Attachment 1

Manufactured Treatment Device (MTD) Registration

1. **Manufactured Treatment Device Name:** HydroDome

2. **Company Name:** Hydroworks, LLC

Mailing Address: 257 Cox Street
City: Roselle
State: NJ Zip: 07203

3. **Contact Name** (to whom questions should be addressed): Graham Bryant

Mailing Address: 257 Cox Street
City: Roselle
State: NJ Zip: 07203
Phone number: 848-235-5950 ext.111
Fax number: 888-783-7271
E-mail address: gbryant@hydroworks.com
Web address: www.hydroworks.com

4. **Technology**

Specific size/capacity of MTD assessed (include units): HydroDome is a hydrodynamic separator that provides both treatment and volume control of stormwater runoff.

HydroDome consists of a copolymer propylene or HDPE rectangular-shaped insert which is housed in a round or rectangular precast structure (Figure 1). The insert includes an outlet pipe designed to fit inside the outlet pipe of the structure. The HydroDome insert itself is bolted to the structure to ensure a permanent and secure installation.

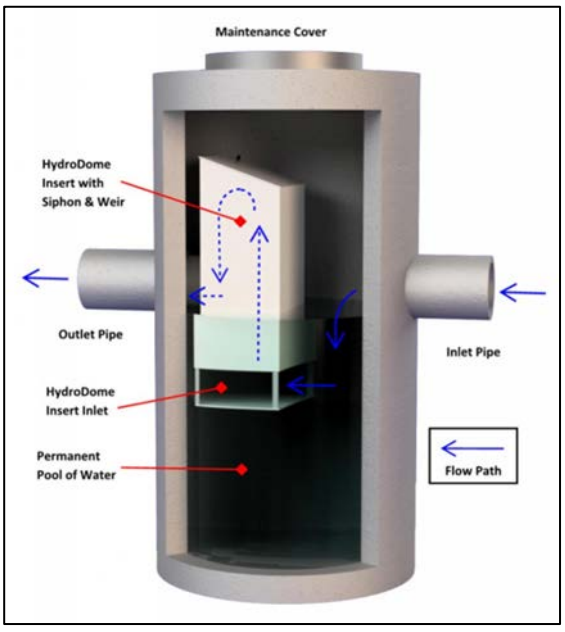


Figure 1. Hydroworks HydroDome

Water enters the manhole, either horizontally though an inlet pipe or vertically through a grated inlet. All flow then enters the rectangular shell of the HydroDome insert through horizontal openings in the insert itself. There is no internal bypass to these horizontal inlets. Oil and less-dense solids float above the horizontal openings and cannot enter since the horizontal inlets are submerged. Dense solids sink down into the sump of the precast manhole and are also prevented from being conveyed downstream.

Once inside the HydroDome insert, water is conveyed through the low-flow path. The low-flow path includes a siphon to regulate the water level in the device. Low-flow then exits HydroDome through an orifice at the outlet.

The water level in HydroDome increases with increasing flowrate. When the water level reaches the elevation of the high-flow weir (located inside the insert) the high-flow path is engaged. High-flow still enters the HydroDome insert through the submerged horizontal inlets. It flows above the siphon and over a weir to the outlet pipe.

The high-flow weir is included when HydroDome is designed for water quality alone. The weir is removed for HydroDome's water quantity control configuration. This configuration is reserved for sites that require both a high level of treatment and volume/flow control. All flow travels through the low-flow path in the quantity control configuration and the orifice and siphon are customized to provide the design release rate based on the upstream storage elevation on a site-by-site basis.

Both HydroDome quality and quantity configurations are available in any size that precast structures are made. Commonly available circular precast sizes and their capacities are provided in Table 1 below.

Table 1. HydroDome Dimensions & Capacities

Model	Inside Diameter (ft)	Depth (ft)**	Sediment Storage (ft^3)*	Oil & Floatable Storage (gal)*	Permanent Pool Volume (gal)*
HD 3	3	4	18	31	211
HD 4	4	4	28	70	376
HD 5	5	5.5	69	134	808
HD 6	6	6.5	120	230	1375
HD 7	7	7.5	190	360	2159
HD 8	8	8.5	285	560	3196
HD 10	10	10.5	555	1125	6169
HD 12	12	12.5	960	1975	10575

*Dimensions and capacities vary with project requirements
**Based on CETV independent testing and NJDEP scaling requirements

Range of drainage areas served by MTD (acres): HydroDome is sized to treat the water quality flow and achieve a desired average annual TSS removal rate of specified particle sizes. As such, the range of drainage areas serviced by each HydroDome model will depend on the local rainfall intensity, imperviousness, and design particle size distribution of the site in question.

Include sizing chart or describe sizing criteria: A HydroDome HD 3 was tested to the NJDEP HDS protocol at Alden Labs in 2021. Testing showed that the HD 3 will provide a weighted 50% removal of a particle size distribution consistent with the NJDEP protocol at a treatment rate of 0.85cfs.

For the 3ft diameter HydroDome tested, this corresponds to a hydraulic loading rate of 54.0 gallons per minute per square foot of treatment area. The NJDEP scaling methodology applies the loading rate to each model HydroDome. The maximum treatment flow rate assigned to each HydroDome by NJDEP is provided in Table 2.

Table 2. HydroDome Maximum Treatment Flow Rates*

Model	Diameter (ft)	Maximum Treatment Flow Rate (cfs)**	Treatment Area (ft^2)	Hydraulic Loading Rate (gpm/ft^2)
HD 3	3	0.85	7.1	54.0
HD 4	4	1.51	12.6	54.0
HD 5	5	2.36	19.6	54.0
HD 6	6	3.40	28.3	54.0
HD 7	7	4.63	38.5	54.0
HD 8	8	6.04	50.3	54.0
HD 10	10	9.44	78.5	54.0
HD 12	12	13.60	13.60	54.0

*NJDEP (2021)
**based on NJDEP PSD – treatment flow rates will vary based on design PSD

HydroDomes are also sized to meet specific design requirements using our simulation model, which is based on EPA SWMM4.4. The modeling software is readily available to all design engineers interested in sizing HydroDome. Users enter a particle size distribution consistent with their local regulatory agency requirements, enter the size and imperviousness of the area draining to the HydroDome, and select a weather station near their site. The model uses historic rainfall data from the selected weather station, buildup and washoff routines from SWMM 4.4, and the Alden test results to determine an average annual removal percentage of the selected particle size distribution for each model HydroDome. This allows the user to ensure that the HydroDome they've selected meets their TSS removal requirement.

Intended application: on-line or offline: HydroDome can be used on-line or off-line. HydroDome has been scour tested to the NJDEP protocol and proven to have negligible scour at 241% of the rated treatment rate.

Media used (if applicable): Not applicable.

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

Hydroworks provides a standard 1-year warranty for manufacturing defects on HydroDome.

6. Treatment Type

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

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

☒ Sedimentation/settling
☐ Infiltration
☐ Filtration (specify filter media)
☐ 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): Removal efficiency tests were conducted on a full-scale HD 3 at 25%, 50%, 75%, 100%, and 125% of the maximum treatment flow rate, which was 0.85cfs. The removal efficiencies at those flow rates ranged from 41.8% to 69.9%, with a weighted removal of 58.5% for the 5 flows. The removal efficiency summary is provided in Table 3.

Table 3. Removal Efficiency Summary

Flow (gpm)	Influent Concentration (mg/L)	Average Effluent Concentration (mg/L)	Removal Efficiency (%)	NJDEP Weight Factor	NJDEP Weighted Removal Efficiency (%)
94.4	206	70.6	65.8	0.25	16.4
173.9	196	59.1	69.9	0.30	21.0
286.3	220	106.3	51.7	0.20	10.3
352.3	188	106.4	43.6	0.15	6.5
439.7	190	110.7	41.8	0.10	4.2
				1.0	58.5

The test unit had a treatment sedimentation area of $7.07 ft^2$, therefore the HydroDome has a surface loading rate of $54.0 gpm/ft^2$.

The HD 3 was also scour tested to the NJDEP protocol. The test was conducted at a target flow of 919gpm, which is 241% of the maximum treatment flow rate. 15 effluent samples were collected throughout the test. The average measured scour concentration adjusted for background was 0mg/L. This qualifies the HydroDome for on-line installation.

Specific size/Capacity of MTD assessed: The HydroDome tested was a full-scale HD 3 installed in a 3ft diameter plastic test tank. The test unit had a 5ft sump and a 7.07ft^2 treatment surface area.

A full-scale HydroDome HD 3 was tested to the ETV Canada protocol with a 4ft sump. No measurable change in performance was observed with the 4ft sump compared to the 5ft sump and both oil and sediment scour testing were performed with the 4ft sump (Appendix 3). HydroDome retained 99.7% of oil surrogate beads during the oil scour test and the scour concentration adjusted for background using the 4ft sump was, again, negligible.

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**
☒ **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.

HydroDome has been certified by NJDEP, based on their 2013 protocol, for a TSS removal rate of 50%. The certification letter dated June 30, 2021 is provided in Appendix 1.

HydroDome has been tested to the ETV Canada OGS protocol (TRCA, 2014) and is currently being verified under ETV Canada (ISO-14034).

Alden Research labs performed testing for both.

Was an established testing protocol followed?
☐ **No**
☒ **Yes**, (1) Provide name of testing protocol followed, (2) list any protocol deviations:

Laboratory testing was done by Alden Research Laboratory in accordance with the New Jersey Department of Environmental Protection "Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device" (January 2013a) (NJDEP Hydrodynamic Protocol) and "The Procedure for Laboratory Testing of Oil-Grit Separators (TRCA, May 2014).

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:

Five removal efficiency tests were performed at target flows of 0.21cfs, 0.43cfs, 0.64cfs, 0.85cfs, and 1.06cfs. These flows correspond with 25%, 50%, 75%, 100% and 125% of the maximum treatment flow rate. All of the flows measured during the tests were within 10% of the target flow as per the protocol.

All tests were run with clean water containing less than 20mg/L sediment solids concentration. At least 25lbs of test sediment was added to the influent pipe for each test. The target influent sediment concentration was 200mg/L for each test. All of the dry samples taken at the injector were within 10% of the target concentration as per the protocol.

Tables 4 and 5 give summaries of target flows and injection rates respectively. The full NJCAT verified lab report is provided in Appendix 2.

Table 4. Test Flow and Temperature Summary

Target (gpm / cfs)	Measured (gpm / cfs)	Deviation from Target	Flow Measurement COV	Maximum Temperature (°F)	QA / QC Compliant
95.4 / 0.21	94.4 / 0.21	-1.1%	0.001	65.4	Y
190.8 / 0.43	173.9 / 0.39	-8.8%	0.002	64.9	Y
286.1 / 0.64	286.3 / 0.64	0.0%	0.002	62.6	Y
381.5 / 0.85	352.3 / 0.78	-7.7%	0.002	63.8	Y
476.9 / 1.06	439.7 / 0.98	-7.8%	0.002	60.8	Y

Table 5. Injected Sediment Summary

Flow (gpm)	Avg Injected Concentration (mg/L)	Injector Measurement COV	Mass/Volume Concentration (mg/L)	Injected Mass (lbs)	Maximum Background Concentration (mg/L)	QA / QC Compliant
94.4	200	0.007	206	28.7	206	Y
173.9	199	0.004	196	28.1	196	Y
286.3	199	0.001	220	30.0	220	Y
352.3	201	0.004	188	28.7	188	Y
439.7	201	0.008	190	30.7	190	Y

Fifteen effluent samples were collected in each test. Sampling started after at least 162s (3 detention times) following sediment injection and/or injection verification. Performance for each run is summarized in Table 3.

A HydroDome HD3 was also tested to the ETV separator protocol in Canada. This protocol differs from the NJDEP protocol by mandating: independent testing, mass capture testing (no sampling for TSS removal), scour testing using the full NJDEP distribution (not truncated), tests for oil capture and scour potential, as well as requiring vendors test at the same surface loading rates. To date, HydroDome achieved the highest removal of any separator tested to this protocol, has no scour (<1 mg/l), and retained 99.7% of oil. Figure 2 shows a comparative graph of TSS removal.

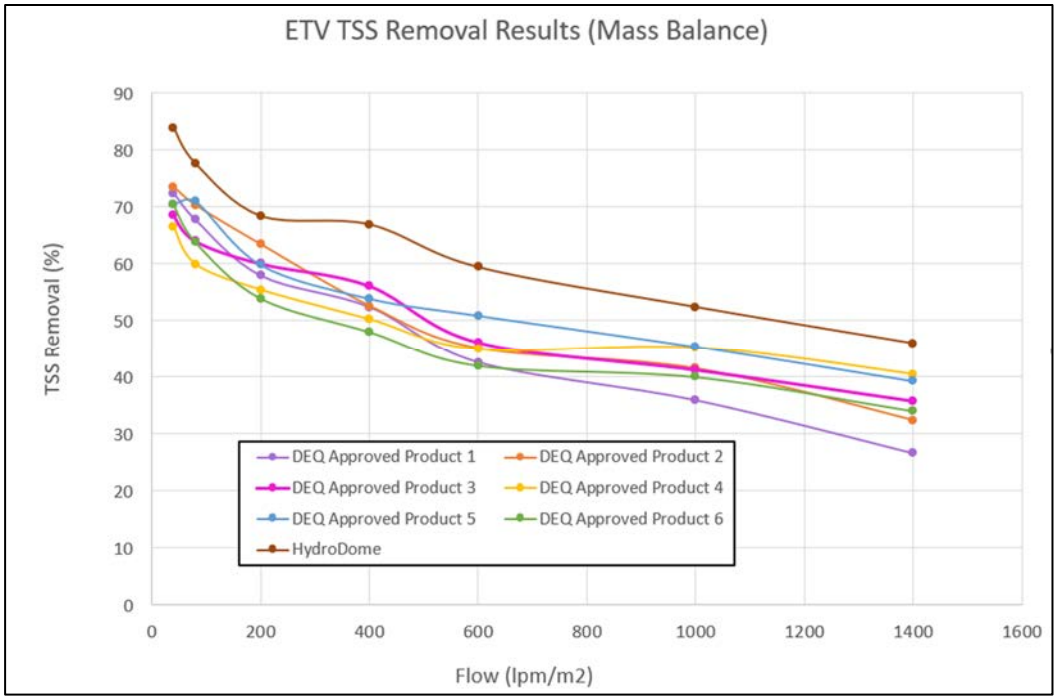


Figure 2. ETV TSS Removal Results

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

The particle size distribution used exceeded the NJDEP PSD sediment specifications. The D_{50} of 62um was less than the required 75um. The data from the PSD samples was used to provide the curve in Figure 3.

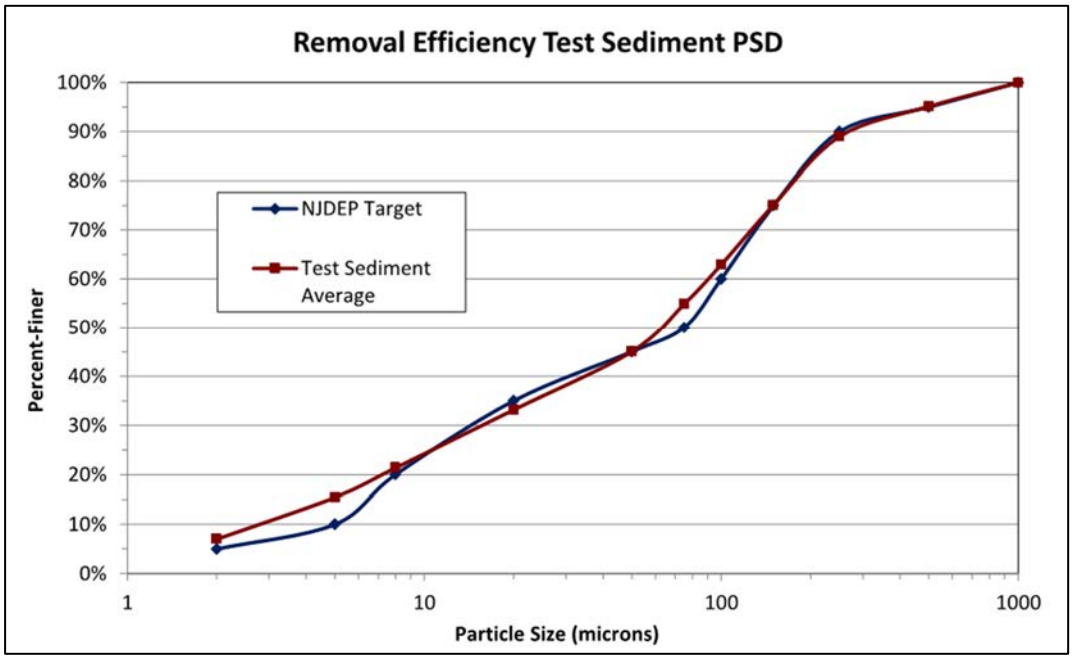


Figure 3. Test Sediment PSD Curve

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

Lab testing was performed on a full-scale HD 3.

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: Not applicable

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): Not applicable

iii. Describe pretreatment, bypass conditions, or other special circumstances at the test site: Not applicable

iv. Provide the number of storms monitored and describe the monitored storm events (amount of precipitation, duration, etc.): Not applicable

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

vi. If particle size distribution was determined for monitored runoff and/or sediment collected by the MTD, provide this information: Not applicable

9. MTD History:

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

The first HydroDome was installed in August, 2020.

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:

No HydroDomes have been installed in Virginia.

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:

Connecticut Army National Guard, Winsor Locks, CT.
Perkins School, Lancaster, MA.
MLS & WID Joint Facility, Strathmore, AB.

10. Maintenance:

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

During the construction period, HydroDome should be inspected every four weeks and after every storm. After the construction period the HydroDome should be inspected annually for stable sites and quarterly if the unit is exposed to oil spills or runoff from unstable sites. Annual and quarterly inspections should be used to determine if more frequent inspections are required.

Maintenance is typically done using a vacuum truck. If a vacuum truck is not available, less effective methods (i.e., clamshell bucket) can be used. The full inspection and maintenance plan, procedure, and checklist is provided in the Operations & Maintenance Manual provided in Appendix 4.

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

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?

Since there is no internal by-pass, HydroDome treats 100% of runoff that drains to it.

The water quality of the runoff will depend on the drainage area and model of HydroDome and size of particles in the runoff. If HydroDome is appropriately sized to the site (using NJDEP certified ratings) and the TSS has the same distribution as the NJDEP PSD, it will provide 50% TSS removal at the site's water quality flow. Hydroworks also uses local historic rainfall records on a site-by-site basis to size HydroDome to achieve a required average annual TSS removal.

The expected maintenance frequency for HydroDome is once per year. Maintenance frequency also depends largely on site usage and exposure. As such, the annual maintenance frequency is a guideline that should be used to determine whether or not more frequent maintenance is required.

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

The life expectancy of HydroDome is the life expectancy of its components (copolymer polypropylene and precast concrete). These materials have an anticipated life span of 50-100 years.

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
☒ No, not proprietary

While the product and technology itself is proprietary, its maintenance is not.

Maintenance complexity (check all that apply):

☐ Confined space training required for maintenance
☒ Liquid pumping and transportation
Specify method: Vacuum Truck.
☒ Solids removal and disposal
Specify method: Local municipality should be consulted for disposal options.
Other noteworthy maintenance parameter (describe):

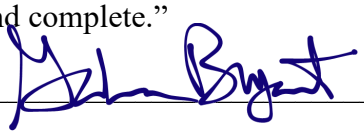
11. Comments

Include any additional explanations or comments:

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: Graham Bryant

Title: President

Date: 8/23/2021

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.