Attachment 1

Manufactured Treatment Device (MTD) Registration

1. **Manufactured Treatment Device Name:**

   Aqua-Swirl® Stormwater Treatment System

2. **Company Name:** AquaShield™, Inc.
   Mailing Address: 2733 Kanasita Drive, Suite 111
   City: Chattanooga
   State: Tennessee
   Zip: 37343

3. **Contact Name (to whom questions should be addressed):** Mark B. Miller
   Mailing Address: 2733 Kanasita Drive, Suite 111
   City: Chattanooga
   State: Tennessee
   Zip: 37343
   Phone number: (423) 870-8888
   Fax number: (423) 826-2112
   E-mail address: mmiller@aquashieldinc.com
   Web address: www.aquashieldinc.com

4. **Technology**
   Specific size/capacity of MTD assessed (include units):

   The Aqua-Swirl® is a single chamber vortex-type hydrodynamic separator. The effective treatment area in the swirl chamber ranges from 2.5 feet to 13 feet in diameter, or an area of 4.9 to 132.7 ft^2. The Aqua-Swirl® can be installed in a twin configuration to allow for doubling the flow capacity. Aqua-Swirl® model names reflect the approximate or actual diameter of the unit including sequential model numbers AS-2 through AS-13 (see sizing chart below).

   Range of drainage areas served by MTD (acres):

   The customization of the Aqua-Swirl® design allows for a wide range of drainage areas to be treated; hence, there is no absolute range of drainage areas served by the device. The maximum drainage area is ultimately limited by the practicality of utilizing an Aqua-Swirl® to meet the water quality flow rate for a given site. See sizing criteria below.

   Include sizing chart or describe sizing criteria:

   The Aqua-Swirl® is sized to meet the maximum water quality treatment flow rate (WQTFR). The current NJDEP sizing chart is included in the attached Laboratory Test Certification letter dated August 31, 2011. Subsequent to that certification letter, the

Aqua-Swirl® is now available in Models AS-11 and AS-13. Those two additional models are listed in Table 1 of the Aqua-Filter™ Field Certification letter dated June 13, 2014 for the Hydrodynamic Pretreatment Chamber Sizing Chart (submitted separately). The Aqua-Swirl® sizing chart for NJDEP is as follows:

Aqua-Swirl® Sizing Chart per NJDEP Criteria		
Aqua-Swirl® Model	**Swirl Chamber Diameter (ft)**	**Maximum WQTFR (cfs)**
AS-2	2.5	0.6
AS-3	3.25	0.9
AS-4	4.25	1.6
AS-5	5	2.2
AS-6	6	3.2
AS-7	7	4.3
AS-8	8	5.6
AS-9	9	7.1
AS-10	10	8.8
AS-11	11	10.6
AS-12	12	12.6
AS-13	13	14.8
AS-XX	Custom/Multiple	

Intended application: on-line or offline:

The Aqua-Swirl® can be installed in an offline or on-line configuration. NJDEP certification limits the Aqua-Swirl® to an offline application. The Washington State Department of Ecology General Use Level Designation (GULD) for Pretreatment and Conditional Use Level Designation (CULD) for Basic (TSS) standalone treatment allows both offline or on-line applications.

Media used (if applicable):

Not applicable.

5. Warranty Information (describe, or provide web address):

See attached AquaShield™ Limited Warranty.

6. Treatment Type

X Hydrodynamic Structure
☐ Filtering Structure
☐ Manufactured Bioretention System
Provide Infiltration Rate (in/hr):
☐ Other (describe):

7. Water Quality Treatment Mechanisms (check all that apply)

- [X] Sedimentation/settling
- [ ] Infiltration
- [ ] Filtration
- [ ] Adsorption/cation exchange
- [ ] Chelating/precipitation
- [ ] Chemical treatment
- [ ] Biological uptake
- [ ] Other (describe):

8. Performance Testing and Certification (check all that apply):

Performance Claim (include removal efficiencies for treated pollutants, flow criteria, drainage area):

The Aqua-Swirl® NJCAT Field Test Verification Report for an offline AS-5 dated November 2012 is attached and is available on the NJCAT website at: http://www.njcat.org/uploads/newDocs/AquaSwirlNJCATFieldVerification1112.pdf. An NJCAT letter dated February 15, 2013 is also attached hereto that summarizes the AS-5 field test results. From that letter:

"The Aqua-Swirl®, having a WQTFR of 41.2 gpm/ft^2, has demonstrated a suspended sediment removal efficiency in excess of 80% on a net annual basis for a clay-loam textured sediment in this field test."

The field test drainage area was 1.19 acres. The average influent particle size was less than 100 microns (µm), with 72% of the particles being less than 63 µm in size. Average influent TSS concentration was 132 mg/L. Average annual TSS removal efficiency was 86% and 87% for TSS and SSC, respectively.

The NJDEP Laboratory Test Certification letter for the Aqua-Swirl® is attached and available on the NJDEP website at: http://www.njstormwater.org/treatment.htm. NJDEP certifies the use of the Aqua-Swirl® at a TSS removal rate of 50% based on a laboratory test loading rate of 52.6 gpm/ft^2. It should be kept in mind that NJDEP limits **all** hydrodynamic separators to a 50% TSS removal rate regardless of whether testing results demonstrate a greater removal rate. The NJCAT-verified laboratory report dated 2005 of an AS-3 is available on the NJCAT website at: http://www.njcat.org/uploads/newDocs/AquaSwirl_AquaFilterNJCATLaboratoryVerification905.pdf. Note that the NJCAT field verification results supersede the NJCAT laboratory verification results.

Specific size/Capacity of MTD assessed:

The AS-5 uses a single 5-foot diameter swirl chamber as the effective treatment area.

Has the MTD been "approved" by an established granting agency, e.g. New Jersey Department of Environmental Protection (NJDEP) , Washington State Department of Ecology, etc.

No

X Yes; **For each approval, indicate (1) the granting agency, (2) use level if awarded (3) the protocol version under which performance testing occurred (if applicable), and (4) the date of award, and attach award letter.**

Attached is the NJDEP Laboratory Test Certification letter for the Aqua-Swirl® dated August 31, 2011 and is available on the NJDEP website at: http://www.njstormwater.org/treatment.htm. Testing was performed by Tennessee Tech University and followed the American Public Works Association Protocol, Appendix B: "An Approach to Lab testing of Stormwater Treatment Facilities."

The Aqua-Swirl® does not currently hold NJDEP Field Certification but is eligible to seek that certification based on the NJCAT-verified AS-5 field test. A WQTFR of 41.2 gpm/ft^2 is supported based on the loading rates experienced during the testing period. The current NJDEP Laboratory Test Certification provides for a higher WQTFR of 52.6 gpm/ft^2. AquaShield™ has elected to keep the current NJDEP laboratory certification in effect for the time being, as there is no regulatory requirement that NJDEP certification automatically be sought subsequent to the NJCAT verification.

Attached is the Washington State Department of Ecology GULD (Pretreatment) and CULD (TSS) for the Aqua-Swirl® dated October 2013. The GULD was first issued based on the results of the NJCAT-verified laboratory test. The CULD was issued based on the AS-5 NJCAT-verified field test. The GULD/CULD is available on Ecology's website at: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html.

Was an established testing protocol followed?

No

X Yes, **(1) Provide name of testing protocol followed, (2) list any protocol deviations:**

The AS-5 field test was performed in accordance with the TARP Tier II protocol (TARP, 2003) and New Jersey Tier II Stormwater Test Requirements – Amendments to TARP Tier II Protocol (NJDEP, 2006). There were no deviations to the field protocol.

Laboratory testing of an AS-3 was performed by Tennessee Tech University and followed the American Public Works Association Protocol, Appendix B: "An Approach to Lab testing of Stormwater Treatment Facilities."

Provide the information below and provide a performance report (attach report):

For lab tests:

i. **Summarize the specific settings for each test run (flow rates, run times, loading rates) and performance for each run:**

The NJCAT verified laboratory test of the Aqua-Swirl® is attached and available on the NJCAT website at http://www.njcat.org/verification-process/technology-verification-database.html. Test runs and results are summarized as follows:

Flow Rate (cfs / gpm/ft²)	*TSS Removal Efficiency (%)*
0.2 / 10.8	89
0.5 / 27.1	82
0.8 / 43.3	57
1.2 / 64.9	18

ii. **If a synthetic sediment product was used, include information about the particle size distribution of the test material:**

OK-110 test sediment is manufactured by US Silica and has a particle gradation range from approximately 50 to 150 microns (µm), and a reported median (d_{50}) of 110 µm. Other product development testing programs for the Aqua-Swirl® performed by Alden Research Laboratory demonstrated that the d_{50} for OK-110 can be as low as 90 µm. Specific gravity for OK-110 is reported to be 2.65.

iii. **If less than full-scale setup was tested, describe the ratio of that tested to the full-scale MTD:**

A full scale commercially available Aqua-Swirl® Model AS-3 was tested in the laboratory.

For field tests:

i. **Provide the address, average annual rainfall and characterized rainfall pattern, and the average annual number of storms for the field-test location:**

Field test site address: Burnt Mills Shopping Center
10731 Columbia Pike
Silver Spring, MD 20901

A total of 18 TARP-qualifying storms and 15.16 inches of rainfall were sampled over 26 months between March 2009 and June 2011. The required minimum number of storm is 15 and at least 15 inches of rain are to be sampled. A TARP-qualifying storm is ≥0.1 inch. Available information indicates that the area

receives approximately 42 inches of annual rainfall. An average of 60% storm flow volume was sampled, TARP requires at least 60%.

According to the NRCS document 210-VI-TR-55, Second Edition, June 1986, the field test site is located in the Type II rainfall distribution region. This same rainfall distribution type covers all of Virginia except the extreme southeastern coastal area. It is considered that the AS-5 rainfall conditions would be consistent with rainfall patterns for the greatest majority of Virginia (~95%).

ii. **Provide the total contributing drainage area for the test site, percent of impervious area in the drainage area, and percentages of land uses within the drainage area (acres):**

The AS-5 field test drainage area is approximately 1.19 acres with an estimated 100% impervious area. An asphalt covered parking lot represents ± 85% of the drainage area, roof runoff ± 15%. A precise determination of roof runoff contribution could not be ascertained but probably does not exceed 20%.

iii. **Describe pretreatment, bypass conditions, or other special circumstances at the test site:**

The AS-5 is installed in an offline configuration using an upstream divergence structure and a downstream convergence structure. It does not appear that bypass conditions occurred during the testing period. No special or adverse circumstances were encountered during the testing program.

iv. **Provide the number of storms monitored and describe the monitored storm events (amount of precipitation, duration, etc.):**

A total of 18 TARP-qualifying storms were sampled. A total of 15.16 inches of rain was sampled. The TARP protocol requires at least 15 inches of rain be sampled. Storm durations ranged from 30 minutes up to 12 hours 5 minutes. Storm sizes ranged from 0.11 to 4.4 inches and averaged 0.84 inches. A TARP-qualifying storm is ≥0.1 inch.

v. **Describe whether or not monitoring examined seasonal variation in MTD performance:**

The field test spanned 27 months that commenced in March 2009 and ended in June 2011. Seasonal variations were monitored during the field testing program.

vi. **If particle size distribution was determined for monitored runoff and/or sediment collected by the MTD, provide this information:**

Refer to pages 18-23, Tables 4 and 6, and Figures 6 and 7 of the NJCAT verification report for a discussion of particle size distribution (PSD) for the AS-5 field test. Serial filtration was used to determine PSD and particles greater than 1,000 µm were excluded from all analyses. From Table 4, the influent PSD distribution from three storms (as required by TARP protocol) indicates that 100% of the particles are finer than 1,000 µm, 94.2% are finer than 500 µm, 91.68% are finer than 250 µm, 85.57% are finer than 125 µm, 71.74% are finer than 63 µm and no particles are finer than 1.5 µm. The AS-5 field test PSD is finer grained than the PSD specified by the NJDEP January 2013 laboratory protocol for hydrodynamic separators.

Figure 21 depicts the sediment layer that accumulated in the swirl chamber as measured at the conclusion of the testing period. Table 6 summarizes the PSD of the captured material. As designed, the sediment profile exhibits similarity to a conical shaped sediment layer at the base of the swirl chamber.

9. MTD History:

How long has this specific model/design been on the market?

The Aqua-Filter™ has been commercially available for 16 years, since 1998. The Aqua-Swirl® is a well established product within the stormwater community.

List no more than three locations where the assessed model size(s) has/have been installed in Virginia. If applicable, provide permitting authority. If known, provide latitude & longitude:

The Aqua-Swirl® has been installed at several thousand locations nationwide and internationally. AquaShield™ can provide additional information on installation locations on a confidential basis. Three example Virginia locations are listed below:

(1) Aqua-Swirl® Model AS-8, Interstate Warehouse, Newport News, VA
(2) Aqua-Swirl® Model AS-4, The Prescott Condominiums, Alexandria, VA
(3) Aqua-Swirl® Model AS-6, Mine Road Square, Stafford, VA

List no more than three locations where the assessed model size(s) has/have been installed outside of Virginia. If applicable, provide permitting authority. If known, provide latitude & longitude:

In addition to the AS-5 test site, three example installation locations near Virginia are listed below. AquaShield™ can provide additional information about installation locations on a confidential basis.

(1) Aqua-Swirl® Model AS-5, Beltway Plaza, Beltsville, MD
(2) Aqua-Swirl® Model AS-5, Market Square, Rockville, MD
(3) Aqua-Swirl® Model AS-5, Giant Foods, Waldorf, MD

10. Maintenance:

What is the generic inspection and maintenance plan/procedure? (attach necessary documents):

See attached Aqua-Swirl® Inspection & Maintenance Manual. We recommend at least quarterly inspections during the first year of installation to determine site runoff conditions and predict maintenance cycles. We also recommend at least annual inspections and maintenance of the swirl chamber and any external conveyance flow structure(s). Inspections of the swirl chamber are performed from the surface without the need for entry. The single swirl chamber allows for easy and quick inspections for floatables and accumulated sediment at the base of the chamber.

Maintenance events typically require a vacuum truck to remove captured materials from the chamber and any external structures. Confined space entry is not needed for the swirl chamber maintenance event.

Is there a maintenance track record/history that can be documented?

X No, no track record.
Yes, track record exists; (provide maintenance track record, location, and sizing of three to five MTDs installed in Virginia [preferred] or elsewhere):

AquaShield™ does not maintain a track record system for its systems, nor does it operate its own fleet of maintenance equipment. Instead, AquaShield™ recommends that end users/owners contract with independent local maintenance providers. We can assist with that service at no cost upon request. AquaShield™ also has a nationwide service agreement with a maintenance provider. We do not keep maintenance track records of services provided by other independent contractors. End users, owners, contractors, etc. can contact their local AquaShield™ representative or our corporate office directly to order maintenance. It is not necessary for AquaShield™ personnel or its representative to be present during inspections or maintenance events.

It is recognized in the industry that Montgomery County, Maryland administers and operates a robust maintenance program for MTDs. AquaShield™ has a large number of systems installed in that county, and to our knowledge the Aqua-Swirl® overall meets the maintenance criteria that has been established by the county's Department of Permit Services.

Aqua-Swirl® systems have been installed in a number of state transportation departments that perform maintenance on a routine basis. To our knowledge, there have been no instances of adverse system functionality or maintenance circumstances.

Recognizing that maintenance is an integral function of the MTD, provide the following: amount of runoff treated, the water quality of the runoff, and what is the expected maintenance frequency for this MTD in Virginia, per year?

Aqua-Swirl® systems are sized according to local stormwater regulations. There is no limitation to the amount of runoff the Aqua-Swirl® is capable of conveying provided that maintenance is performed as required to ensure functionality. Annual maintenance frequency is expected (and recommended) for Aqua-Swirl® systems in Virginia as supported through field testing. Site conditions will ultimately dictate maintenance frequency.

Total life expectancy of MTD when properly operated in Virginia and, if relevant, life expectancy of media:

The Aqua-Swirl® will have a life expectancy of 50 years or more. There is no filter media in the Aqua-Swirl®.

For media or amendments functioning based on cation exchange or adsorption, how long will the media last before breakthrough (indicator capacity is nearly reached) occurs?

Not applicable.

For media or amendments functioning based on cation exchange or adsorption, how has the longevity of the media or amendments been quantified prior to breakthrough (attach necessary performance data or documents)?

Not applicable.

Is the maintenance procedure and/or are materials/components proprietary?
Yes, proprietary
X No, not proprietary

There are no proprietary maintenance procedures or materials used for the Aqua-Swirl®.

Maintenance complexity (check all that apply):

Confined space training required for maintenance

No confined space access is needed to clean the Aqua-Swirl®.

X Liquid pumping and transportation
Specify method:

A standard vacuum truck is commonly used to pump and transport liquids and floatable oil for disposal according to local guidelines.

X Solids removal and disposal
Specify method:

A vacuum truck is used to remove solids for disposal according to local guidelines.

Other noteworthy maintenance parameter (describe):

The Aqua-Swirl® utilizes a single swirl chamber for both treatment and materials storage. There are no blind or limited access areas within the structure that would prevent complete access for inspections and cleaning. All inspections and maintenance events for Aqua-Swirl® are performed from the surface through access riser. Larger models and/or twin configurations utilize two or more risers to facilitate inspections and maintenance.

11. Comments

Include any additional explanations or comments:

Independent field testing of an offline Aqua-Filter™ Model AF-5.3, using the same Aqua-Swirl® Model AS-5 used for the NJCAT verification, demonstrated over 65% annual Total Phosphorus (TP) removal efficiency for a clay-loam textured sediment influent at a filter surface area loading rate up to 17.5 gpm/ft^2. Refer to the separate Aqua-Filter™ approval request for additional information about TP removal. It is recognized that the Aqua-Swirl® achieved over 80% TSS removal on an annual basis; and, Aqua-Filter™ system (Aqua-Swirl® plus filtration chamber) field test achieved approximately 10% improvement of the TSS removal efficiency than the Aqua-Swirl® component alone. It is indicated that the Aqua-Swirl® will provide a high level of TP removal efficiency in association with its proven high solids removal capability to support the 40% TP removal credit.

12. Certification

Signed by the company president or responsible officer of the organization:

"I certify that all information submitted is to the best of my knowledge and belief true, accurate, and complete."

Signature: _____

Name: Stuart C. Ellis

Title: Research & Development Manager

Date: 6/20/2014

NOTE: All information submitted to the department will be made publically accessible to all interested parties. This MTD registration form will be posted on the Virginia Stormwater BMP Clearinghouse website.