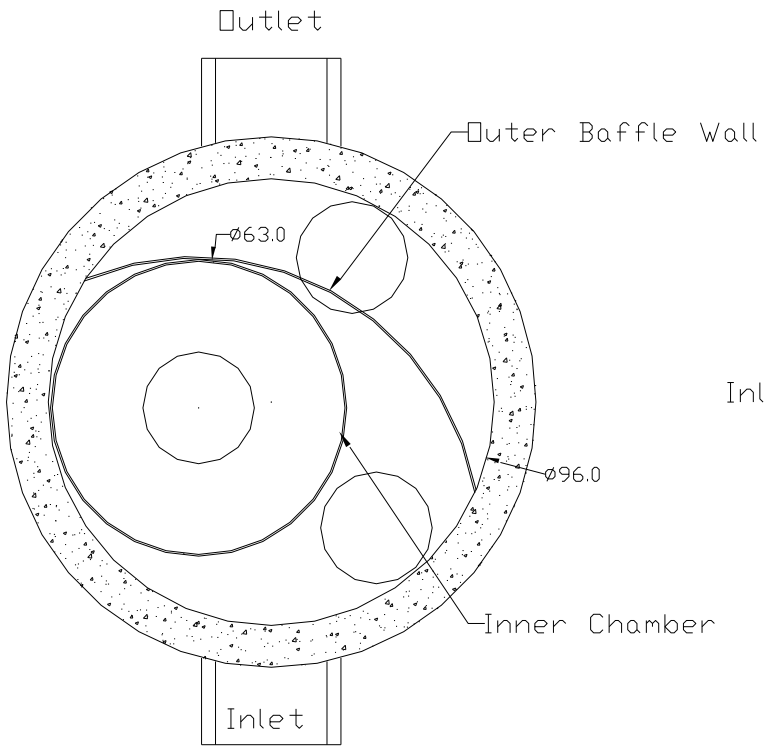
Hydroworks HG 7 (84"ø)

PROJECT:

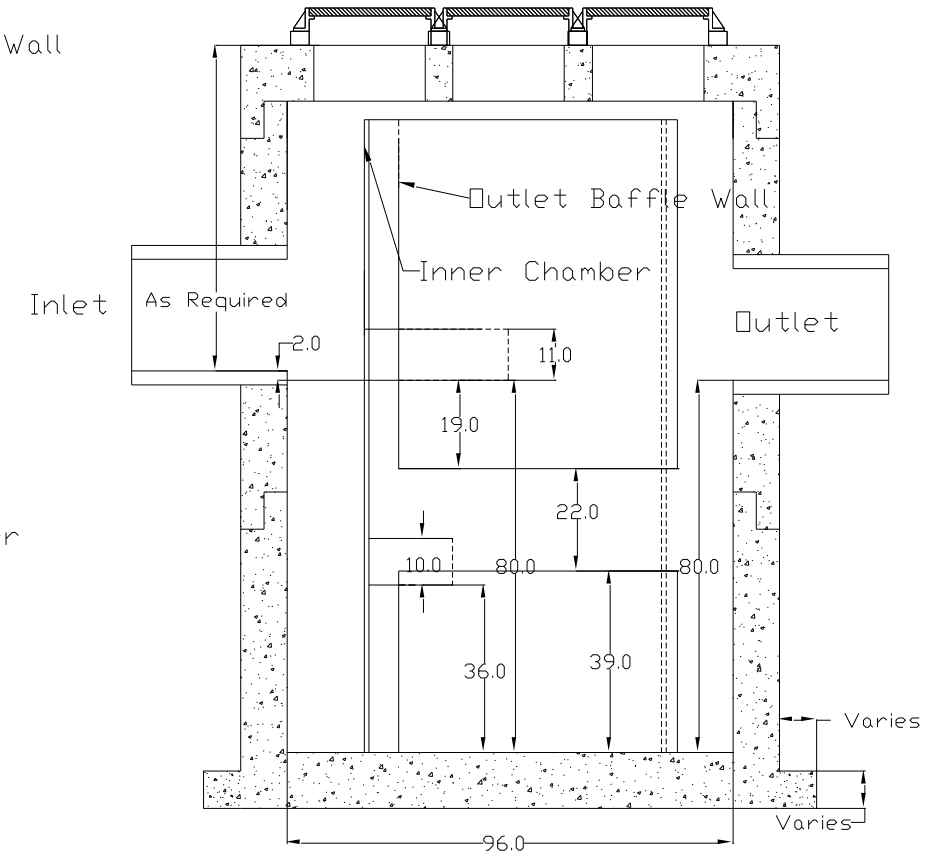
LOCATION:

REVISION DATE: 01/09/2009

Hydroworks



Plan



Profile

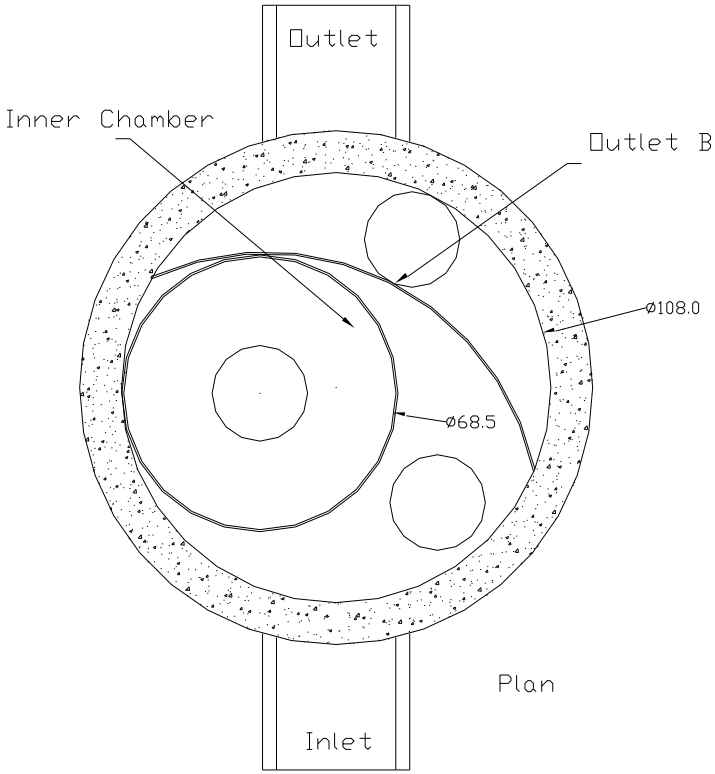
U.S. Patent No. 6,951,619

Dimensions in inches
Permanent Pool Volume = 2500 US gallons
The Hydroguard must be cleaned after the construction period if it is used as a sediment and erosion control measure
The Hydroguard should be inspected once per year for stabilized sites
Inspection will determine the maintenance frequency (annual maintenance or once every two years typical for stabilized sites)
Sites with unstable conditions (exposed soil or materials storage) will require more frequent inspection and maintenance

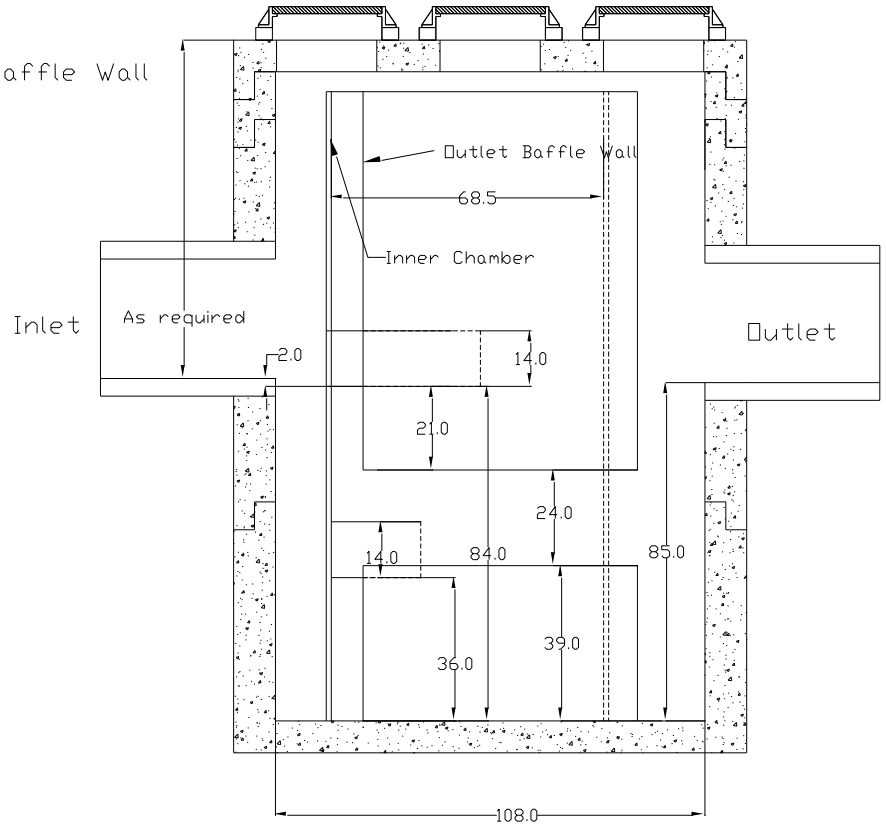
Hydroworks, LLC
50 S. 21st St., Kenilworth, NJ 07033
Phone: 888-290-7900 Fax: 888-783-7271
Web: www.hydroworks.com

Hydroworks HG8 (96"ø)	
PROJECT:	
LOCATION:	
REVISION DATE: 01/09/2009	

Hydroworks



Plan



Profile

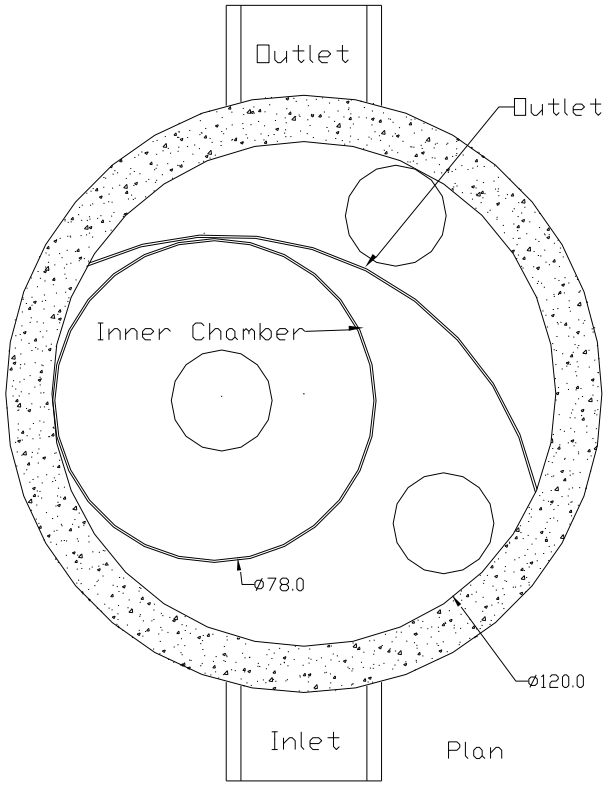
U.S. Patent No. 6,951,619

Dimensions in inches
Permanent Pool Volume = 3370 US gallons
The Hydroguard must be cleaned after the construction period if it is used as a sediment and erosion control measure
The Hydroguard should be inspected once per year for stabilized sites
Inspection will determine the maintenance frequency (annual maintenance or once every two years typical for stabilized sites)
Sites with unstable conditions (exposed soil or materials storage) will require more frequent inspection and maintenance

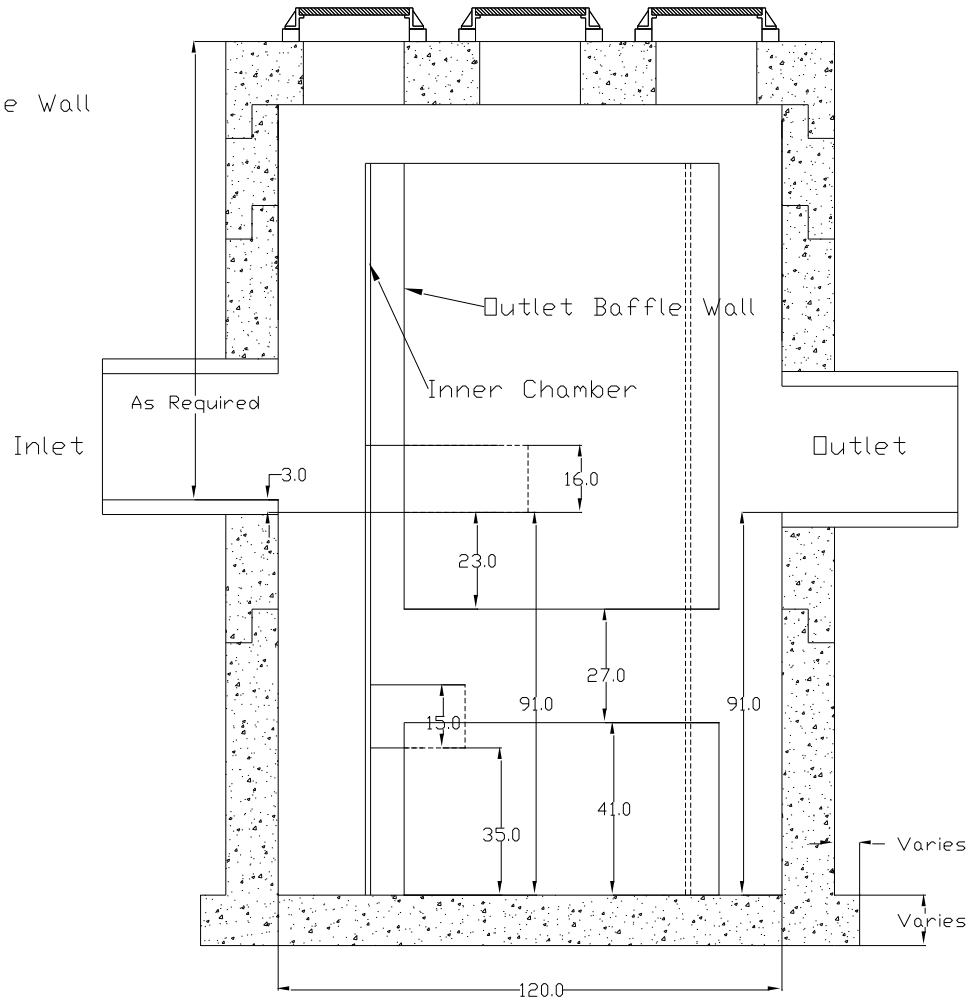
Hydroworks, LLC
50 S. 21st St., Kenilworth, NJ 07033
Phone: 888-290-7900 Fax: 888-783-7271
Web: www.hydroworks.com

Hydroworks HG9 (108"Ø)
PROJECT:
LOCATION:
REVISION DATE: 01/09/2009

Hydroworks



Plan



Profile

U.S. Patent No. 6,951,619

Dimensions in inches
Permanent Pool Volume = 4450 US gallons
The Hydroguard must be cleaned after the construction period if it is used as a sediment and erosion control measure
The Hydroguard should be inspected once per year for stabilized sites
Inspection will determine the maintenance frequency (annual maintenance or once every two years typical for stabilized sites)
Sites with unstable conditions (exposed soil or materials storage) will require more frequent inspection and maintenance

Hydroworks, LLC
50 S. 21st St., Kenilworth, NJ 07033
Phone: 888-290-7900 Fax: 888-783-7271
Web: www.hydroworks.com

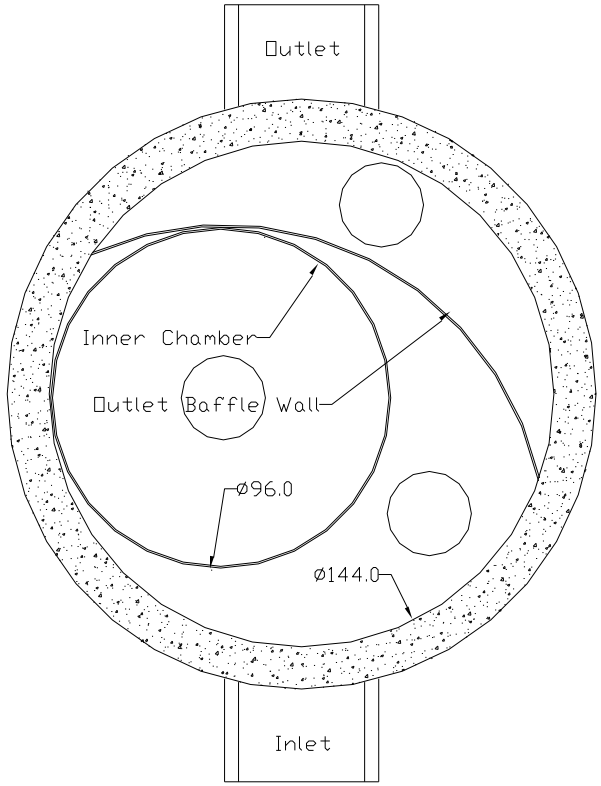
Hydroworks HG10 (120"Ø)

PROJECT:

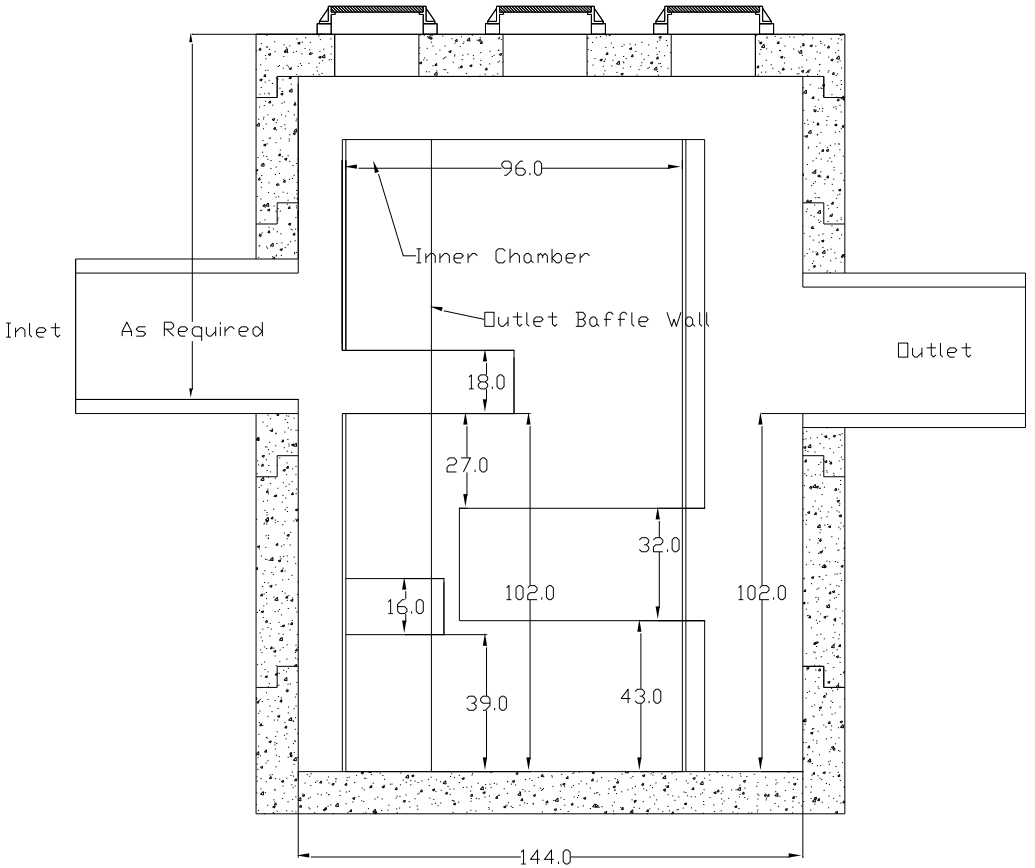
LOCATION:

REVISION DATE: 01/09/2009

Hydroworks



Plan



Profile

U.S. Patent No. 6,951,619

Dimensions in inches
Permanent Pool Volume = 7190 US gallons
The Hydroguard must be cleaned after the construction period if it is used as a sediment and erosion control measure
The Hydroguard should be inspected once per year for stabilized sites
Inspection will determine the maintenance frequency (annual maintenance or once every two years typical for stabilized sites)
Sites with unstable conditions (exposed soil or materials storage) will require more frequent inspection and maintenance

Hydroworks, LLC
50 S. 21st St., Kenilworth, NJ 07033
Phone: 888-290-7900 Fax: 888-783-7271
Web: www.hydroworks.com

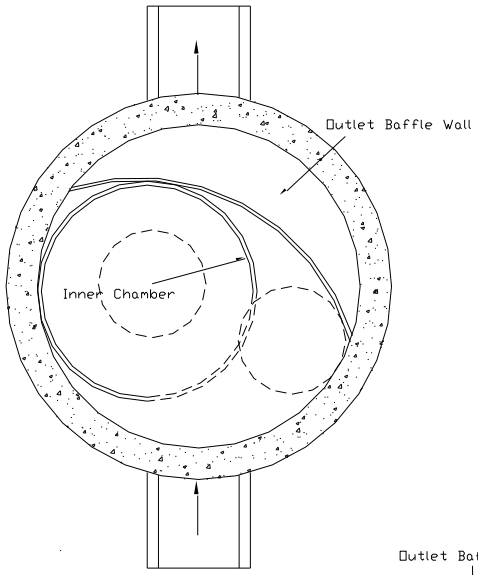
Hydroworks HG12 (144"ø)

PROJECT:

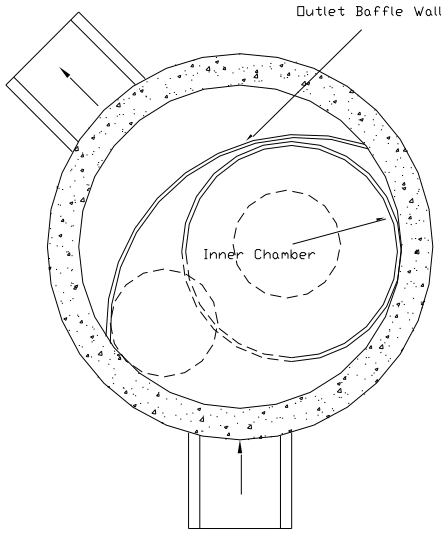
LOCATION:

REVISION DATE: 01/09/2009

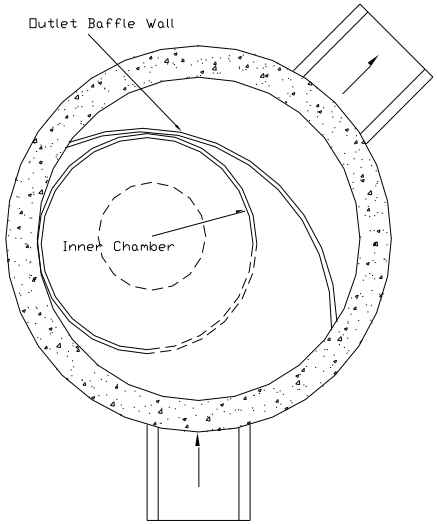
Hydroworks



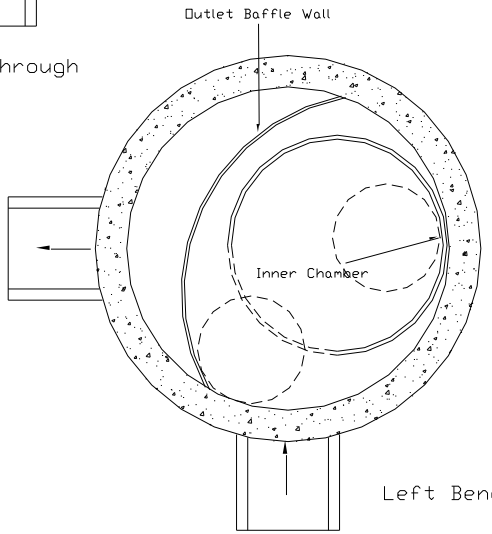
Straight Through



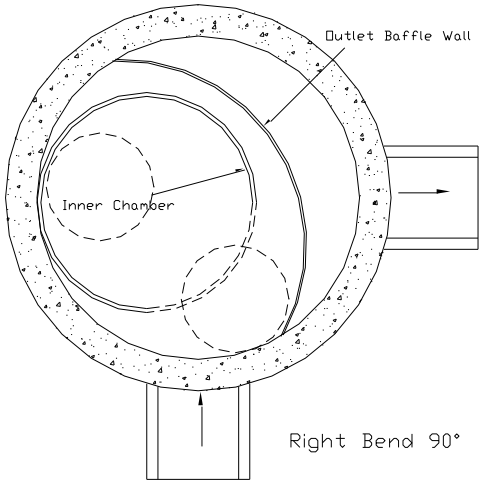
Left Bend (45°)



Right Bend (45°)



Left Bend 90°



Right Bend 90°

U.S. Patent No. 6,951,619

Hydroworks, LLC
50 S. 21st St., Kenilworth, NJ 07033
Phone: 888-290-7900 Fax: 888-783-7271
Web: www.hydroworks.com

Hydroworks HG Alternate Layouts

REVISION DATE: 01/09/2009

Hydroworks

APPENDIX D

HG INSPECTION SHEET

HYDROGUARD 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	☐	☐

Hydroguard	**Yes**	**No**
Incorrect access orientation	☐ ***	☐
Obstructions in the inlet or outlet	☐ *	☐
Missing internal components	☐ **	☐
Improperly installed 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	**< 25% of surface area**	☐	**> 25% surface area**	☐ *
Sludge depth	**< 14" (350mm)**	☐	**> 14" (350mm)**	☐ *****

Other Comments: _____
_____
_____

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

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.

APPENDIX E

HYDROWORKS HG WARRANTY

Hydroworks® Hydroguard

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 Hydroguard 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 50 S 21st St., Kenilworth, NJ 07033 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 Hydroguard 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 Hydroguard, or the cost of other goods or services related to the purchase and installation of the Hydroguard. For this Limited Warranty to apply, the Hydroguard 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 Hydroguard 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 Hydroguard, whether the claim is based upon contract, tort, or other legal basis.