



**Aqua-Swirl™**  
**Stormwater Treatment System**  
**Inspection and Maintenance Manual**

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# **AquaShield™, Inc. Table of Contents**

## **Introduction / Installation / Maintenance**

- **Introduction to AquaShield™ Stormwater Treatment Systems**
- **Operation of the Aqua-Swirl™ Stormwater Treatment System**
- **Installation of the Aqua-Swirl™ System**
- **Inspection & Maintenance of the Aqua-Swirl™ System**
- **Appendix**

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## **AquaShield™, Inc** **Stormwater Treatment Solutions**

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The highest priority of AquaShield™, Inc. (AquaShield™) is to protect waterways by providing stormwater treatment solutions to businesses across the world. These solutions have a reliable foundation based on over 20 years of water treatment experience.

Local regulators, engineers, and contractors have praised the AquaShield™ systems for their simple design and ease of installation. All the systems are fabricated from High-Density Polyethylene (HDPE), and contractors prefer the quick and simple installation of our structures that saves them money.

The AquaShield™ line of patented stormwater treatment products provide for high levels of stormwater treatment:

- The ***Aqua-Swirl™ Stormwater Treatment System*** is a hydrodynamic separator, which provides a highly effective means for the removal of TSS (fine to coarse sediment), floating debris and free-oil.
- The ***Aqua-Filter™ Stormwater Filtration System*** is an in-line stormwater filtration system capable of gross contaminant removal, and the removal of fine sediments, waterborne hydrocarbons, heavy metals (i.e. zinc) and nutrients such as phosphorous and nitrogen.



**Aqua-Swirl™ Stormwater  
Treatment System**



**Aqua-Filter™ Stormwater  
Filtration System**



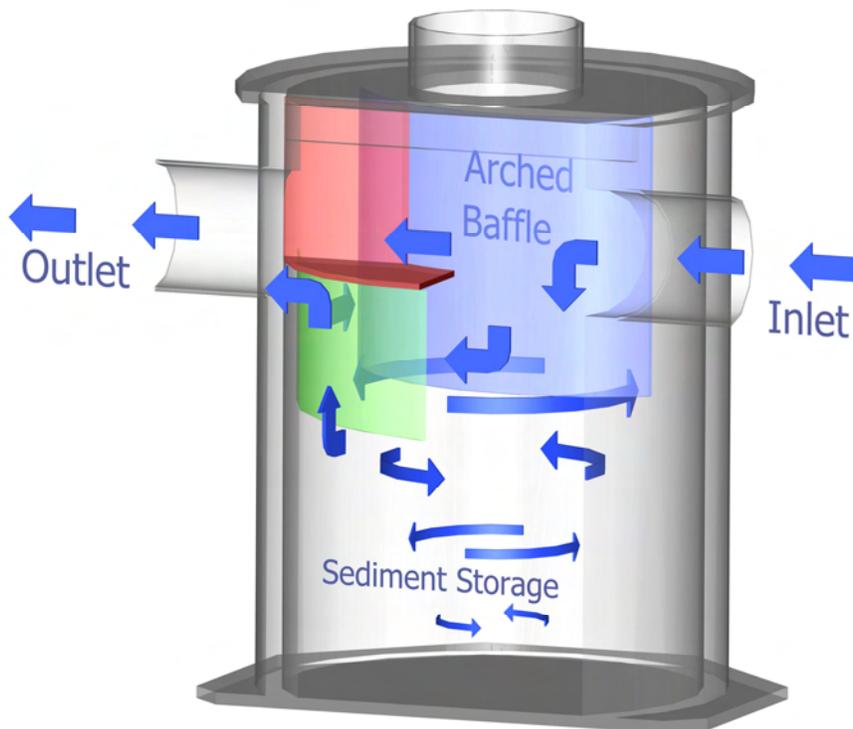
## Aqua-Swirl™ Stormwater Treatment System

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The patented *Aqua-Swirl™* Stormwater Treatment System is a hydrodynamic separator, which provides a highly effective means for the removal of sediment, free oil, and floating debris. Independent university laboratory performance evaluations have shown that the *Aqua-Swirl™* achieves a TSS removal of 91% calculated on a net annual basis.

The *Aqua-Swirl™*, with a conveyance flow diversion system, allows simple installation by connecting “directly” to the existing storm conveyance pipe. This connection provides full treatment of the “first flush,” while the peak design storm is diverted and channeled through the main conveyance pipe.

### Aqua-Swirl™





## **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**

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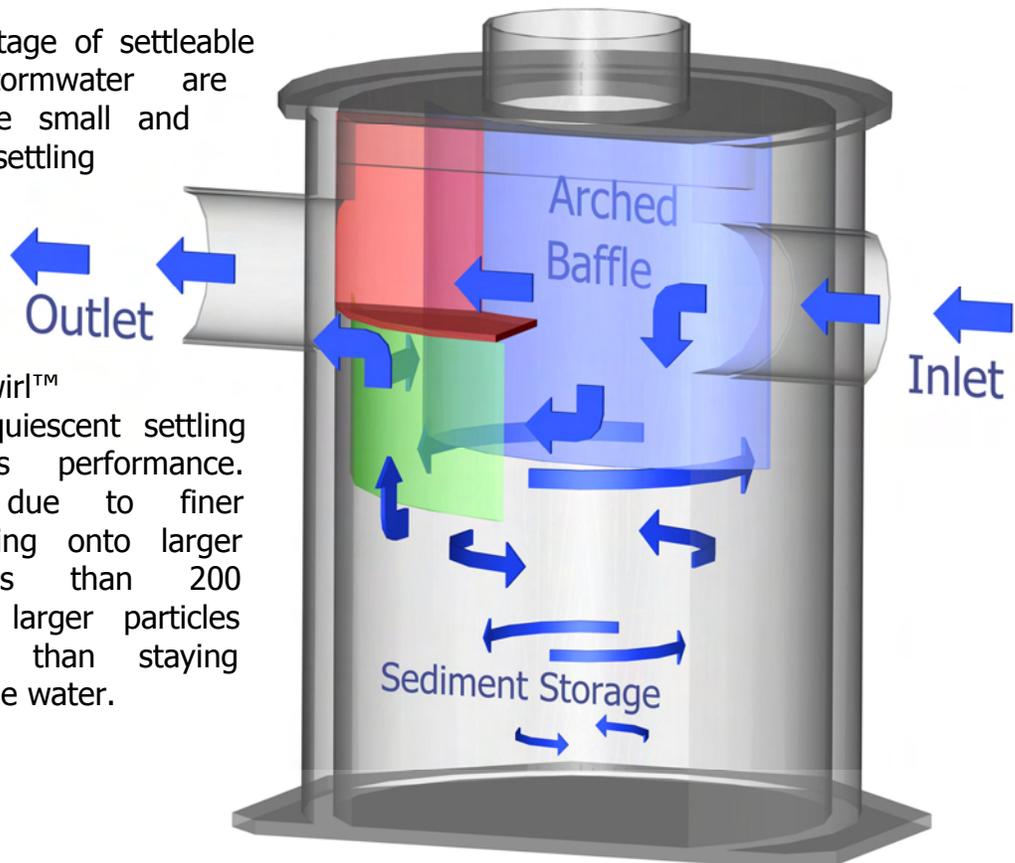
The Aqua-Swirl™, with a conveyance flow diversion system, provides full treatment for the most contaminated "first flush", while the cleaner peak storm flow is diverted and channeled through the main conveyance pipe. Many regulatory agencies are in the process of establishing "water quality treatment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

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 contaminants 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.



**Floatable debris in the Aqua-Swirl™**

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

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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

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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.



## HDPE AquaShield™ Products Installation

Throughout this section and in our individual product specifications, references will be made to specific ASTM standards for the manufacturing and the installation of the AquaShield™ products. Quality control is a high priority within AquaShield™. That is why all of the patented products are fabricated, inspected and tested before leaving for the job site. The AquaShield™ systems are a modular design and constructed to facilitate the installation process. Because each system is constructed of High-Density Polyethylene (HDPE), even the largest units can be off-loaded and installed without the use of a crane or other special lifting equipment.



**Lifting cable for installation**

Lifting cables are provided on each Aqua-Swirl™ and Aqua-Filter™, allowing an excavator or backhoe to maneuver and position the system. Furthermore, the systems can be stored on the job site following off-loading to accommodate changing schedules.

Stub-outs for the inlet and outlet are part of the modular design of the Aqua-Swirl™ and Aqua-Filter™, which allows the contractor to attach the pipes to the inlet and outlet of the Stormwater Treatment System with couplings. Typically, an AquaShield™ representative is present on-site to assist in the installation process.

Both the Aqua-Swirl™ and the Aqua-Filter™ come with risers and custom manhole frames and covers. Delivery is typically less than four weeks from final approval of shop drawings.



## Aqua-Swirl™ Installation

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Routine installation steps for the Aqua-Swirl™ units involve preparation and excavation of the area that is to contain the Aqua-Swirl™. This includes grading, leveling, and compacting the base material before lowering the unit into the excavation and connecting the Aqua-Swirl™ inlet and outlet stub-outs with appropriate pipe couplings.

Prior to shipping, the purchasing contractor provides written confirmation to install AquaShield™ products in accordance with manufacturer's specifications.

### Step 1 – Excavation and Bedding

The trench and trench bottom shall be constructed in accordance with ASTM D 2321, 6, Trench Excavation, and Section 7, Installation. The excavation pit is best positioned slightly offset of the center line of the incoming drain pipe trench because of the tangential inlet pipe connecting to the Aqua-Swirl™.

The Aqua-Swirl™ 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 Aqua-Swirl™ installation are the responsibility of the contractor.

### Step 2 – Pipe Connection Devices

Couplings to and from the Aqua-Swirl™ shall be supplied by the contractor and shall be Fernco®, Mission™ or equal type flexible boot with stainless steel tension bands or equal. Using a metal sheer guard will protect the flexible connector.



**On-site excavation**



**The coupling between the Aqua-Swirl™ and the pipe**

### Step 3 – Backfill Requirements

Backfill materials shall be Class I or II stone materials, (well graded gravels, gravelly sands; content, 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 Aqua-Swirl™ and for the full height to sub-grade and extend laterally to undisturbed soils.



Class I backfill material around the Aqua-Swirl™

Sufficient backfill shall be placed over components prior to using heavy compaction or construction equipment to prevent damage. Support shall be provided for vertical risers as commonly found at service connections, cleanouts, and drop manholes to preclude vertical or lateral movement.

### Step 4 – Traffic Loading

A reinforced concrete pad shall be placed over the entire Aqua-Swirl™ when subject to H-20 (or greater) traffic loading. The pad shall extend no less than 12 inches beyond the outside diameter of the Aqua-Swirl™.

A professional engineer shall provide final approval of the design of the concrete pad and the calculations must be included in the submittal. Traffic rated foundry rims and covers shall be installed such that no contact is made between the HDPE access riser and cast iron frame.



A reinforced concrete pad for H-20 traffic loading

### Step 5 – Non-Traffic Loading

Bollards shall be placed around access risers in non-traffic areas to prevent inadvertent loading by maintenance vehicles.



## AquaShield™ Product System Maintenance

The long-term performance of the stormwater treatment structures (including manufactured systems, ponds, swales, etc.), and the effective protection of receiving waters, depends on a consistent maintenance plan. Inspection and maintenance functions are simple and easy for the AquaShield™ Stormwater Treatment Systems allowing all inspections to be performed from the surface. An AquaShield™ field representative will be available as needed to assist local maintenance personnel in the field. Please contact us for a copy of a product-specific "Inspection and Maintenance Manual".



It is important that a routine inspection and maintenance program be established for each unit based on (1) the volume or load of the contaminants of concern, (2) the frequency of releases of contaminants at the facility or location, and (3) the nature of the area being drained.

In order to ensure that our systems are being maintained properly, AquaShield™ offers a maintenance solution to all of our customers. We will arrange to have maintenance performed.





## Inspection

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All AquaShield™ products can be inspected from the surface, eliminating the need to enter the systems to determine when cleanout should be performed.

In most cases, AquaShield™ recommends a quarterly inspection of the Stormwater Treatment Systems for the first year of operation to develop an appropriate schedule of maintenance.

Based on experience of the system's first year in operation, we recommend that the inspection schedule be revised to reflect the site-specific conditions encountered. Typically, the inspection schedule for subsequent years is reduced to semi-annual inspection.



## Aqua-Swirl™ Maintenance

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The Aqua-Swirl™ has been designed to minimize and simplify the inspection and maintenance process. The system can be inspected and maintained completely from the surface, thereby eliminating the need for confined space entry.

Furthermore, the entire structure (specifically, the floor) is accessible for visual inspection from the surface. There are no areas of the structure that are blocked from visual inspection or periodic cleaning.

Inspection of any free-floating oil and floatable debris can be directly observed and maintained through the manhole access provided directly over the swirl chamber.

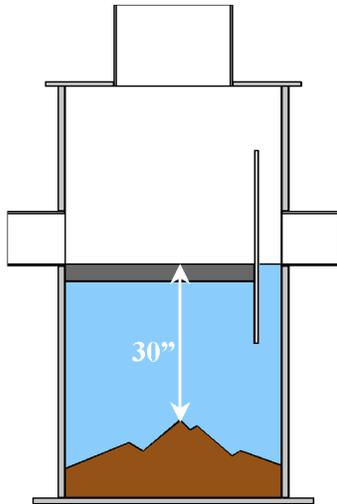
### Aqua-Swirl™ Inspection Procedure

To inspect the Aqua-Swirl™, a hook is needed to remove the manhole cover. AquaShield™ provides a customized manhole cover with our logo to make it easy for maintenance crews to locate the system in the field. We also provide a permanent metal information plate attached inside the access riser, which provides our contact information, the Aqua-Swirl™ model size, and serial number.



**Sediment inspection  
using a stadia rod**

The only tools needed to inspect the Aqua-Swirl™ system are a flashlight and a measuring device such as a stadia rod or pole. Given the tremendous accessibility provided, floating oil and debris can be observed directly from the surface. Sediment depths can easily be determined by lowering a measuring device to the top of the sediment pile and to the surface of the water. When the sediment pile is within 30 to 36 inches of the water surface, the system should be maintained.



It should be noted that in order to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the *top* of the sediment pile. The finer sediment at the top of the pile, typically offers less resistance to the measuring device than the larger particles.

### **Aqua-Swirl™ Cleanout Procedure**

Clean out of the Aqua-Swirl™ is simple. Free-floating oil and floatable debris can be observed and removed directly through the 30-inch service access provided.

A vacuum truck can be used to remove the accumulated sediment and debris. It is important to note that the entire sediment storage area can be reached with a vacuum hose from the surface (reaching all the sides).

Disposal of the material is typically treated in the same fashion as catch basin cleanouts. AquaShield™ recommends that all materials removed be handled and disposed of in accordance with local and state requirements.



**Vacuum truck cleans the Aqua-Swirl™**

*Inspection Data Sheets are provided in the Appendix of this Manual.*

## **APPENDIX**

# Aqua-Swirl™

## Inspection and Maintenance Manual for BMP Owners

(Note: Attach certifications for local regulatory authority including any applicable fees.)

### Site and Owner Information

Site Name: \_\_\_\_\_ Change in ownership since last inspection'    Y    N

Owner Name: \_\_\_\_\_

Owner Address: \_\_\_\_\_

Owner Phone Number: \_\_\_\_\_

Emergency Phone Number: \_\_\_\_\_

Location: \_\_\_\_\_

Date: \_\_\_\_\_

Time: \_\_\_\_\_

Inspector Name: \_\_\_\_\_

### Maintenance Items

#### Inspection

##### **Floatable Debris and Oil**

1. Remove manhole lid to expose liquid surface of Aqua-Swirl™.
2. Remove floatable debris with basket or net if any present.
3. If oil is present, measure its depth. Clean liquids from system if 1/2" or more oil is present (see "Cleaning" Figure 5).

**Note: Water in an Aqua-Swirl™ can appear black like oil due to the dark body of the surrounding structure. Oil appears darker than water in the system and is usually accompanied by debris (e.g. Styrofoam, etc.) with obvious signs of oil stains. The depth of oil can be measured with an oil/water interface probe, a stadia rod with water phyllic paste, a coliwasa, or by simply collecting a representative sample with a jar attached to a rod.**

##### **Sediment Accumulation**

Make measurements as follows (see Figures 1 and 2):

1. Lower measuring device (i.e. stadia rod) into Aqua-Swirl™ through service access provided. (See Figure 2)
2. Record distance to top fo sediment pile (in): \_\_\_\_\_
3. Record distance to top of water (in): \_\_\_\_\_
4. Calculate distance to sediment minus distance to water (in): \_\_\_\_\_
5. Schedule cleaning if value in step 4 is 30" or less. (See Figure 3).

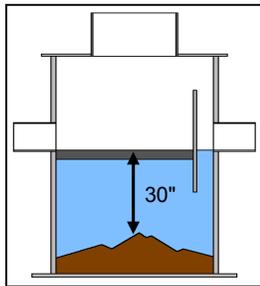


Figure 1



Figure 2

## Inspection (continued)

### Diversion Structures

If a diversion structure is present on the site, this should be inspected for the following items.

1. Inspect weir or other structure for structural decay or damage. Weirs are more susceptible to damage than off-set piping and should be checked to confirm that they are not crumbling, in the case of concrete or brick weirs, or decaying if a steel weir was used.
2. Inspect diversion structure and by-pass piping for signs of structural damage or blockage from debris or sediment accumulation.
3. Measure elevations on diversion weir or piping to ensure it is consistent with site plan design.
4. Inspect downstream structure in diversion system for signs of blockage or structural failure.

## Cleaning

Schedule cleaning with local vactor company or AquaShield™'s Maintenance Department to remove sediments, oils, and other floatable pollutants with a vactor trailer. The captured sediment generally does not require any special treatment or handling for disposal. AquaShield recommends that all materials removed during the maintenance process be handled and disposed of in accordance with local and state requirements.



Figure 3

## Maintenance Schedule

### During Construction

Inspect the Aqua-Swirl™ every three months and clean the system as needed. The Aqua-Swirl™ should be inspected and cleaned at the end of construction regardless of whether it has reached its sediment or oil storage capacity.

### First Year Post-Construction

Inspect the Aqua-Swirl™ every three months and clean the system as needed.

Inspect and clean the system once annually regardless of whether it has reached its sediment or floatable pollutant storage capacity.

### Second and Subsequent Years Post-Construction

If the Aqua-Swirl™ did not reach full sediment or floatable pollutant capacity in the First Year Post-Construction, the system can be inspected and cleaned once annually.

If the Aqua-Swirl™ reached full sediment or floatable pollutant capacity in less than 12 months in the First Year Post-Construction, the system should be inspected once every six months and cleaned as needed. The Aqua-Swirl™ should be cleaned annually regardless of whether it reaches its sediment or floatable pollutant capacity.

### Bypass Structures

Bypass structures should be inspected whenever the Aqua-Swirl™ is inspected and maintained as needed.

### Maintenance Company Information

Company Name: \_\_\_\_\_

Street Address: \_\_\_\_\_

City, State, Zip: \_\_\_\_\_

Contact: \_\_\_\_\_

Office Phone: \_\_\_\_\_

Mobile Phone: \_\_\_\_\_

Pager: \_\_\_\_\_



### Activity Log

Date of cleaning: \_\_\_\_\_ (Next inspection should be 3 months from this date for the first year).

Time of cleaning: \_\_\_\_\_

Date of next inspection: \_\_\_\_\_

Floatable debris present (Y/N)? \_\_\_\_\_

Oil present (Y/N)? \_\_\_\_\_ Oil depth (inches): \_\_\_\_\_

### Structural Conditions and Comments

Any structural damage?	Y	N	Where? _____
Any evidence of structural wear?	Y	N	Where? _____
Odors present?	Y	N	Describe: _____
Any plugging?	Y	N	Describe: _____



# Aqua-Swirl™

## TABULAR MAINTENANCE SCHEDULE

**Date Construction Started:** \_\_\_\_\_

**Date Construction Ended:** \_\_\_\_\_

During Construction												
Activity	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Inspect and Clean as Needed			X			X			X			X
Inspect Bypass Structures (if applicable) and Maintain As Needed			X			X			X			X
Clean System*												X*

\* The Aqua-Swirl™ should be cleaned once a year regardless of whether it has reached full pollutant storage capacity. In addition, the system should be cleaned at the end of construction regardless of whether it has reach full pollutant storage capacity.

First Year Post-Construction												
Activity	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Inspect and Clean as Needed			X			X			X			X
Inspect Bypass Structures (if applicable) and Maintain As Needed			X			X			X			X
Clean System*												X*

\* The Aqua-Swirl™ should be cleaned once a year regardless of whether it has reached full pollutant storage capacity.

Second and Subsequent Years Post-Construction												
Activity	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Inspect and Clean as Needed*												X*
Inspect Bypass Structures (if applicable) and Maintain As Needed												X*
Clean System*												X*

\*If the Aqua-Swirl™ did not reach full sediment or floatable pollutant capacity in the First Year Post-Construction, the system can be inspected and cleaned once annually.

If the Aqua-Swirl™ reached full sediment or floatable pollutant capacity in less than 12 months in the First Year Post-Construction, the system should be inspected once every six months (more frequently if past history warrants) and cleaned as needed. The Aqua-Swirl™ should be cleaned annually regardless of whether it reaches its sediment or floatable pollutant capacity.