Aqua-Swirl™ Stormwater Treatment

AquaShield™
STORMWATER TREATMENT SOLUTIONS

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2733 Kanasita Drive, Suite B • Chattanooga, Tennessee 37343
Phone (888) 344-9044 • Fax (423) 826-2112
www.aquashieldinc.com

Aqua-Swirl™ Stormwater Treatment System

The patented *Aqua-Swirl™ Stormwater Treatment System* provides a highly effective means for the removal of sediment, floating debris, and free oil. Swirl technology, or vortex separation, is a proven form of treatment utilized in the stormwater industry to accelerate gravitational separation. Independent university laboratory performance evaluations have shown the Aqua-Swirl™ achieves a TSS (Total Suspended Solids) removal of 91% calculated on a net annual basis. *See the "Performance and Testing" Section for more details.*

Each Aqua-Swirl™ is constructed of lightweight and durable materials, eliminating the need for heavy lifting equipment during installation. Inspection and maintenance are made easy, with oversized risers that allow for both examination and cleanout without entering the chamber.

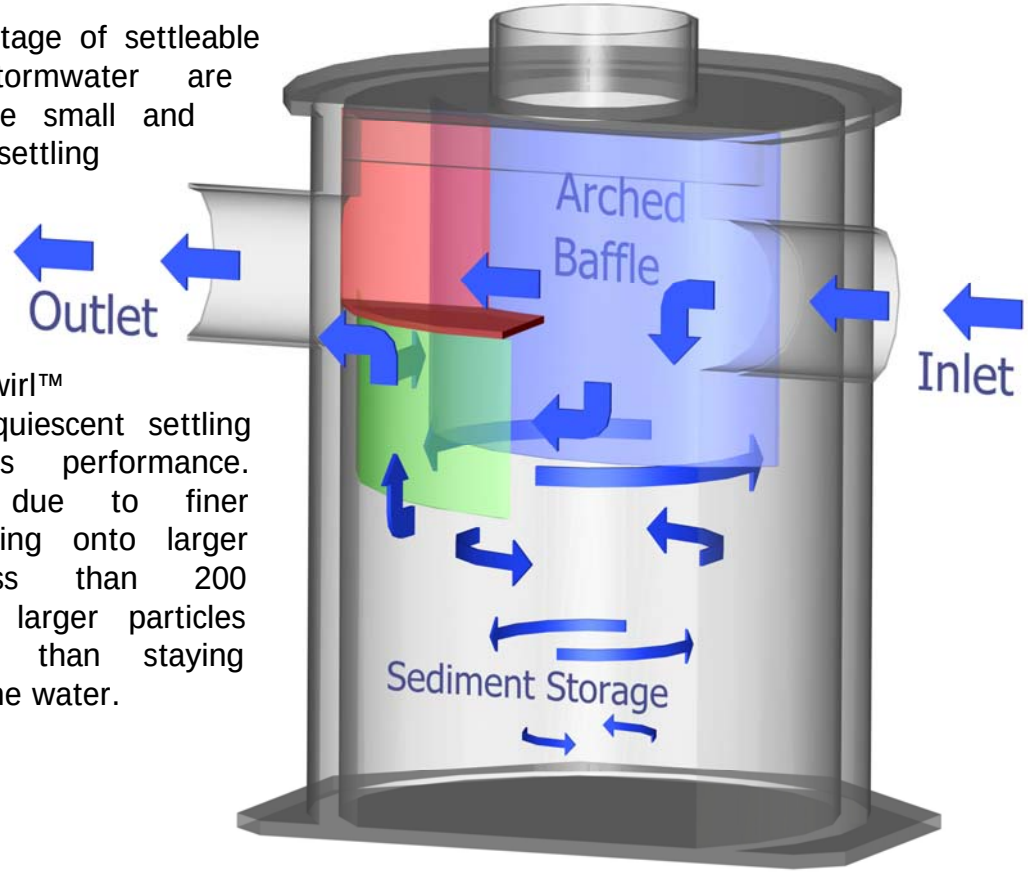
System Operation

The Aqua-Swirl™, with a conveyance flow diversion system, provides full treatment for the most contaminated "first flush", while the cleaner peak storm flow is diverted and channeled through the main conveyance pipe. Many regulatory agencies are in the process of establishing "water quality treatment flow rates" for specific areas based on the initial migration of pollutants into the storm drainage system.

Floatable debris in the Aqua-Swirl™

The treatment operation begins when stormwater enters the Aqua-Swirl™ through a tangential inlet pipe that produces a circular (or vortex) flow pattern that causes contaminates to settle to the base of the unit. Since stormwater flow is intermittent by nature, the Aqua-Swirl™ retains water between storm events providing both "dynamic and quiescent" settling of solids. The dynamic settling occurs during each storm event while the quiescent settling takes place between successive storms. A combination of gravitational and hydrodynamic drag forces encourages the solids to drop out of the flow and migrate to the center of the chamber where velocities are the lowest, as shown from extensive CFD modeling. *See "Performance and Testing" for more details.*

A large percentage of settleable solids in stormwater are reported to be small and have low settling velocities. Therefore, the volume of water retained in the Aqua-Swirl™ provides the quiescent settling that increases performance. Furthermore, due to finer sediment adhering onto larger particles (less than 200 microns), the larger particles settle, rather than staying suspended in the water.



The treated flow then exits the Aqua-Swirl™ behind the arched outer baffle. The top of the baffle is sealed across the treatment channel, thereby eliminating floatable pollutants from escaping the system. A vent pipe is extended up the riser to expose the backside of the baffle to atmospheric conditions, preventing a siphon from forming at the bottom of the baffle.

As recommended by the Center for Watershed Protection and several municipalities, the Aqua-Swirl™ can also operate in an offline configuration providing full treatment of the "first flush." However, this orientation requires the installation of additional manhole structures to diverge the flow to the Aqua-Swirl™ for treatment and conveyance back to the existing main conveyance storm drainage system.

Custom Applications

Custom designed AS-9 Twin, Aqua-Swirl™

The Aqua-Swirl™ system can be modified to fit a variety of purposes in the field, and the angles for inlet and outlet lines can be modified to fit most applications. The photo on the left demonstrates the flexibility of Aqua-Swirl™ installations. Two Aqua-Swirl™ units were placed side by side in order to treat a high volume of water while occupying a small amount of space. This configuration is an example of the many ways AquaShield™ can use our products to adapt to a variety of applications.

Retrofit Applications

The Aqua-Swirl™ system is designed so that it can easily be used for retrofit applications. With the invert of the inlet and outlet pipe at the same elevation, the Aqua-Swirl™ can easily be connected directly to the existing storm conveyance drainage system. Furthermore, because of the lightweight nature and small footprint of the Aqua-Swirl™, existing infrastructure utilities (i.e., wires, poles, trees) would be unaffected by installation.

Installation

The Aqua-Swirl™ system is designed and fabricated as a modular unit with no moving parts so that no assembly is required on site. This facilitates an easy installation of the system.

Since all AquaShield™ systems are fabricated from high performance materials, the Aqua-Swirl™ is lightweight, and can be installed without the use of heavy lifting equipment. Lifting supports or cables are provided to allow easy offloading and installation with a trackhoe. Compared to concrete systems, using an Aqua-Swirl™ can significantly reduce installation costs.

In addition, manufactured stub-outs for the inlet and outlet are provided. This allows the contractor to simply attach the Aqua-Swirl™ directly to the main conveyance storm pipe with rubber couplings. Typically, an AquaShield™ representative is present on-site to assist in the installation process.

The Aqua-Swirl™ installed using a trackhoe

Buoyancy

All Aqua-Swirl™ systems are supplied with an octagonal base plate that extends a minimum of 6 inches beyond the outside diameter of the swirl chamber. The function of the extension on this base plate is to provide additional surface area to counter any buoyant force exerted on the system. The forces created on the base plate by the weight of the surrounding fill material offsets the buoyant force generated within the system. If needed, concrete can be poured directly onto the base plate to provide additional resistive force. The AquaShield™ engineering staff can provide buoyancy calculations for your site-specific conditions.

Traffic Loading

Concrete pad protects the Aqua-Swirl™ from impact loading

When installed in traffic areas, the system will be designed to withstand H-20 loading. In order to accomplish this, a reinforced concrete pad shall be poured in place above the system.

See the "Installation and Fabrication" section for sample concrete pad details and further details on installation.

Inspection and Maintenance

Sediment inspection using a stadia rod

Inspection and cleanout of the Aqua-Swirl™ is simple. The chamber can be inspected and maintained completely from the surface. Free-floating oil and floatable debris can be directly observed and removed through the provided service access.

Cleanout of accumulated solids is needed when the usable storage volume has been occupied. The depth of solids can easily be determined using a stadia rod or tape to measure the top of the solids pile and calculate the distance to the water's surface.

A vacuum truck can be used to remove the accumulated sediment and debris. Disposal of the material is typically treated in the same manner as catch basin cleanouts. AquaShield™ recommends that all materials removed be handled and disposed of in accordance with local and state requirements.

For further details on inspection and cleanout procedures, please see the "Maintenance" section.

Vacuum truck cleans the Aqua-Swirl™

Aqua-Site Worksheets

Aqua-Site worksheets are provided as an example of the information that AquaShield™ will need to customize an AquaSwirl™ to a specific work site.

- *1 completed example*
- *2 blank worksheets*

AquaShield™, Inc.
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Aqua-Site Worksheet

Project Information

Project Name: *County Hospital*

Location (City, State): *AnyTown, USA*

Site Use (circle one): Residential (Commerical) Industrial Other

Site Plan Attached: ☐ YES ☑ NO

Pollutants (TSS, Floatable Debris, oils/grease, TP, etc.): *TSS, Debris*

AutoCAD Version: *4.0*

Date Submitted: *3/12/2004*

Specifier Information

Designer's Name: *Sheri Phillips*

Design Firm: *Phillips Engineering*

Address: *123 Main Street*

City, State, Zip: *AnyTown, USA*

Phone: *423-870-8888*

Fax: *423-826-2112*

E-mail: *sheri@phillipsengr.com*

Specifications

Unit Label or Manhole Number	AquaShield™ Model	Design Flow Rate		Inlet/Outlet Pipe			Rim Elevation	Drainage Area Info				Traffic Loads
		Water Quality Treatment Flow[1] (cfs - L/s)	Peak Design Flow[2] (cfs - L/s)	Size (ID) (in - mm)	Invert Elevation (ft - m)	Pipe Material Type	Finish Grade Elevation (ft - m)	Area (acres - ha)	Incoming Slope (%)	Runoff Coefficient C	Estimated Groundwater Elevation (ft - m)	Is the system subject to H-20 loadings? Yes or No
A-1	*AS-6*	*5.3*	*15.9*	*18*	*736.2*	*RCP*	*745.6*	*8.2*	*0.74*	*0.9*	*N/A*	*Yes*

Special Site Conditions or Requirements:

How did you learn about Aqua-Shield™ ? *Website*

Please provide copy of Site Plans showing orientation

(1) Water Quality Treatment Flow is presribed by local regulatory agencies to achieve full treatment of specific amount of stormwater.
(2) Peak Design Flow refers to maximum calculated flow for an outfall or recurrence interval (10-yr, 25-yr event)

Specifier's Signature: *Sheri Phillips* **Date:** 12-Mar-04

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Aqua-Site Worksheet

Project Information

Project Name:

Location (City, State):

Site Use (circle one): Residential Commerical Industrial Other

Site Plan Attached: ☐ YES ☐ NO

Pollutants (TSS, Floatable Debris, oils/grease, TP, etc.):

AutoCAD Version:

Date Submitted:

Specifier Information

Designer's Name:

Design Firm:

Address:

City, State, Zip:

Phone:

Fax:

E-mail:

Specifications

Unit Label or Manhole Number	AquaShield™ Model	Design Flow Rate		Inlet/Outlet Pipe			Rim Elevation	Drainage Area Info				Traffic Loads
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Aqua-Site Worksheet

Project Information

Project Name:

Location (City, State):

Site Use (circle one): Residential Commerical Industrial Other

Site Plan Attached: ☐ YES ☐ NO

Pollutants (TSS, Floatable Debris, oils/grease, TP, etc.):

AutoCAD Version:

Date Submitted:

Specifier Information

Designer's Name:

Design Firm:

Address:

City, State, Zip:

Phone:

Fax:

E-mail:

Specifications

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Specifier's Signature: **Date:**

Aqua-Swirl™ Sizing Chart *(English)*

Aqua-Swirl™ Model	Swirl Chamber Diameter (ft.)	Maximum Stub-Out Pipe Outer Diameter (in.)		Water Quality Treatment Flow[2] (cfs)	Oil/Debris Storage Capacity (gal)	Sediment Storage Capacity (ft^3)
		On/Offline	CFD[1]			
AS-2	2.50	8	12	1.1	37	10
AS-3	3.25	10	16	1.8	110	20
AS-4	4.25	12	18	3.2	190	32
AS-5	5.00	12	24	4.4	270	45
AS-6	6.00	14	30	6.3	390	65
AS-7	7.00	16	36	8.6	540	90
AS-8	8.00	18	42	11.2	710	115
AS-9	9.00	20	48	14.2	910	145
AS-10	10.0	22	54	17.5	1130	180
AS-12	12.0	24	48	25.2	1698	270
AS-XX	Custom	--	--	>26	--	--

***Higher water quality treatment flow rates can be designed with multiple swirls.**

1) *The **Aqua-Swirl™ Conveyance Flow Diversion (CFD)** provides full treatment of the "first flush," while the peak design storm is diverted and channeled through the main conveyance pipe. Please refer to your local representative for more information.*

2) *Many regulatory agencies are establishing "water quality treatment flow rates" for their areas based on the initial movement of pollutants into the storm drainage system. The treatment flow rate of the Aqua-Swirl™ system is engineered to meet or exceed the local water quality treatment criteria. This **"water quality treatment flow rate"** typically represents approximately 90% to 95% of the total annual runoff volume.*

The design and orientation of the Aqua-Filter™ generally entails some degree of customization. For assistance in design and specific sizing using historical rainfall data, please refer to an AquaShield™ representative or visit our website at www.AquaShieldInc.com. CAD details and specifications are available upon request.

Aqua-Swirl™ Sizing Chart *(Metric)*

Aqua-Swirl™ Model	Swirl Chamber Diameter (mm.)	Maximum Stub-Out Pipe Outer Diameter (mm.)		Water Quality Treatment Flow[2] (L/s)	Oil/Debris Storage Capacity (L)	Sediment Storage Capacity (m^3)
		On/Offline	CFD[1]			
AS-2	762	203	305	31	140	0.28
AS-3	991	254	406	51	416	0.57
AS-4	1295	305	457	91	719	0.91
AS-5	1524	305	610	125	1022	1.27
AS-6	1829	356	762	178	1476	1.84
AS-7	2134	406	914	243	2044	2.55
AS-8	2438	457	1067	317	2687	3.26
AS-9	2743	508	1219	402	3444	4.11
AS-10	3048	559	1372	495	4277	5.10
AS-12	3658	610	1219	713	6427	7.65
AS-XX	Custom	--	--	>713	--	--

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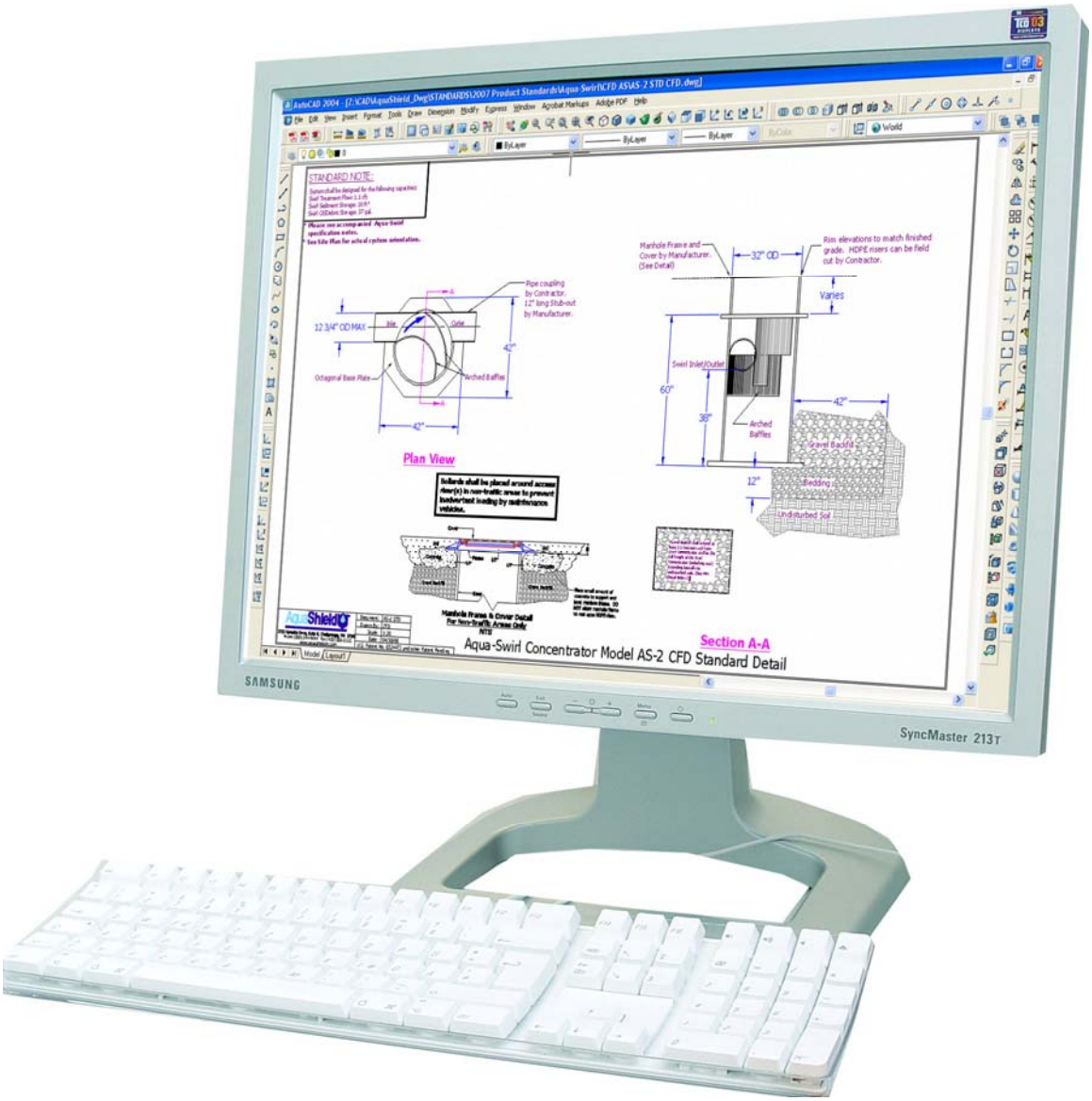
Aqua-Swirl™ Sample Detail Drawings

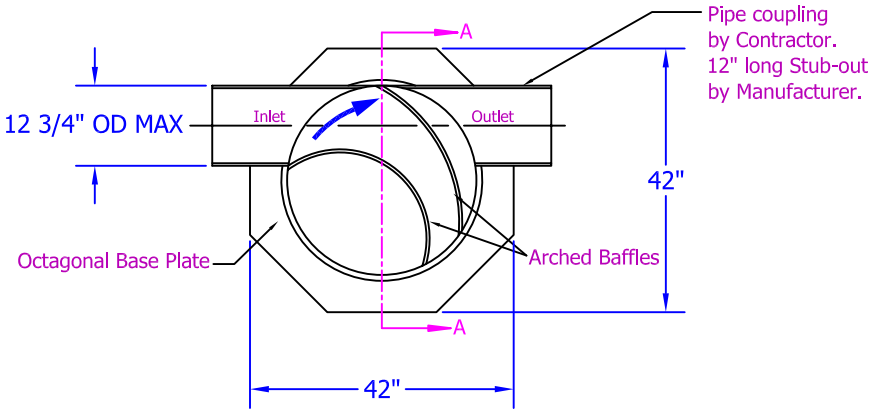
Sample Aqua-Swirl™ detail drawings are provided as examples of the type of systems that AquaShield™ can offer for a specific work site.



STANDARD NOTE:

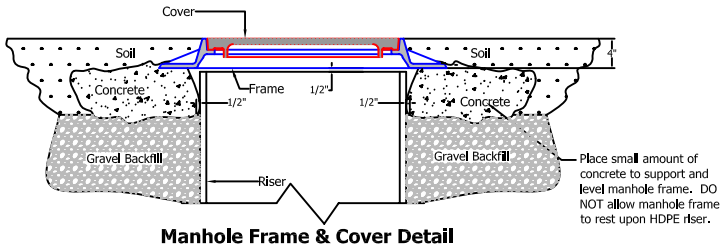
System shall be designed for the following capacities:
Swirl Treatment Flow: 1.1 cfs
Swirl Sediment Storage: 10 ft³
Swirl Oil/Debris Storage: 37 gal.

*** Please see accompanied Aqua-Swirl specification notes.**
*** See Site Plan for actual system orientation.**

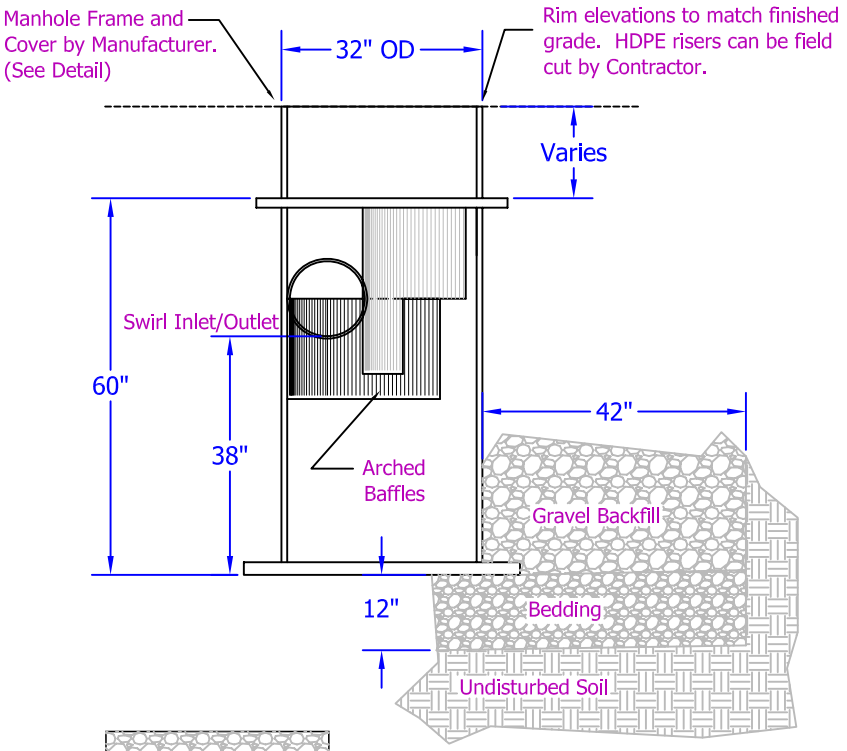


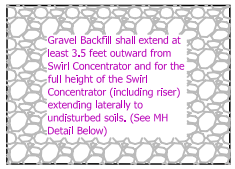
Plan View

Bollards shall be placed around access riser(s) in non-traffic areas to prevent inadvertent loading by maintenance vehicles.



Manhole Frame & Cover Detail
For Non-Traffic Areas Only
NTS





Section A-A

Aqua-Swirl Concentrator Model AS-2 CFD Standard Detail

AquaShield
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Document:	AS-2 STD
Drawn By:	JTD
Scale:	1:20
Date:	04/18/06

U.S. Patent No. 6524473 and other Patent Pending

Aqua-Swirl™ Specifications

GENERAL

This specification shall govern the performance, materials and fabrication of the Stormwater Treatment System.

SCOPE OF WORK

The Aqua-Swirl™ shall be provided by AquaShield™, Inc., 2733 Kanasita Drive, Chattanooga, TN (888-344-9044), and shall adhere to the following material and performance specifications at the specified design flows and storage capacities.

MATERIALS

A. Stormwater Treatment System shall be made from High-Density Polyethylene (HDPE) resins meeting the following requirements:

1) HDPE Material – The HDPE material supplied under this specification shall be high density, high molecular weight as supplied by manufacturer. The HDPE material shall conform to ASTM D3350-02 with minimum cell classification values of 345464C.

2) PHYSICAL PROPERTIES OF HDPE COMPOUND
   a) Density - the density shall be no less than 0.955 g/cm^3 as referenced in ASTM D 1505.
   b) Melt Index - the melt index shall be no greater than 0.15 g/10 minutes when tested in accordance with ASTM D 1238- Condition 190/2.16.
   c) Flex Modulus - flexural modulus shall be 110,000 to less than 160,000 psi as referenced in ASTM D 790.
   d) Tensile Strength at Yield - tensile strength shall be 3,000 to less than 3,500 psi as referenced in ASTM D 638.
   e) Slow Crack Growth Resistance shall be greater than 100 hours (PENT Test) as referenced in ASTM F 1473 or greater than 5,000 hours (ESCR) as referenced in ASTM D 1693 (condition C).

f) Hydrostatic Design Basis shall be 1,600 psi at 23 degrees C when tested in accordance with ASTM D 2837.
g) Color – black with minimum 2% carbon black.

B. REJECTION - The Stormwater Treatment System may be rejected for failure to meet any of the requirements of this specification.

PERFORMANCE

A. The Stormwater Treatment System shall include a ___-inch inner diameter (ID) circular hydrodynamic flow-through treatment chamber to treat the incoming water. A tangential inlet shall be provided to induce a swirling flow pattern that will cause sedimentary solids to accumulate in the bottom center of the chamber in such a way as to prevent re-suspension of captured particles. An arched baffle wall shall be provided in such a way as to prevent floatable liquid oils and solids from exiting the treatment chamber while enhancing the swirling action of the stormwater.

B. The Stormwater Treatment System shall have a sediment storage capacity of ___ cubic feet and be capable of capturing ____ gallons of petroleum hydrocarbons. The Stormwater Treatment System shall have a treatment capacity of _____ cubic feet per second (cfs). The Stormwater Treatment System shall be capable of removing floating trash and debris, floatable oils and 80% of total suspended solids from stormwater entering the treatment chamber.

C. Service access to the Stormwater Treatment System shall be provided via 30-inch inner diameter (ID) access riser(s) over the treatment chamber such that no confined space entry is required to perform routine inspection and maintenance functions.

TREATMENT CHAMBER CONSTRUCTION

A. The treatment chamber shall be constructed from solid wall HDPE ASTM F 714 cell class 345464C. For sizes above 63-inch OD, the treatment chamber shall be constructed from profile wall HDPE ASTM F 894 RSC 250 pipe or solid wall HDPE.

B. The bottom thickness of the treatment chamber will be determined in accordance with ASTM F 1759. Calculations must be provided to justify the thickness of the bottom.

C. The inlets and outlets shall be extrusion welded on the inside and outside of the structure using accepted welding methods.

D. The arched baffle wall shall be constructed from HDPE and shall be extrusion welded to the interior of the treatment chamber using accepted welding methods with connections made at 180 degrees of each end.

E. HDPE lifting supports may be provided on the exterior of the Stormwater Treatment System in such a way as to allow the prevention of undue stress to critical components of the Stormwater Treatment System during loading, off-loading, and moving operations. The lifting supports shall be constructed as an integral part of the treatment chamber and extrusion welded using accepted welding methods.

F. The top of the treatment chamber shall be built to the requirements of the drawings. Deep burial applications shall require a reinforced HDPE top.

Reinforced concrete pads spanning the treatment chamber will be required with traffic rated frames and covers when the Stormwater Treatment System is used in traffic areas. A professional engineer shall approve the design of the concrete pad and the calculations must be included in the submittal.

The manufacturer, upon request, can supply anti-flotation/ buoyancy calculations. In addition, typical drawings of the AquaShield™ Stormwater Treatment System with concrete anti-flotation structures can also be provided. Anti-flotation structure design and approval are ultimately the responsibility of the specifying engineer. The contractor shall provide the anti-flotation structures.

INSTALLATION

A. Excavation and Bedding

The trench and trench bottom shall be constructed in accordance with ASTM D 2321, Section 6, Trench Excavation, and Section 7, Installation. The Stormwater Treatment System shall be installed on a stable base consisting of 12 inches of Class I stone materials (angular, crushed stone or rock, crushed gravel; large void content, containing little or no fines) as defined by ASTM D 2321, Section 5, Materials, and compacted to 95% proctor density.

All required safety precautions for the Stormwater Treatment System installation are the responsibility of the contractor.

B. Backfill Requirements

Backfill materials shall be Class I or II stone materials (well graded gravels, gravelly sands; containing little or no fines) as defined by ASTM D 2321, Section 5, Materials, and compacted to 90% proctor density. Class I materials are preferred. Backfill and bedding materials shall be free of debris. Backfilling shall conform to ASTM F 1759, Section 4.2, "Design Assumptions." Backfill shall extend at least 3.5 feet beyond the edge of the Stormwater Treatment System for the full height to sub grade and extend laterally into undisturbed soils.

C. Pipe Couplings

Pipe couplings to and from the Stormwater Treatment System shall be Fernco®, Mission™ or an equal type flexible boot with stainless steel tension bands. A metal sheer guard shall be used to protect the flexible boot.

DIVISION OF RESPONSIBILITY

A. Stormwater Treatment System Manufacturer

The manufacturer shall be responsible for delivering the Stormwater Treatment System to the site. The system includes the treatment chamber with debris baffle, inlet and outlet stub-outs, lifting supports, 30-inch ID service access riser(s) to grade with temporary cover(s), and manhole frame(s) and cover(s).

B. Contractor

The contractor shall be responsible for preparing the site for the system installation including, but not limited to, temporary shoring, excavation, cutting and removing pipe, new pipe, bedding, and compaction. The contractor shall be responsible for furnishing the means to lift the system components off the delivery trucks. The contractor shall be responsible for providing any concrete anti-floatation/anti-creep restraints, anchors, collars, etc. with any straps or connection devices required. The contractor shall be responsible for field cutting, if necessary, and HDPE service access risers to grade. The contractor shall be responsible for sealing the pipe connections to the Stormwater Treatment System, backfilling and furnishing all labor, tools, and materials needed.

SUBMITTALS

The contractor shall be provided with dimensional drawings; and when specified, utilize these drawings as the basis for preparation of shop drawings showing details for construction and reinforcing. Shop drawings shall be annotated to indicate all materials to be used and all applicable standards for materials, required tests of materials, and design assumptions for structural analysis. Shop drawings shall be prepared at a scale of not less than ¼ inch per foot. Three (3) hard copies of said shop drawings shall be submitted to the specifying engineer for review and approval.

QUALITY CONTROL INSPECTION

A. Materials

The quality of materials, the process of manufacturing, and the finished sections shall be subject to inspection by the specifying engineer. Such inspection may be made at the place of construction, on the work site after delivery, or at both places. The sections shall be subject to rejection at any time if material conditions fail to meet any of the specification requirements, even though sample sections may have been accepted as satisfactory at the place of manufacture. Sections rejected after delivery to the site shall be marked for identification and shall be removed from the site at once. All sections, which are damaged beyond repair after delivery will be rejected; and, if already installed, shall be repaired to the specifying engineer's acceptance level, if permitted, or removed and replaced entirely at the contractor's expense.

B. Inspection

All sections shall be inspected for general appearance, dimensions, soundness, etc.

C. Defects

Structural defects may be repaired (subject to the acceptance of the specifying engineer) after demonstration by the manufacturer that strong and permanent repairs will be made. The specifying engineer, before final acceptance of the components, shall carefully inspect repairs.