Attachment 1

Manufactured Treatment Device (MTD) Registration

1. **Manufactured Treatment Device Name: StormTree Biofiltration System**

2. **Company Name: MMT, Inc**
   Mailing Address: 24 Corliss, St., Suite 9092
   City: Providence
   State: RI Zip: 02940

3. **Contact Name (**to whom questions should be addressed)**:** Paul Iorio
   Mailing Address: 25 Blodgett Ave
   City: Pawtucket
   State: RI Zip: 02860
   Phone number: 781-534-2218
   Fax number: NA
   E-mail address: piorio@storm-tree.com
   Web address: storm-tree.com

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

   A 4'X6' StormTree unit was tested at a design hydraulic loading rate of 120 in/hr (1.25 gpm/sf). It is important to note that due to the unique "open design" Washington Ecology credited the StormTree with an enlarged treatment footprint. For example, a conventional "closed box vault" of a similar dimension, would have an effective treatment area of 4'X6', or 24ft2. However, due to the open wall construction of the StormTree system, the surface of the treatment media surface becomes saturated outside of the inner dimensions of the concrete structure to the approximate extent of the outer edge of the concrete structure (5 inches). So, a typical 4'X6' StormTree with three open sidewalls as field tested, would have an effective media area of 29.6ft2. See the attached Washington Ecology GULD report, and the summary and performance sections of the Technology Evaluation Report (TER) for the field test.

   Range of drainage areas served by MTD (acres):

   The StormTree system is scalable to drainage areas ranging from 0 acres to greater than 2.0 acres based on a design flow rate of 120 in/hr (36.9gpm or 1.25 gpm/sf).

Include sizing chart or describe sizing criteria:

Model Size (feet)	Effective Media Surface Area (ft2)[a]	Water Quality Design Flow Rate (gpm)	Treatment Flow Rate (cfs)
4 x 6	29.6	36.9	0.09
4 x 8	38.6	48.3	0.13
4 x 10	47.6	59.5	0.16
4 x 15	69.6	87.0	0.23
4 x 21	97	121.3	0.32
6 x 6	42	52.5	0.14
8 x 8	72	90.0	0.24

[a] Per WA Ecology, this area includes the media surface within the frame as well as the media under the openings of the frame.

It is important to note that the sizing methodology of the test unit as included in the TER was done in accordance to western Washington state requirements as shown above.

It is important to note that the above calculations are based on a closed dimension (i.e., four sidewalls; closed bottom) structure. Since the StormTree system allows for direct infiltration into the surrounding native soils due to the open bottom, depending upon permeability and infiltration of resident (native) soils, additional volumes of treated water may factor into the overall treatment flow rate through exfiltration. Contrary to a "one size fits all" paradigm, on a site specific basis, the StormTree system may be sized based upon the design flow rate, as well as the National Resources Conservation Service (NRCS) Hydrologic Soil Groups with respect to the potential for infiltration.

For Virginia, applicable sizing will be based on a design flow rate of 120 in/hr (36.9gpm or 1.25 gpm/sf).

NRCS Design Methodology

- Storm Type: Type II 24 hour
- Design Storm: 1.00" rainfall
- StormTree media flow rate: 120 in/hr
- RCN: 98
- Time of Concentration: 6 minutes

Included are the calculations and Hydrograph based on the Rational Method for a hypothetical 4X6 system with an effective media surface area of 29.6 ft2 for a contributing drainage area of 0.1 acres.

Intended application: on-line or offline:

StormTree can be designed for both on-line and off-line applications. Both internal and external bypass options are available.

Media used (if applicable):

StormTree uses a high flow rate biofiltration media developed by StormTree and independently tested by 3rd party testing per the TER. The high flow rate engineered media utilizes physical, chemical, and biological functions to attenuate or remove pollutants in stormwater runoff. A hydraulic load rate of 120 in/h coupled with an overlying mulch layer reduces clogging and flooding potential in an efficient footprint.

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

StormTree warrants its structures to be free from defects in material and workmanship for a period of five years from the actual delivery date.

6. Treatment Type

☐ Hydrodynamic Structure
X Filtering Structure
X Manufactured Bioretention System
Provide Infiltration Rate (in/hr): 120 in/hr
☐ Other (describe):

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

X Sedimentation/settling
X Infiltration
X Filtration (specify filter media)
X Adsorption/cation exchange
X Chelating/precipitation
☐ Chemical treatment
X 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 following removal efficiencies represent the UCL95 Mean percentages, followed by the median of each pollutant from the TAPE field testing. The system successfully met target removal efficiencies at loading rates of up to 1.25 gpm/sf.

TAPE Removal Efficiencies:

- TSS Average Removal Efficiency – 90.6%/93%
- Total Phosphorus Average Removal Efficiency – 61.6%/62.5%
- Dissolved Copper Average Removal Efficiency – 31.4%/36%
- Dissolved Zinc Average Removal Efficiency – 66.7%/70%

Specific size/Capacity of MTD assessed:

The 4'X6' StormTree unit that was field tested has a design hydraulic capacity 36.9 gpm (1.25 gpm/sf or 120 in/hr). See accompanying WA Ecology TER report.

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.**

The StormTree has been approved by Washington State Department of Ecology for "General Use Level Designation" (GULD) for Basic (TSS), Phosphorous, and Enhanced ((metals) copper/zinc) in accordance with the TAPE testing protocol in October 2021. See accompanying GULD approval.

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

1. Technology Assessment Protocol-Ecology (TAPE) followed for field test.
2. Protocol was followed without deviation.

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

Attached-TER for the StormTree TAPE field test.

For lab tests:

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

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

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

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:**

The StormTree field study was conducted at the Ship Canal Testing facility (SCTF) located in Seattle WA in the Interstate 5 right-of-way beneath the north side of the Lake Union ship Canal Bridge. The average annual rainfall for Seattle is approximately 37 inches, with the majority occurring primarily during the "wet season" between October and May each year. The rainfall pattern is a Type 1A according to the USDA-NRCS rainfall distributions for the United States.

The rain gauge at the StormTree monitoring site (Wall-RG) during the field testing period (March 2020 through May 2021) registered 47.45" in total.

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 drainage area contributing to the SCTF stie is approximately 31.6 acres, with 22.7 acres of pavement, and 8.9 acres of roadside landscaping. The site allows for simultaneous testing of up to four treatment systems. Through a series of diversion structures, the runoff from the drainage area is split to the four treatment systems.

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

Due to historical issues with filter clogging at the SCTF, a type 2 catch basin was installed upstream of the StormTree to function as a debris sink/mixing tank. The intake for influent sampling was located downstream of this structure so the test system was not credited with any removal which occurred in the sump. A 3-inch deep hardwood mulch layer overlying the filter media served as the pretreatment mechanism for the filter.

The system as tested was an offline with an external bypass. The bypass consisted of an 8" diameter PVC pipe at the downstream end of an attached curb tray. The

invert elevation of the bypass pipe was at the same elevation as the inside roof slab which is the maximum ponding depth of the WQv.

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

During the March 24, 2020, through May 27, 2021, monitoring period, 30 storm events were sampled to characterize the water quality treatment performance of the StormTree system. The amount of precipitation and duration of each qualifying event is provided in the TER summary section.

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

Yes. The monitoring extended over 14 month period and experienced seasonal variations: spring/summer/fall/winter/spring.

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

The PSD was monitored and the particles are mostly comprised of silt sized particles with an average D_{50} of 83 microns with approximately 40% of the PSD silt and finer.

9. MTD History:

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

7 years

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:

None to date 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:

1. City of Fall River (Massachusetts) Middle Street Drainage Improvements; ((10) 4'X9' systems)
2. City of Portland, Maine, CSO separation project: ((7) 4'X9' systems)
3. City of Contra Costa, California 26 acre Mixed Use Development; ((9) 10.6'X7'; (1) 9'X5'

10. Maintenance:

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

See attached maintenance procedure for a system with interior pretreatment. Additional information will be found in the TER summary section.

Is there a maintenance track record/history that can be documented?
X No, no track record. Jurisdictions where projects were completed prior to TAPE certification did not require documented maintenance practices.

☐ **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?

Maintenance requirements for the StormTree systems are a direct function of pollutant load in the runoff treated by the device, rainfall patterns, and snow loading. For Virginia, twice yearly maintenance would be recommended: typically in spring; and in fall following leaf drop, but prior to typical anticipated snow season.

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

Since the StormTree is a biofiltration system relying on physical/biological/chemical processes, performance is anticipated to be indefinitely provide that regular routine maintenance is practiced. Additionally, excepting for southern California, all StormTree systems are constructed with either a separate interior sump or monolithic attached catch basin to segregate quantities of sand, sediment and trash prior to entering the media portion of the system. Therefore, other tree (box) MTD filter systems do not provide a separate pretreatment facility, the potentiality of premature clogging exists. StormTree was designed based on an understanding of New England states weather where prolonged winters and major snow events often occur resulting in excessive amounts of sand and sediment loading.

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?

Excepting for the overlying hardwood mulch layer, the media portion of the StormTree system includes a combination of nonproprietary organic and non-organic aggregates with low degradation potential. Adsorption and cation exchange capacity is strongly influenced by the presences of low or non-degrading organics which make up close to

10% of the StormTree media blend. With microbiological complexing, sorption, and sequestration initiating and building with the introduction and continued flow thru of soluble and insoluble nutrients, our data set revealed an ambient level of attenuation with no appreciable reduction in removal efficiency. An ever increasing root mass provides additional stimulus for sorption of nutrients. Although a limited uptake of soluble nutrients is expected to take place depending upon bioavailability as the plant system matures, it cannot be discounted in maintaining the longevity of the system and reducing the potential for breakthrough.

StormTree's unique open design and expanded media footprint allows for a greater treatment zone, and unrestricted root growth allows for healthier and more vigorous tree growth which in turn enables greater sorption potential and long term microbial enhancement.

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)?

Given regularly scheduled maintenance breakthrough is not expected. The results of the TER field study confirmed that maintenance including mulch replenishment contributed to the consistent rates of nutrient attenuation.

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

Maintenance complexity (check all that apply):

☐ **Confined space training required for maintenance**
☐ **Liquid pumping and transportation**
Specify method:
X Solids removal and disposal
Specify method:
Manual rake and shovel to remove floatable trash and the mulch layer. The interior pretreatment sump or attached catch basin is best maintained via conventional vactoring equipment.

Other noteworthy maintenance parameter (describe):

As necessary, remove any dead twigs and branches. For systems that have a fiberglass grate, the opening can be expanded with power tools to prevent the possibility of tree trunk girdling.

11. Comments

Include any additional explanations or comments:

The results of TAPE field testing determined that the StormTree system exhibited the highest median TSS removal rate (93%) of proprietary biofiltration practice.

The StormTree system is purposely designed with partially open sidewalls and open bottom to facilitate biofiltration AND bio-infiltration and unrestricted root expansion to maintain healthy and vigorous tree growth which optimizes the operational processes to maintain long tern functionality. The StormTree could also incorporate an impermeable liner surrounding the sidewalls and/or bottom to restrict infiltration should sensitive receptors be present. However, this liner can extend beyond the immediate structural footprint to increase the treatment area and provide for additional stormwater detention.

Unique to the StormTree system, an optional combination interior cleanout and overflow/bypass pipe can be installed which reduces the quantity of exterior bypass.

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: Paul Iorio

Name: Paul Iorio

Title: Sr. Project Manager

Date: 11/22/21

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