APPENDIX G

RELATIVE PERCENT DIFFERENCE SUMMARY

TABLE 1

DUPLICATE PRECISION TABLE

	Suspended Solids		Nitrate		Kjeldahl Nitrogen, TKN		Phosphorus, Total		Copper		Lead		Zinc	
	Influent Relative Percent Difference	Effluent Relative Percent Difference	Influent Relative Percent Difference	Effluent Relative Percent Difference	Influent Relative Percent Difference	Effluent Relative Percent Difference	Influent Relative Percent Difference	Effluent Relative Percent Difference	Influent Relative Percent Difference	Effluent Relative Percent Difference	Influent Relative Percent Difference	Effluent Relative Percent Difference	Influent Relative Percent Difference	Effluent Relative Percent Difference
Event 1	57.32%	52.63%	4.46%	1.91%	0.00%	0.00%	0.00%	0.00%	12.01%	4.25%	37.80%	1.49%	22.73%	16.98%
Event 2	N/A	1.82%	N/A	3.13%	N/A	0.00%	N/A	0.00%	N/A	0.00%	N/A	0.00%	N/A	2.62%
Event 3	9.66%	12.20%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Event 4	3.98%	13.03%	1.52%	2.97%	8.63%	64.51%	0.79%	8.53%	18.18%	0.00%	9.76%	0.00%	6.70%	0.00%
Event 5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Event 6	23.42%	7.69%	0.00%	0.00%	0.00%	78.20%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Event 7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Event 8	1.59%	N/A	0.00%	N/A	18.05%	N/A	0.00%	N/A	19.63%	N/A	0.00%	N/A	11.31%	N/A
Event 9	N/A	3.82%	N/A	4.49%	N/A	0.00%	N/A	0.00%	N/A	0.00%	N/A	0.00%	N/A	0.00%
Event 10	2.09%	8.00%	0.86%	2.21%	5.90%	0.00%	2.23%	0.00%	15.64%	0.00%	27.56%	0.00%	2.09%	0.00%
Event 11	6.35%	5.31%	1.56%	0.75%	16.67%	15.91%	35.90%	0.00%	8.87%	0.00%	17.35%	0.00%	13.24%	0.00%
Event 12	N/A	10.53%	N/A	1.42%	N/A	22.31%	N/A	0.00%	N/A	0.00%	N/A	0.00%	N/A	0.00%

APPENDIX H

TYPICAL SPECIFICATIONS AND DETAILS

SPECIFICATION
HIGH PERFORMANCE MODULAR BIOFILTRATION SYSTEM (HPMBS)
Material, Performance and Installation Specification

I. Summary

The following general specifications describe the components and installation requirements for a volume based High Performance Modular Biofiltration System (HPMBS) that utilizes physical, chemical and biological mechanisms of a soil, plant and microbe complex to remove pollutants typically found in urban storm water runoff. The modular treatment system in which the biologically active biofiltration media is used shall be a complete, integrated system designed to be placed in Square Foot or Linear Foot increments per the approved drawings to treat contaminated runoff from impervious surfaces.

The High Performance Modular Biofiltration System (HPMBS) is comprised of the following components:

A. Plant Component

1. Supplier shall provide a regionalized list of acceptable plants.

2. Plants, as specified in the approved drawings/supplier's plant list, shall be installed at the time the HPMBS is commissioned for use.

3. Plants and planting are typically included in landscape contract.

B. Biofilter Component

1. This component employs a high performance cross-section in which each element is highly dependent on the others to meet the performance specification for the complete system. It is important that this entire cross-section be provided as a complete system, and installed as such.

2. As indicated in the approved drawings, the elements of the Biofilter include:

    A. *A mulch protective layer (if specified).*

    B. *An advanced high infiltration rate biofiltration planting media bed which utilizes physical, chemical and biological mechanisms of the soil, plant, and microbe complex, to remove pollutants found in storm water runoff.*

    C. *A separation layer which utilizes the concept of 'bridging' to separate the biofiltration media from the underdrain without the use of geotextile fabrics.*

D. *A wide aperture mesh layer utilized to prevent bridging stone from entering the underdrain/storage element.*

E. *A modular, high infiltration rate 'flat pipe' style underdrain/storage system which is designed to directly infiltrate or exfiltrate water through its surface. The modular underdrain must provide a minimum of 95% void space.*

C. Energy Dissipation Component

1. An Energy Dissipation Component is typically specified to slow and spread out water as it enters the system. This component is dependent upon the design in the approved drawings, but typically consists of a rock gabion, rock filter dam or dense vegetation element, such as native grasses, either surrounding the Biofiltration Component or located immediately upstream of it.

D. Pretreatment Component

1. Pretreatment, when specified, is typically accomplished by locating the Biofiltration Component within a traditional vegetated BMP such as a vegetated swale, vegetated depression, traditional bioretention system, vegetated filter strip, sediment forebay, etc. These BMPs provide primary TSS removal when desirable.

E. Observation and Maintenance Component

1. An Observation and Maintenance Port shall be installed per the approved drawings to provide for easy inspection of the underdrain/storage element, and cleanout access if needed.

F. Extreme Event Overflow (by others)

1. An Extreme Event Overflow should be located external to, but near the Biofiltration element to provide bypass when needed. This may be an overland flow bypass structure, beehive overflow grate structure, or equivalent that serves the purpose. If a beehive overflow structure is utilized it should include a removable filter insert to provide for effective control of gross pollutants, trash and floatables.

II. Quality Assurance and Performance Specifications

The quality and composition of all system components and all other appurtenances and their assembly process shall be subject to inspection upon delivery of the system to the work site.

Installation is to be performed only by skilled work people with satisfactory record of performance on earthworks, pipe, chamber, or pond/landfill construction projects of

comparable size and quality.

A. Plants

1. Plants must be compatible with the HPMBS media and the associated highly variable hydrologic regime. Plants are typically facultative with fibrous roots systems such a native grasses and shrubs.

2. Supplier shall provide a regionalized list of acceptable plants.

3. All plant material shall comply with the type and size required by the approved drawings and shall be alive and free of obvious signs of disease.

B. Mulch

1. Mulch, typically double shredded hardwood (non-floatable), shall comply with the type and size required by the approved drawings, and shall be screened to minimize fines.

C. Biofiltration Media

1. Biologically active biofiltration media shall be visually inspected to ensure appropriate volume, texture and consistency with the approved drawings, and must bear a batch number marking from the supplier which certifies performance testing of the batch to meet or exceed the required infiltration rate (100 in/hr). A third party laboratory test must be provided to certify the 100 in/hr rate.

2. Within 90 days after project completion, the infiltration rate shall be confirmed at the supplier's expense, by a wetted condition hydraulic conductivity test.

    a. *Failure to pass this test will result in removal and replacement of all media in the system at no cost to the project owner/operator.*

    b. *Test must utilize the equipment and follow the standard operating procedures found in the Harris County Texas manual entitled, Low Impact Development & Green Infrastructure Design Criteria for Storm Water Management (2011).*

    c. *Replacement media, if required, must be taken from a different batch than the original.*

3. Supplier shall provide, at no additional cost to the project owner/operator, maintenance of the biofiltration system for a period of one year.

4. Pollutant Removal performance, composition and characteristics of the Biofiltration Media must meet or exceed the following minimum standards as

demonstrated by testing acceptable to the project engineer:

Pollutant	Removal Efficiency
TSS	> 80%
Phosphorus	≥ 60%
Nitrogen	≥ 48%
Composition and Characteristics	
Sand - Fine	< 5%
Sand – Medium	10% - 15%
Sand – Coarse	15% - 25%
Sand – Very Coarse	40% - 45%
Gravel	10% - 20%
Infiltration Rate	>100 inches per hour
Peat Moss*	5% - 15%
*** Peat Moss Specification**	
Listed by Organic Materials Review Institute 100% natural peat (no composted, sludge, yard or leaf waste) Total Carbon >85% Carbon to Nitrogen Ratio 15:1 to 23:1 Lignin Content 49% to 52% Humic Acid >18% pH 6.0 to 7.0 Moisture Content 30% to 50% 95% to 100% passing 2.0mm sieve > 80% passing 1.0mm sieve	

D. Underdrain/Storage System

1. Underdrain/storage components shall be manufactured in an ISO certified facility and be manufactured from at least 90% post consumer recycled materials.

2. Underdrain/storage components shall meet or exceed the following characteristics:

Property	Value
Surface Void Area	≥ 85%
Unit Weight	3.25 lbs/cf
Service Temperature	-14° to 167°
Unconfined Crush Strength	32.48 psi
180 Day Creep Test	
Load Applied – Initial and Sustained	11.16 psi
• Creep Sustained – After 180 Days	0.20 inches
• Creep Sustained – After 180 Days	1.13 %
• Projected Creep – 40 years	1.72%

E. Separation Mesh

1. Separation Mesh shall be composed of high-tenacity monofilament polypropylene yarns that are woven together to produce an open mesh geotextile which shall be inert to biological degradation and resistant to naturally encountered chemicals, alkalis and acids. The mesh shall meet or exceed the following characteristics:

Properties	Test Method	Unit	Min Ave Roll Value	
			MD	CD
Tensile Strength	ASTM D4595	kN/m (lbs/ft)	21 (1440)	25.3 (1733)
Creep Reduced Strength	ASTM D5262	kN/m (lbs/ft)	6.9 (471)	8.3 (566)
Long Term Allowable Design Load	GRI GG-4	kN/m (lbs/ft)	5.9 (407)	7.2 (490)
UV Resistance (at 500 hours)	-	% strength retained	90	
Aperture Size (machine direction)	-	mm (in)	2 (0.08)	
Aperture Size (cross machine direction)	-	mm (in)	2 (0.08)	
Mass/Unit Area	ASTM D5261	g/m^2 (oz/yd^2)	197 (5.8)	

F. Bridging Stone

1. Bridging Stone shall be 3/8" pea gravel, or other diameter sized to prevent migration of filter media, as specified by supplier.

2. Stone must be washed and free from sediment, soil and contaminants.

III. Delivery, Storage and Handling

A. Protect all materials from damage during delivery and store UV sensitive materials under tarp to protect from sunlight including all plastics, when time from delivery to installation exceeds one week. Storage should occur on smooth surfaces, free from dirt, mud and debris.

B. Biofiltration media shall be segregated from any other aggregate materials and shall be protected against contamination, including contamination from any stormwater runoff from areas of the site which are not stabilized.

IV. Submittals

A. Product Data

1. Submit supplier's product data and approved Installation Manual as well as supplier's Operations and Maintenance Manual for the system. It will be the responsibility of the system owner/operator or their contractor to ensure the system is operated and maintained in accordance with the manual.

B. Certification

1. Supplier shall submit a letter of certification that the complete system meets or exceeds all technical and packaging requirements. Biofiltration media packaging must bear a batch number marking from the supplier which matches a letter from the supplier certifying performance testing of the batch to meet or exceed the required infiltration rate.

C. Drawings

1. Supplier shall provide dimensional drawings including details for construction, materials, specifications and pipe connections.

D. Warranty

1. Supplier shall provide a warranty for all components of the HPMBS for a period of one year provided the unit is installed, operated and maintained in accordance with the manual. Improper operation, maintenance or accidental or illegal activities (i.e. dumping of pollutants, vandalism, etc.) will void the warranty. Biofiltration media shall be warranted to pass the post-installation infiltration test described in this document.

E. Design Computations

1. The HPMBS must be sized using a volume based sizing criteria and demonstrate, using a SCS stormwater modeling software/spreadsheet calculator that the required water quality volume (defined by the Engineer of Record) passes through the HPMBS prior to activation of the overflow device (set no lower higher than six (6) inches above the top elevation of the HPMBS (typically defined as top of mulch)). Design computations must be provided as part of the submittal process. Sizing based solely on a filter surface area to drainage area ratio method will not be accepted.

F. Substitutions

1. Any proposed equal alternative product substitution to this specification must be submitted for review and approved prior to bid opening. Review package should include third party reviewed performance data of the biofiltration media that includes saturated conductivity measurements and pollutant removal efficiency. Pollutant removal data must follow specified protocols. All components must meet or exceed Quality Assurance and Performance Criteria indicated herein.

V. Project Conditions

A. Review supplier's recommended installation procedures and coordinate installation with other work affected, such as grading, excavation, utilities, construction access and erosion control to prevent all non- installation related construction traffic over the completed HPMBS.

B. Cold Weather

1. Do not use frozen materials or materials mixed or coated with ice or frost.

2. Do not build on frozen ground or wet, saturated or muddy subgrade.

3. Care must be taken when handling plastics when air temperature is at 40 degrees or below as plastic becomes brittle.

C. Protect partially completed installation against damage from other construction traffic when work is in progress and following completion of backfill by establishing a perimeter with highly visible construction tape, fencing, or other means until construction is complete.

D. Soil stabilization of the surrounding site must be complete before the Biofiltration System can be brought online. Soil stabilization occurs when 90% of the site has been paved or vegetated. Temporary erosion control and/or sedimentation prevention measures shall be implemented to reduce the possibility of sediments being transported into the Biofiltration System prior to full stabilization of the site. Significant sediment loads can damage the HPBMS and lead to failure if not prevented or remediated promptly.

VI. PRODUCTS

A. Acceptable HPBMS

FocalPoint High Performance Biofiltration System

B. Acceptable Beehive Overflow Grate Structure (Optional)

Beehive Overflow Grate Structure with removable StormSack

C. Acceptable System Supplier

Convergent Water Technologies, Inc.
(800) 711-5428
www.convergentwater.com

D. Authorized Value Added Reseller

ACF Environmental
2831 Cardwell Road
Richmond, VA 23234
(800 448-3636
www.acfenvironmental.com

VII. Packaging

A. HPMBS is assembled on site.

B. Modular underdrain/storage unit is shipped flat and modules are assembled prior to installation.

C. Biofiltration media is delivered in one ton super sacks each labeled with supplier's batch number and/or in bulk with accompanying supplier's certification.

D. Other components are delivered in bulk or super sacks

VIII. Execution

A. Excavation and Backfill

1. Base of excavation shall be smooth, level and free of lumps or debris, and compacted unless infiltration of storm water into subgrade is desired. A thin layer (3") of compacted base material is recommended to establish a level working platform (may not be needed in sandy soils). If the base of the excavation is pumping or appears excessively soft, a geotechnical engineer should be consulted for advice. In many cases, a stabilization geotextile and 6" of compactable material that drains well will be sufficient to amend the bearing capacity of the soil.

2. Most applications require 8 oz Non-Woven Geotextile or equivalent nonwoven geotextile with a nominal weight of 8 oz per square yard to line the excavation to separate in situ soils and the HPMBS. (Applications requiring water to infiltrate the in situ sub-soils should use a bridging stone rather than geotextile to provide a separation layer between the HPMBS and the in situ soils). Geotextile, when utilized, should be placed on the bottom and up the sides of the excavation. Absolutely no geotextiles should be used in the water column. If an impermeable liner is specified, it shall be installed according to supplier's instructions and recommendations.

3. Specified backfill material must be free from lumps, debris and any sharp objects that could penetrate the geotextile. Material is used for backfill along the sides of the system as indicated in engineering detail drawings.

B. Inspection

1. Examine prepared excavation for smoothness, compaction and level. Check for presence of high water table, which must be kept at levels below the bottom of the under drain structure at all times. If the base is pumping or appears excessively soft, a geotechnical engineer should be consulted for advice.

2. Installation commencement constitutes acceptance of existing conditions and responsibility for satisfactory performance. If existing conditions are found to be unsatisfactory, contact Project Manager or Engineer for resolution prior to installation.

IX. Cleanup and Protection during Ongoing Construction Activity

A. Perform cleaning during the installation and upon completion of the work.

B. Remove from site all excess materials, debris, and equipment. Repair any damage to adjacent materials and surfaces resulting from installation.

C. If surrounding drainage area is not fully stabilized, a protective covering of geotextile fabric should be securely placed to protect the Biofiltration Media.

D. Construction phase erosion and sedimentation controls shall be placed to protect the inlet(s) to the Biofiltration System. Excessive sedimentation, particularly prior to establishment of plants may damage the HPMBS.

E. Strictly follow supplier's guidelines with respect to protection of the HPMBS between Installation and Commissioning phases.

X. Commissioning

A. Commissioning should only be carried out once the contributing drainage area is fully stabilized. If Commissioning must be carried out sooner, it is imperative that appropriate erosion and sediment controls be placed to prevent the entry of excessive sediment/pollutant loads into the system.

B. Commissioning entails removing the protective covering from the Biofiltration Media, planting the plant material in accordance with the approved drawings, and placing mulch if specified.

1. Dig planting holes the depth of the root ball and two to three times as wide as the root ball. Wide holes encourage horizontal root growth that plants naturally produce.

2. With trees, you must ensure you are not planting too deep. Don't dig holes deeper than root balls. The media should be placed at the root collar, not above the root collar. Otherwise the stem will be vulnerable to disease.

3. Strictly follow supplier's planting guidance.

C. Cover the exposed root ball top with mulch. Mulch should not touch the plant base because it can hold too much moisture and invite disease and insects. Evenly place 3 inches of double-shredded hardwood mulch (if specified) on the surface of the media.

D. Plantings shall be watered-in at installation and temporary irrigations shall be provided, if specified.

XI. Using the HPMBS

A. Maintenance Requirements

1. Each correctly installed HPMBS is to be maintained by the supplier for a minimum period of one year. The cost of this service is to be included in the supplier's price of the system.

2. Annual maintenance consists of two (2) scheduled visits unless otherwise specified.

3. Each maintenance visit consists of the following:

    1. *Complete system inspection*

    2. *Removal of foreign debris, silt, plant material, trash and mulch (if needed)*

    3. *Evaluation of biofiltration media*

    4. *Evaluation of plant health*

    5. *Inspection of underdrain/storage system via Observation/Maintenance Port*

    6. *Properly dispose of all maintenance refuse items (trash, mulch, etc.)*

    7. *Take photographs documenting plant growth and general system health*

    8. *Update and store maintenance records*

    9. *To ensure long term performance of the HPMBS, continuing annual maintenance should be performed per the supplier's Operations and Maintenance Manual.*

4. If sediment accumulates beyond an acceptable level in the underdrain/storage system, it will be necessary to flush the underdrain. This can be done by pumping

water into the Observation/Maintenance Port or adjacent overflow structure, allowing the turbulent flows through the underdrain to re- suspend the fine sediments. If multiple Observation/Maintenance Ports have been installed, water should be pumped into each port to maximize flushing efficiency.

Sediment-laden water can be pumped out and either captured for disposal or filtered through a Dirtbag filter bag, if permitted by the locality.

XII. Measurement and Payment

Given the integrated nature of the HPMBS, measurement and payment will be based not on the individual component prices, but on the size of the Biofiltration Media bed. The external dimension as indicated in the approved plans and executed in the installation will be measured in Square Feet and payment will be made per HPMBS system.

Measurement and payment of beehive overflow grate structure with removable filter insert will be based on per unit price.

SPECIFICATION
HIGH PERFORMANCE MODULAR BIOFILTRATION SYSTEM (HPMBS)
Material, Performance and Installation Specification

I. Summary

The following general specifications describe the components and installation requirements for a flow based High Performance Modular Biofiltration System (HPMBS) that utilizes physical, chemical and biological mechanisms of a soil, plant and microbe complex to remove pollutants typically found in urban storm water runoff. The modular treatment system in which the biologically active biofiltration media is used shall be a complete, integrated system designed to be placed in Square Foot or Linear Foot increments per the approved drawings to treat contaminated runoff from impervious surfaces.

The High Performance Modular Biofiltration System (HPMBS) is comprised of the following components:

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2. Plants, as specified in the approved drawings/supplier's plant list, shall be installed at the time the HPMBS is commissioned for use.

3. Plants and planting are typically included in landscape contract.

B. Biofilter Component

1. This component employs a high performance cross-section in which each element is highly dependent on the others to meet the performance specification for the complete system. It is important that this entire cross-section be provided as a complete system, and installed as such.

2. As indicated in the approved drawings, the elements of the Biofilter include:

    A. *A mulch protective layer (if specified).*

    B. *An advanced high infiltration rate biofiltration planting media bed which utilizes physical, chemical and biological mechanisms of the soil, plant, and microbe complex, to remove pollutants found in storm water runoff.*

    C. *A separation layer which utilizes the concept of 'bridging' to separate the biofiltration media from the underdrain without the use of geotextile fabrics.*

D. *A wide aperture mesh layer utilized to prevent bridging stone from entering the underdrain/storage element.*

E. *A modular, high infiltration rate 'flat pipe' style underdrain/storage system which is designed to directly infiltrate or exfiltrate water through its surface. The modular underdrain must provide a minimum of 95% void space.*

C. Energy Dissipation Component

1. An Energy Dissipation Component is typically specified to slow and spread out water as it enters the system. This component is dependent upon the design in the approved drawings, but typically consists of a rock gabion, rock filter dam or dense vegetation element, such as native grasses, either surrounding the Biofiltration Component or located immediately upstream of it.

D. Pretreatment Component

1. Pretreatment, when specified, is typically accomplished by locating the Biofiltration Component within a traditional vegetated BMP such as a vegetated swale, vegetated depression, traditional bioretention system, vegetated filter strip, sediment forebay, etc. These BMPs provide primary TSS removal when desirable.

E. Observation and Maintenance Component

1. An Observation and Maintenance Port shall be installed per the approved drawings to provide for easy inspection of the underdrain/storage element, and cleanout access if needed.

F. Extreme Event Overflow (by others)

1. An Extreme Event Overflow should be located external to, but near the Biofiltration element to provide bypass when needed. This may be an overland flow bypass structure, beehive overflow grate structure, or equivalent that serves the purpose. If a beehive overflow structure is utilized it should include a removable filter insert to provide for effective control of gross pollutants, trash and floatables.

II. Quality Assurance and Performance Specifications

The quality and composition of all system components and all other appurtenances and their assembly process shall be subject to inspection upon delivery of the system to the work site.

Installation is to be performed only by skilled work people with satisfactory record of performance on earthworks, pipe, chamber, or pond/landfill construction projects of

comparable size and quality.

A. Plants

1. Plants must be compatible with the HPMBS media and the associated highly variable hydrologic regime. Plants are typically facultative with fibrous roots systems such a native grasses and shrubs.

2. Supplier shall provide a regionalized list of acceptable plants.

3. All plant material shall comply with the type and size required by the approved drawings and shall be alive and free of obvious signs of disease.

B. Mulch

1. Mulch, typically double shredded hardwood (non-floatable), shall comply with the type and size required by the approved drawings, and shall be screened to minimize fines.

C. Biofiltration Media

1. Biologically active biofiltration media shall be visually inspected to ensure appropriate volume, texture and consistency with the approved drawings, and must bear a batch number marking from the supplier which certifies performance testing of the batch to meet or exceed the required infiltration rate (100 in/hr). A third party laboratory test must be provided to certify the 100 in/hr rate.

2. Within 90 days after project completion, the infiltration rate shall be confirmed at the supplier's expense, by a wetted condition hydraulic conductivity test.

    a. *Failure to pass this test will result in removal and replacement of all media in the system at no cost to the project owner/operator.*

    b. *Test must utilize the equipment and follow the standard operating procedures found in the Harris County Texas manual entitled, Low Impact Development & Green Infrastructure Design Criteria for Storm Water Management (2011).*

    c. *Replacement media, if required, must be taken from a different batch than the original.*

3. Supplier shall provide, at no additional cost to the project owner/operator, maintenance of the biofiltration system for a period of one year.

4. Pollutant Removal performance, composition and characteristics of the Biofiltration Media must meet or exceed the following minimum standards as

demonstrated by testing acceptable to the project engineer:

Pollutant	Removal Efficiency
TSS	> 80%
Phosphorus	≥ 60%
Nitrogen	≥ 48%
Composition and Characteristics	
Sand - Fine	< 5%
Sand – Medium	10% - 15%
Sand – Coarse	15% - 25%
Sand – Very Coarse	40% - 45%
Gravel	10% - 20%
Infiltration Rate	>100 inches per hour
Peat Moss*	5% - 15%
*** Peat Moss Specification**	
Listed by Organic Materials Review Institute 100% natural peat (no composted, sludge, yard or leaf waste) Total Carbon >85% Carbon to Nitrogen Ratio 15:1 to 23:1 Lignin Content 49% to 52% Humic Acid >18% pH 6.0 to 7.0 Moisture Content 30% to 50% 95% to 100% passing 2.0mm sieve > 80% passing 1.0mm sieve	

D. Underdrain/Storage System

1. Underdrain/storage components shall be manufactured in an ISO certified facility and be manufactured from at least 90% post consumer recycled materials.

2. Underdrain/storage components shall meet or exceed the following characteristics:

Property	Value
Surface Void Area	≥ 85%
Unit Weight	3.25 lbs/cf
Service Temperature	-14° to 167°
Unconfined Crush Strength	32.48 psi
180 Day Creep Test	
Load Applied – Initial and Sustained	11.16 psi
• Creep Sustained – After 180 Days	0.20 inches
• Creep Sustained – After 180 Days	1.13 %
• Projected Creep – 40 years	1.72%

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1. Separation Mesh shall be composed of high-tenacity monofilament polypropylene yarns that are woven together to produce an open mesh geotextile which shall be inert to biological degradation and resistant to naturally encountered chemicals, alkalis and acids. The mesh shall meet or exceed the following characteristics:

Properties	Test Method	Unit	Min Ave Roll Value	
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Tensile Strength	ASTM D4595	kN/m (lbs/ft)	21 (1440)	25.3 (1733)
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Long Term Allowable Design Load	GRI GG-4	kN/m (lbs/ft)	5.9 (407)	7.2 (490)
UV Resistance (at 500 hours)	-	% strength retained	90	
Aperture Size (machine direction)	-	mm (in)	2 (0.08)	
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F. Bridging Stone

1. Bridging Stone shall be 3/8" pea gravel, or other diameter sized to prevent migration of filter media, as specified by supplier.

2. Stone must be washed and free from sediment, soil and contaminants.

III. Delivery, Storage and Handling

A. Protect all materials from damage during delivery and store UV sensitive materials under tarp to protect from sunlight including all plastics, when time from delivery to installation exceeds one week. Storage should occur on smooth surfaces, free from dirt, mud and debris.

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1. Submit supplier's product data and approved Installation Manual as well as supplier's Operations and Maintenance Manual for the system. It will be the responsibility of the system owner/operator or their contractor to ensure the system is operated and maintained in accordance with the manual.

B. Certification

1. Supplier shall submit a letter of certification that the complete system meets or exceeds all technical and packaging requirements. Biofiltration media packaging must bear a batch number marking from the supplier which matches a letter from the supplier certifying performance testing of the batch to meet or exceed the required infiltration rate.

C. Drawings

1. Supplier shall provide dimensional drawings including details for construction, materials, specifications and pipe connections.

D. Warranty

1. Supplier shall provide a warranty for all components of the HPMBS for a period of one year provided the unit is installed, operated and maintained in accordance with the manual. Improper operation, maintenance or accidental or illegal activities (i.e. dumping of pollutants, vandalism, etc.) will void the warranty. Biofiltration media shall be warranted to pass the post-installation infiltration test described in this document.

E. Design Computations

1. The HPMBS shall be sized using hydraulic properties of the media and demonstrate using an SCS stormwater modeling software/spreadsheet calculator that the peak water quality flow (defined by the Engineer of Record) passes through the HPMBS prior to activation of the overflow device. A minimum amount of ponding depth (6 inches recommended) above the top elevation of the HPMBS (typically defined as top of mulch) should be provided to account for headloss through the system. Design computations must be provided as part of the submittal process. Sizing based solely on a filter surface area to drainage area ratio method will not be accepted.

F. Substitutions

1. Any proposed equal alternative product substitution to this specification must be submitted for review and approved prior to bid opening. Review package should include third party reviewed performance data of the biofiltration media that includes saturated conductivity measurements and pollutant removal efficiency. Pollutant removal data must follow specified protocols. All components must

meet or exceed Quality Assurance and Performance Criteria indicated herein.

V. Project Conditions

A. Review supplier's recommended installation procedures and coordinate installation with other work affected, such as grading, excavation, utilities, construction access and erosion control to prevent all non- installation related construction traffic over the completed HPMBS.

B. Cold Weather

1. Do not use frozen materials or materials mixed or coated with ice or frost.

2. Do not build on frozen ground or wet, saturated or muddy subgrade.

3. Care must be taken when handling plastics when air temperature is at 40 degrees or below as plastic becomes brittle.

C. Protect partially completed installation against damage from other construction traffic when work is in progress and following completion of backfill by establishing a perimeter with highly visible construction tape, fencing, or other means until construction is complete.

D. Soil stabilization of the surrounding site must be complete before the Biofiltration System can be brought online. Soil stabilization occurs when 90% of the site has been paved or vegetated. Temporary erosion control and/or sedimentation prevention measures shall be implemented to reduce the possibility of sediments being transported into the Biofiltration System prior to full stabilization of the site. Significant sediment loads can damage the HPBMS and lead to failure if not prevented or remediated promptly.

VI. PRODUCTS

A. Acceptable HPBMS

FocalPoint High Performance Biofiltration System

B. Acceptable Beehive Overflow Grate Structure (Optional)

Beehive Overflow Grate Structure with removable StormSack

C. Acceptable System Supplier

Convergent Water Technologies, Inc.
(800) 711-5428
www.convergentwater.com

D. Authorized Value Added Reseller

ACF Environmental
2831 Cardwell Road
Richmond, VA 23234
(800 448-3636
www.acfenvironmental.com

VII. Packaging

A. HPMBS is assembled on site.

B. Modular underdrain/storage unit is shipped flat and modules are assembled prior to installation.

C. Biofiltration media is delivered in one ton super sacks each labeled with supplier's batch number and/or in bulk with accompanying supplier's certification.

D. Other components are delivered in bulk or super sacks

VIII. Execution

A. Excavation and Backfill

1. Base of excavation shall be smooth, level and free of lumps or debris, and compacted unless infiltration of storm water into subgrade is desired. A thin layer (3") of compacted base material is recommended to establish a level working platform (may not be needed in sandy soils). If the base of the excavation is pumping or appears excessively soft, a geotechnical engineer should be consulted for advice. In many cases, a stabilization geotextile and 6" of compactable material that drains well will be sufficient to amend the bearing capacity of the soil.

2. Most applications require 8 oz Non-Woven Geotextile or equivalent nonwoven geotextile with a nominal weight of 8 oz per square yard to line the excavation to separate in situ soils and the HPMBS. (Applications requiring water to infiltrate the in situ sub-soils should use a bridging stone rather than geotextile to provide a separation layer between the HPMBS and the in situ soils). Geotextile, when utilized, should be placed on the bottom and up the sides of the excavation. Absolutely no geotextiles should be used in the water column. If an impermeable liner is specified, it shall be installed according to supplier's instructions and recommendations.

3. Specified backfill material must be free from lumps, debris and any sharp objects that could penetrate the geotextile. Material is used for backfill along the sides of the system as indicated in engineering detail drawings.

B. Inspection

1. Examine prepared excavation for smoothness, compaction and level. Check for presence of high water table, which must be kept at levels below the bottom of the under drain structure at all times. If the base is pumping or appears excessively soft, a geotechnical engineer should be consulted for advice.

2. Installation commencement constitutes acceptance of existing conditions and responsibility for satisfactory performance. If existing conditions are found to be unsatisfactory, contact Project Manager or Engineer for resolution prior to installation.

IX. Cleanup and Protection during Ongoing Construction Activity

A. Perform cleaning during the installation and upon completion of the work.

B. Remove from site all excess materials, debris, and equipment. Repair any damage to adjacent materials and surfaces resulting from installation.

C. If surrounding drainage area is not fully stabilized, a protective covering of geotextile fabric should be securely placed to protect the Biofiltration Media.

D. Construction phase erosion and sedimentation controls shall be placed to protect the inlet(s) to the Biofiltration System. Excessive sedimentation, particularly prior to establishment of plants may damage the HPMBS.

E. Strictly follow supplier's guidelines with respect to protection of the HPMBS between Installation and Commissioning phases.

X. Commissioning

A. Commissioning should only be carried out once the contributing drainage area is fully stabilized. If Commissioning must be carried out sooner, it is imperative that appropriate erosion and sediment controls be placed to prevent the entry of excessive sediment/pollutant loads into the system.

B. Commissioning entails removing the protective covering from the Biofiltration Media, planting the plant material in accordance with the approved drawings, and placing mulch if specified.

1. Dig planting holes the depth of the root ball and two to three times as wide as the root ball. Wide holes encourage horizontal root growth that plants naturally produce.

2. With trees, you must ensure you are not planting too deep. Don't dig holes deeper than root balls. The media should be placed at the root collar, not above the root collar. Otherwise the stem will be vulnerable to disease.

3. Strictly follow supplier's planting guidance.

C. Cover the exposed root ball top with mulch. Mulch should not touch the plant base because it can hold too much moisture and invite disease and insects. Evenly place 3 inches of double-shredded hardwood mulch (if specified) on the surface of the media.

D. Plantings shall be watered-in at installation and temporary irrigations shall be provided, if specified.

XI. Using the HPMBS

A. Maintenance Requirements

1. Each correctly installed HPMBS is to be maintained by the supplier for a minimum period of one year. The cost of this service is to be included in the supplier's price of the system.

2. Annual maintenance consists of two (2) scheduled visits unless otherwise specified.

3. Each maintenance visit consists of the following:

    1. *Complete system inspection*

    2. *Removal of foreign debris, silt, plant material, trash and mulch (if needed)*

    3. *Evaluation of biofiltration media*

    4. *Evaluation of plant health*

    5. *Inspection of underdrain/storage system via Observation/Maintenance Port*

    6. *Properly dispose of all maintenance refuse items (trash, mulch, etc.)*

    7. *Take photographs documenting plant growth and general system health*

    8. *Update and store maintenance records*

    9. *To ensure long term performance of the HPMBS, continuing annual maintenance should be performed per the supplier's Operations and Maintenance Manual.*

4. If sediment accumulates beyond an acceptable level in the underdrain/storage system, it will be necessary to flush the underdrain. This can be done by pumping

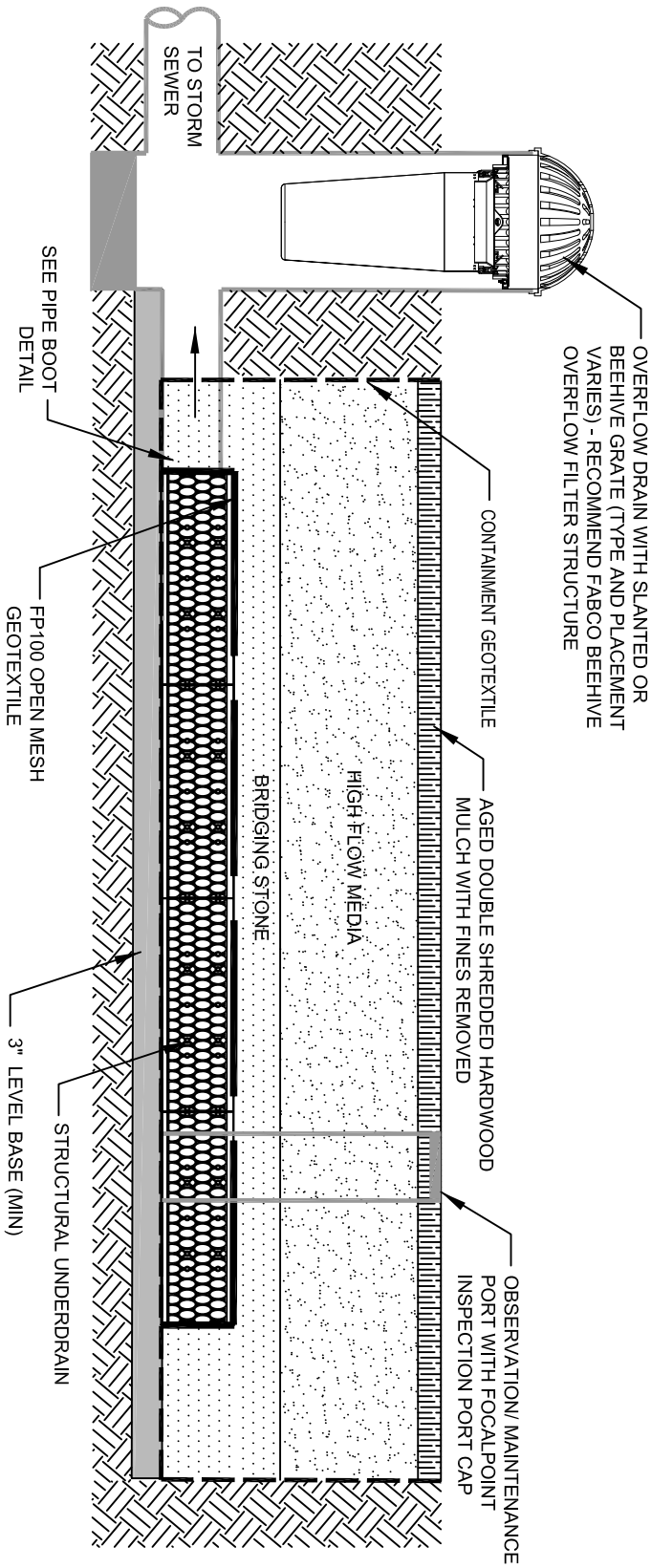
water into the Observation/Maintenance Port or adjacent overflow structure, allowing the turbulent flows through the underdrain to re- suspend the fine sediments. If multiple Observation/Maintenance Ports have been installed, water should be pumped into each port to maximize flushing efficiency.

Sediment-laden water can be pumped out and either captured for disposal or filtered through a Dirtbag filter bag, if permitted by the locality.

XII. Measurement and Payment

Given the integrated nature of the HPMBS, measurement and payment will be based not on the individual component prices, but on the size of the Biofiltration Media bed. The external dimension as indicated in the approved plans and executed in the installation will be measured in Square Feet and payment will be made per HPMBS system.

Measurement and payment of beehive overflow grate structure with removable filter insert will be based on per unit price.



FOCALPOINT HP SECTION X-X

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WWW.ACFENVIRONMENTAL.COM
800.448.3636

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FOCALPOINT HP PERFORMANCE SPECIFICATION:

HIGH PERFORMANCE MEDIA

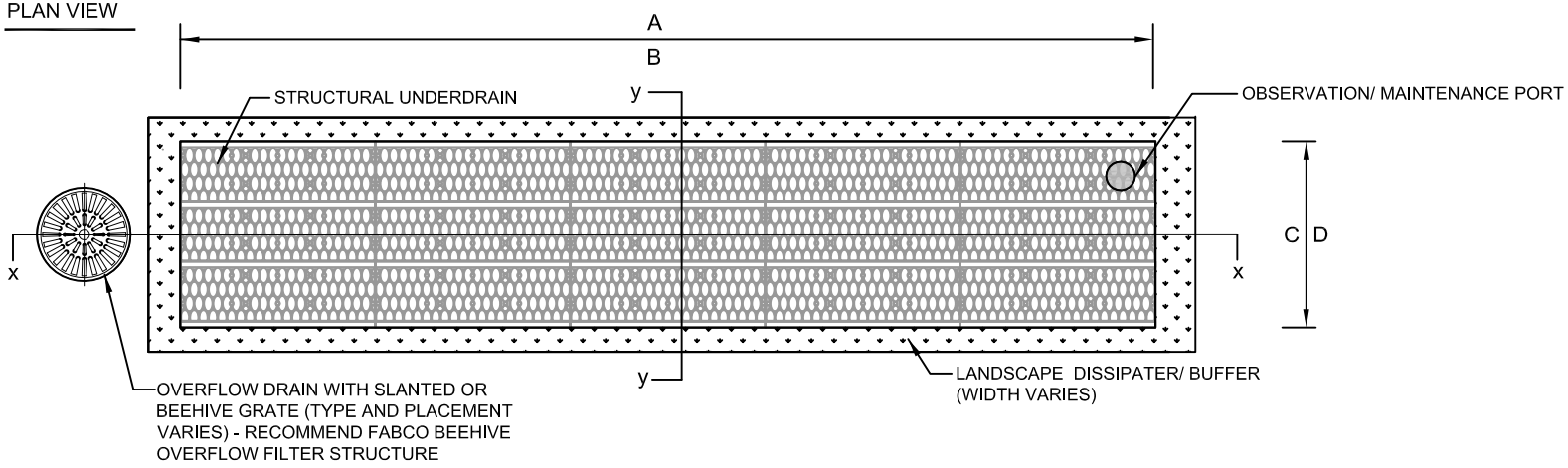
HIGH PERFORMANCE MEDIA MUST MEET A MINIMUM OF 100" PER HOUR INFILTRATION RATE.
FIELD HYDRAULIC CONDUCTIVITY TESTING MUST BE CONDUCTED WITHIN 30 DAYS OF INSTALLATION.
FIELD TEST MUST BE CONDUCTED WITH PROSCRIBED INFILTROMETER AND SOP (SEE SPECIFICATION).
FAILURE TO MEET FIELD TESTING WILL RESULT IN THE REMOVAL OF MEDIA AND REPLACEMENT FROM ALTERNATE BATCH.

HIGH PERFORMANCE STRUCTURAL UNDERDRAIN

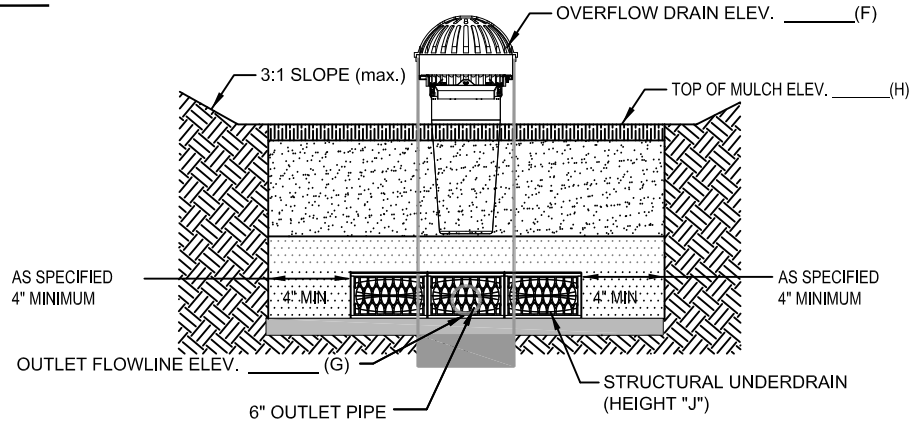
MUST HAVE A MINIMUM OF 19 SQUARE INCHES OF ORIFICE OPENING PER SQUARE FOOT.
MUST MEET H20 LOADING REQUIREMENTS.
MUST BE MODULAR IN NATURE AND ASSEMBLED ON SITE.
MUST HAVE MINIMUM 90% INTERIOR VOID SPACE.

FOCALPOINT HP CONSTRUCTION GUIDE		
A	FOCALPOINT LENGTH	
B	# UNDERDRAIN LONG	
C	FOCALPOINT WIDTH	
D	# UNDERDRAIN WIDE	
E	WATER QUALITY VOLUME	
F	OVERFLOW ELEVATION	
G	OUTLET FLOWLINE	
H	TOP OF MULCH	
I	TOP OF GABION (OPTIONAL)	
J	UNDERDRAIN HEIGHT	

PLAN VIEW



SECTION Y-Y



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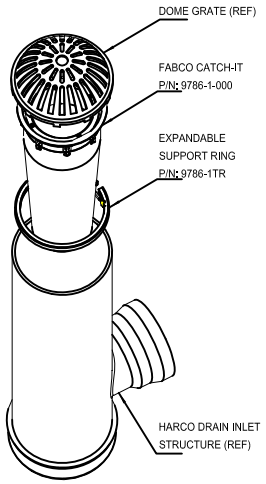
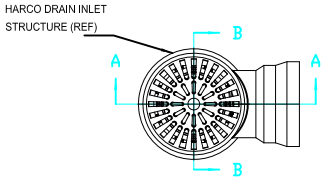
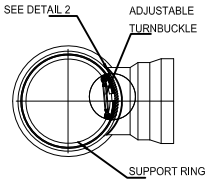
NOTES:

1. STORMSACK WEIGHT (EMPTY): 12 LB MAX
2. MATERIAL:
   A) SHROUD: HIGH DENSITY POLYETHYLENE (TYPICAL WALL THICKNESS .125")
   B) SUPPORT HUB: CRS, POWDER COATED
   C) STORMSACK: WOVEN POLYPROPYLENE GEOTEXTILE (GEOTEX 117F)
   D) HARDWARE: ALUMINUM POP-RIVETS
3. RECOMMENDED MINIMUM VAULT DEPTH: 2-IN BELOW CARTRIDGE
4. TYPICAL INSTALLATION: RAISE STORM GRATE, PUSH CATCH-IT SHROUD DOWN ON FRAME SUPPORT LEDGE UNTIL LOCKING-CLIPS CLICK IN PLACE, LOWER STORM GRATE.
5. USE ONLY WITH FABCO REPLACEABLE STORMSACK.

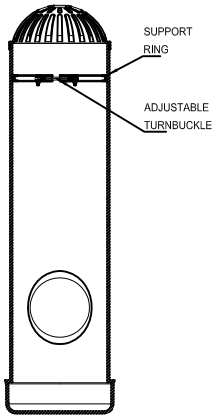
STRUCTURE DIAMETER (INCHES)	DEBRIS CAPACITY (CF)	FILTERED FLOWRATE (CFS)	BYPASS FLOWRATE (CFS)	TOTAL SYSTEM FLOWRATE (CFS)
12	0.77	2.2	1.2	3.4
18	1.65	2.5	1.0	3.5
24	3.60	4.9	2.4	7.3
30	6.20	4.9	2.4	7.3



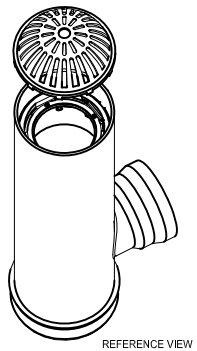




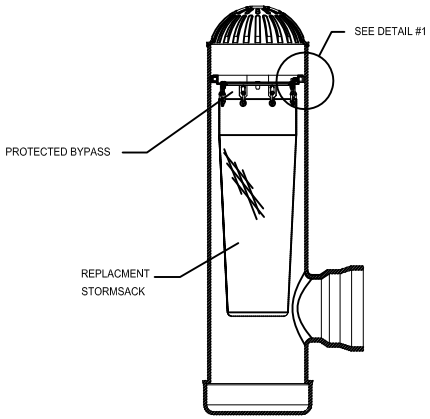
CUTAWAY 1
(CATCH-IT
REMOVED FOR CLARITY)



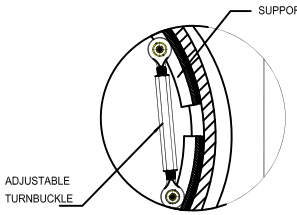
SECTION B-B
(VIEW ROTATED 90~)
(CATCH-IT
REMOVED FOR CLARITY)



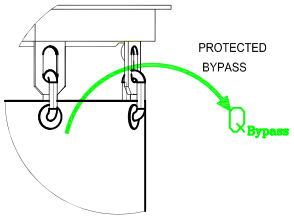
REFERENCE VIEW



SECTION A-A



DETAIL 2



DETAIL 1

FABCO BEEHIVE OVERFLOW FILTER STRUCTURE DETAILS

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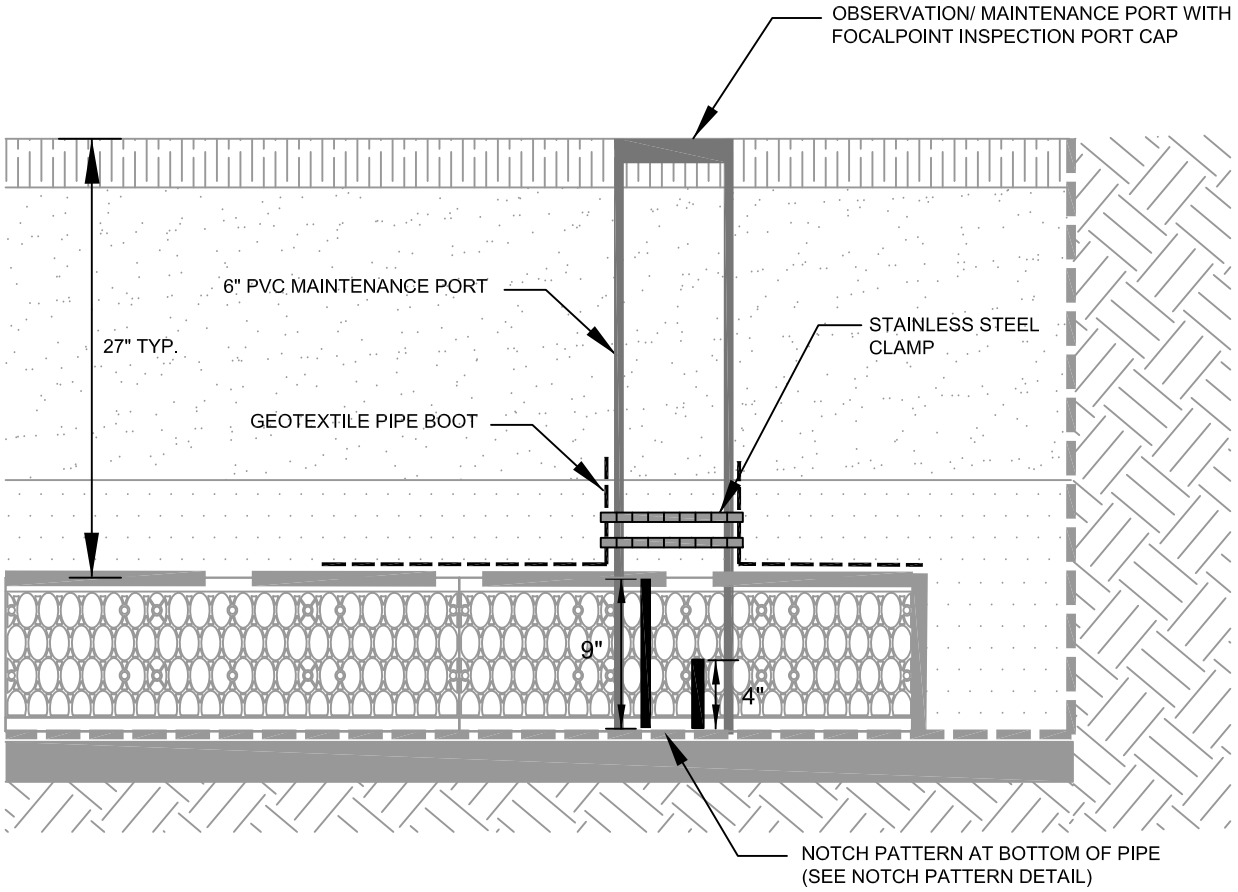
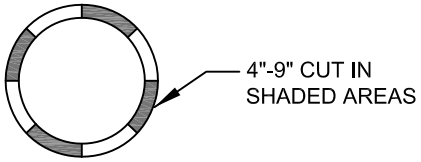
OBSERVATION/ MAINTENANCE PORT

PORT USED FOR INSPECTION PURPOSES AND FOR SYSTEM MAINTENANCE AS REQUIRED. WATER SHALL BE PUMPED INTO THE SYSTEM AND RESUSPEND ACCUMULATED SEDIMENT. MINIMUM REQUIRED MAINTENANCE INCLUDES A QUARTERLY INSPECTION FOR THE FIRST YEAR OF OPERATION AND A YEARLY INSPECTION THEREAFTER FLUSH AS NEEDED.



PIPE NOTCH PATTERN DETAIL



FOCALPOINT OBSERVATION/ MAINTENANCE PORT

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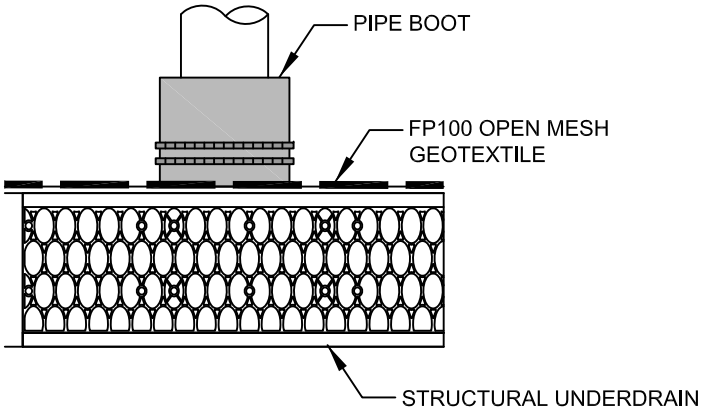
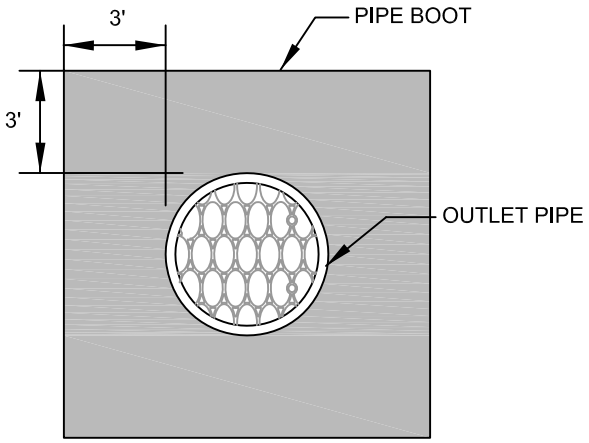
FOCALPOINT PIPE CONNECTION

OBSERVATION/ MAINTENANCE PORT CONNECTION

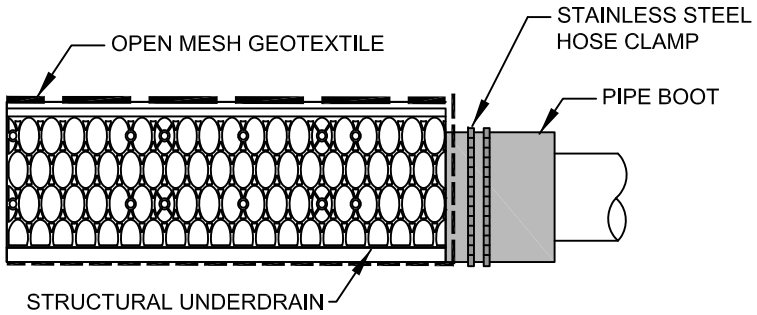


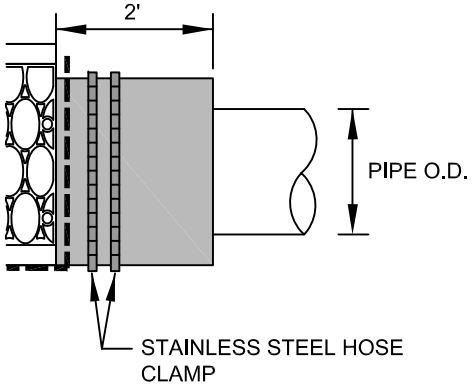
PIPE BOOT DETAIL



FRONT VIEW

OUTLET/ INLET PIPE CONNECTION





SIDE VIEW

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APPENDIX I

INSTALLATION AND MAINTENANCE GUIDELINES

FocalPoint

BIOFILTRATION SYSTEMS

High Performance Modular Biofiltration System (HPMBS)
Installation Guide

ACF ENVIRONMENTAL
Customer Focused, Environmentally Committed

Summary

FocalPoint High Performance Modular Biofiltration System (HPMBS) is a scalable biofiltration system which combines the efficiency of high flow rate engineered soils with the durability and modularity of an open cell underdrain/storage/infiltration system.

The following contents of this Installation Guide are the necessary steps required for FocalPoint HPMBS installation, and activation. In this guide you'll find detailed chapters with corresponding photos for each step, to improve ease of installation and your profitability on the project. You'll be advised about specific steps which require extra attention.

ALL STEPS MUST BE COMPLETED IN THE ORDER OUTLINED TO ENSURE A SUCCESSFUL FOCALPOINT INSTALLATION AND ACTIVATION.

Table of Contents

General Notes

Be sure to contact your local Convergent Water Technologies Value Added Reseller (VAR) at least two weeks prior to installation. We will provide you with onsite installation support AT NO CHARGE in order to facilitate a successful installation.

All pictures, illustrations and instructions have been included to guide you through a typical installation. The approved engineering drawing should ALWAYS take precedence over these instructions.

It is advised that the FocalPoint HPMBS be installed after site stabilization, or when other landscaping is being done. The components of the FocalPoint system include an engineered, high-flow media that must be protected from site erosion and sediment. The easiest way to prevent this is to not install it until the final phase of construction.

However, if it is necessary that the system be installed prior to final stabilization, this guide provides instructions for our 'cap & seal' procedure that will protect the integrity of the system until activation is deemed appropriate (i.e., after the site is at least 90% stabilized). Failure to adequately protect the system will result in premature contamination and possible system failure.

Throughout this document you will see three types of notes:

***TIP**: Ideas to improve your efficiency and profitability on the installation*

***IMPORTANT**: Steps that require extra attention*

***WARNING**: Critical issues that MUST be handled correctly to ensure a successful installation*

Pre-Construction Checklist

TOOLS YOU WILL NEED:

- Laser or Transit
- Measuring Tape (Long enough to mark FocalPoint HPMBS footprint)
- Razor Knife
- Screw Driver / Nut Driver Set
- String Line
- Marking Paint
- Reciprocating Saw (To cut Inspection & Maintenance Port and Receiving Holes)
- Dead Blow Mallet
- Worktable (3/4" plywood placed on saw horses works well)
- Hog Ring Gun and Rings for Gabion (if specified)
- Level
- Torch (etc) to "weld" geotextile for 'cap & seal' step

MATERIALS YOU WILL NEED:

- Modular Underdrain Panels
- 8oz Non-Woven Geotextile to line excavation
- Microgrid Mesh
- Washed Bridging Stone (Typically 3/8" - 1/2" pea gravel)
- High Flow Biofiltration Media
- Base Material (95% compactable angular stone (½" – 1½") or coarse sand
- Pipe Boot Kits (If not using kits, you will need duct tape and a stainless steel band clamp for each inlet and outlet pipe, and for each inspection or maintenance port.)
- Pipe for Inspection and Maintenance Ports (Typically 6" or 12" SCH 40 PVC)
- Pipe Cap & Serialized FocalPoint Identification Cover
- Gabion basket(s) or other energy dissipation device (If Specified)
- Rock (For Gabions or Flow Dissipation, if Specified)
- Aged, Double Shredded Hardwood Bark Mulch, which has been screened to remove fines
- 10-33mm EPDM, or other impermeable material sized to cover the surface of the media bed, if the system will not be immediately activated.

EQUIPMENT YOU WILL NEED:

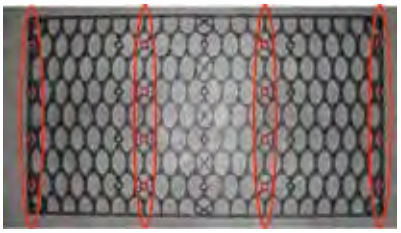
- Forklift and other equipment/tools needed to unload box truck
- Walk behind trench roller (plate compactor may also work)

Note: This list does not include equipment or tools needed to excavate or level the floor of the excavation

1 ASSEMBLE MODULAR UNDERDRAIN

If Modular Underdrain units arrive on your project in flat panels they will need to be assembled on-site. Assembling the units should take 2-3 minutes per module. This is a conservative estimate used to approximate the total man hours needed for assembly. The estimate includes the workers doing the assembly as well as material handling people to keep the assembly workers moving.

Figure 1: Attach small plates at locations marked in red. The holes to be used for the middle panels are centered on an "X"



Unit	Mini	Single	Double	Triple	Quadruple	Penta
Time	2-3 minutes	2-3 minutes	4-6 minutes	6-9 minutes	8-12 minutes	10-15 minutes

Assembly Instructions – following the drawings in Fig. 2: Connect four small panels (B) into one large panel (A) using the short pegs (not the long pegs). Attach small panels onto the large panel at the locations marked in red on Fig. 1. Do NOT use the row of pin holes directly in the center or the two interior rows nearest the edges, as marked in red on Fig. 1.

Next, working from one end to the other, attach a second large plate (A) on the opposite side of the first.

Once the top and bottom large plates are attached, two more side plates (A) are attached to complete the sides of the Modular Underdrain unit. The picture in figure 2 shows is a SINGLE MINI Modular Underdrain. A single modular underdrain unit will be assembled in the same manner.

To build a DOUBLE unit (or larger), follow the directions above, starting at "Assembly Instructions:" using the top of the existing unit as the large plate. Bottom of the next module.

Figure 2: Follow these steps to assemble the underdrain units

Figure 3: Assembling on site during excavation will increase speed once the excavation is completed

TIP: To increase the speed of the installation, many contractors choose to assemble the Modular Underdrain units prior to or during excavation (Step 2) and base preparation (Step 3) (Fig. 3). Other contractors wait until these steps are completed and then perform the assembly IN THE EXCAVATION allowing completed units to be placed into their final location as they are assembled. Consider which option will work best for your project.

2 EXCAVATE

Excavate the designated area according to plans. Typical excavations should include:

- One foot perimeter around underdrain modules to allow for proper compaction of backfill
- Enough depth to accommodate a minimum 3" base (if required) below the underdrain modules

Level the bottom of the excavation (Fig. 4) as shown on plans. Most excavations have a flat bottom while some will slightly slope toward the outlet pipe.

Figure 4: Excavation according to plans, following all governmental regulations

Prepare the subgrade according to plans. This could require compaction for stability or prohibit compaction to promote infiltration.

If the subgrade is pumping or appears excessively soft, the design engineer should be consulted for advice. In many cases a stabilization geotextile and 6" of compactable material that drains well will be sufficient to amend the bearing capacity of the soil.

3 PREPARE BASE

Standing water in the excavation will prevent proper base preparation and must be removed, if present. In regions with sandy soils meeting the requirements noted and where the subgrade elevation is above the groundwater table, imported base materials may not be needed.

Base materials must be:

Compaction	95% Compaction (If infiltration is not a primary goal)
Shape	Angular
Size	Not larger than 1.5" in diameter
Consistency	Free of lumps, debris, and sharp objects that could cut geotextile
Applicability	Stone or coarse sand is acceptable if it meets requirements; In no case shall clays be used

Grade and level base as shown on plans.

TIP: Creating a smooth, level platform will allow for faster installation of Modular Underdrain, as units will fit together evenly, eliminating detail work that can delay your progress (Figure 5)

Figure 5: Base must be smooth to ensure units fit together without gaps

4 PLACE GEOTEXTILE ENVELOPE

Geotextile will be required on all FocalPoint HPMBS installations to separate the surrounding in-situ soils from the FocalPoint System. Check your plans to ensure that geotextile is to line your entire excavation, or will only be placed on the sides (if infiltration is a primary goal).

Cut full-width strips of Geotextile to the proper length and place them over the base and up the sides of the excavation, covering the floor and beyond walls of the excavation. This will be important in fulfilling step 11.

IMPORTANT: Allow enough geotextile to wrap the top of the system. This will aid in protecting the system until the site is completely stabilized and ready for activation.

Geotextiles are flammable. No smoking should be permitted on the geotextile.

Adjacent panels of material should be overlapped by 12" or more, as shown on the plans (Fig. 6).

Use pins, staples, sandbags or other ballast to hold the geotextile in place, preventing it from blowing or sliding out of position.

TIP: A prefabricated geotextile envelopes are available for smaller systems. This helps cut down waste and speeds up the installation process (Fig.7)

Figure 6: Roll out geotextile cut to fit the excavation in order to keep in-situ soils from migrating into the FocalPoint System. Geotextile strips must be cut generously in order to cover entire excavation on completion of the installation.

5 INSTALL MODULAR UNDERDRAIN

Determine the starting location. It is often helpful to use an inlet or outlet pipe to guide you. Using a string line, establish two adjacent edges of the Modular Underdrain footprint. Ensure that your corner is square. Mark these two edges with marking paint and remove the string line (Fig. 8).

5 INSTALL MODULAR UNDERDRAIN *continued*

Begin placing Modular Underdrain in the corner of the marked area. Do NOT place units on their sides, as this will void the warranty. Check your plans to ensure correct orientation of the Modular Underdrain (Fig. 9).

Check the plans to ensure the Modular Underdrain is running in the correct direction (North/South vs. East/West) to match the footprint shown.

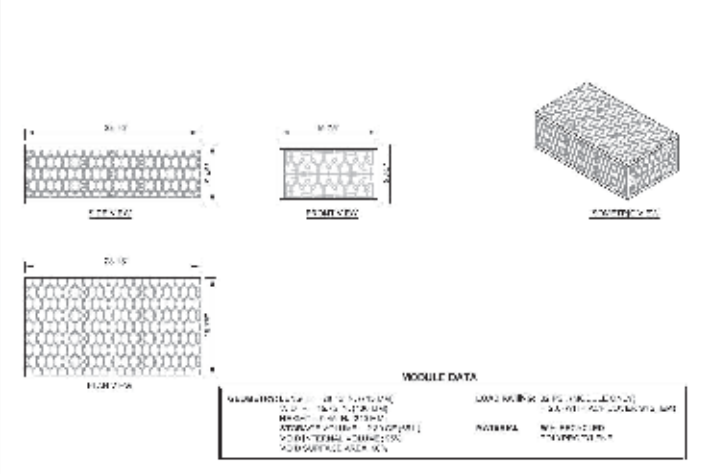


Figure 9: Make sure the tanks are oriented properly in the excavation.

Figure 8: Place modular underdrain in specified configuration within geotextile envelope.

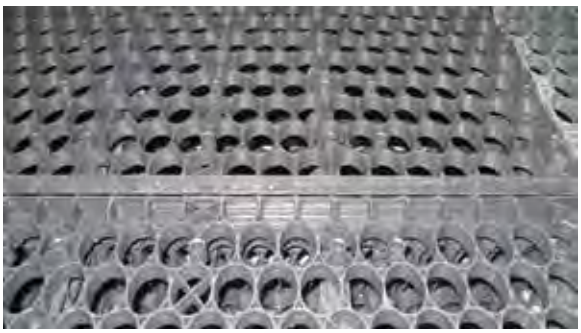


Figure 9A: Minor Variations (less than width of top plate) in tank height are acceptable

Modular Underdrain units should fit together evenly. Minor gaps between units (< ½") or variations in the height of the units (< ½") are acceptable (Fig. 9A), but reasonable efforts should be made to minimize these variations. Minor gaps will be eliminated during compaction of side backfill material.

No lateral connections between adjacent underdrains modules are required.

6 INSTALL INSPECTION/MAINTENANCE PORTS

All ports should be made from pipe long enough to extend from the bottom of the Modular Underdrain to a point slightly above finished grade of the FocalPoint HPMBS. Taller is better, as the pipes can be trimmed on completion of the system installation. They are typically Schedule 40 PVC pipe, but can be formed from other types of pipe, as well.

Figure 11: 8" slots cut in to bottom of inspection port caps

Identify the location of all ports as specified on the approved drawings and remove the Underdrain Module(s) which will receive the port from each location.

Cut the pipe to length, leaving enough excess to trim the top when final grade is reached.

Cut several horizontal slots in the pipe starting at the bottom (Fig. 11). Slots should extend as high as the height of the lowest underdrain module being used. No perforations or slots should be visible above the top of the Modular Underdrain once the port is in place.

Using a reciprocating saw, cut the horizontal underdrain module plates in the center, between the two internal vertical plates, to receive the port (Fig. 12). Cut the openings for a tight fit around the port pipe. If the pipe specified will not fit between the two interior plates, one or both plates may be moved to the outer connection locations on the large plate . All horizontally oriented plates will need to be cut EXCEPT FOR THE BOTTOM PLATE. In total you will need to cut:

Unit	Cut
Mini & Single	1 plate
Double	2 plates
Triple	3 plates
Quadruple	4 plates
Penta	5 plates

TIP: If the location of the inspection ports is not shown on your plans, use a single inspection port located in the middle of the underdrain field. Install a port for every X sf of the underdrain system

IMPORTANT: Do not over-cut the Modular Underdrain plates. Minimize the gaps between the pipe and the Modular Underdrain plates. This is particularly important with the top plate.

For all units larger than a Single or Mini Underdrain Module, you will need to disassemble the Underdrain module in order to cut the interior horizontal plates. Reassemble the Underdrain Module when cutting is completed, and replace the Underdrain Module into the proper location.

TIP: If using Prefabricated Pipe Boot Kits, install them onto the pipe now, leaving the band clamps loose so that final adjustments may be made in Step 7.

Install the pipe into the Underdrain Modules.

Place the port pipe with pre-cut slots into hole. (Fig. 13). Be sure to cut the top of the pipe so that once the FocalPoint HPMBS Inspection Port Cap is placed onto the top of the pipe, the top of the Inspection Port Cap will be flush with or just above the finished grade. Once the pipe is in place, put the FocalPoint inspection port Cap or a temporary cap on the port to prevent debris from entering the system during backfill procedures (Fig. 14).

Figure 12: Cut 6" Hole into top panel of underdrain module to accommodate 6" pipe

Figure 13: Place inspection port into underdrain module

Figure 14: Cut inspection port to appropriate height stated on plans. Seal the opening on top of the pipe with the FocalPoint Inspection Port Cap or temporary lid

7 INSTALL MICROGRID MESH

Clean off any debris that may be lying on top of the exposed geotextile around the perimeter of the Modular Underdrain.

Cut strips of Microgrid Mesh to fit over the top and down both sides of the modular underdrain system. Adjacent strips of Mesh should overlap at least 12" or as shown on plans. Use rock bags or other ballast to temporarily secure overlaps (Fig. 15).

Where Modular underdrain intersects an Inspection or Maintenance Port, cut an "X" into the geotextile and pull it over the pipe. The flaps of the "X" should point AWAY from the Modular Underdrain (Fig. 16). Use stainless steel band clamp to seal the flaps to the pipe, being careful not to leave gaps that will allow bridging stone to enter the underdrain.

Figure 15 (Above): 12" overlap of Biaxial Mesh on top of underdrain module

IMPORTANT: Take special care with Inside Corners on the footprint of the system. Cut Microgrid Mesh as needed to ensure that it lays flat against the Modular Underdrain. Use additional pieces to seal the corner and any cuts that are made (12" overlap).

Figure 16 (Below): Cut an "X" into Biaxial Mesh to accommodate pipe penetration

Figure 17: fold corners flat against the tank

Fold Mesh for outside corners similar to sheets on a bed, and lay excess material flat against Modular Underdrain. Leave corners loose to avoid creating weak spots in the material. Temporarily secure excess fabric with duct tape (Fig. 17 left).

TIP: If using Prefabricated Pipe Boot Kits, install them onto the Inlet and Outlet Pipes, leaving the band clamps loose so that final adjustments may be made.

Connect Inlet & Outlet Pipes

Where the inlet and outlet pipes connect to an underdrain module or exits the excavation, cut an "X" into the Microgrid Mesh or geotextile so that the pipe runs through the Microgrid and makes DIRECT contact with the underdrain module (Fig: 18). Pull the flaps of the "X" cut over the pipe so that the flaps of the "X" point AWAY from underdrain module. Use a stainless steel band clamp to seal the flaps to the pipe, being careful not to leave gaps that will allow bridging stone to enter the underdrain.

Figure 18: Cut "X" in Biaxial Mesh and Geotextile to accommodate outlet pipes and seal with stainless steel band clamps

8 BACKFILL SIDES & TOP WITH PEAGRAVEL

Backfill bridging stone material around perimeter of the underdrain modules, distributing the material evenly to prevent shoving of the underdrain modules.

Use a trench roller, plate compactor, or hand tamper to compact backfill. When using taller underdrain modules, this placement and compaction should be done in 12" lifts.

Continue placing and compacting backfill around underdrain modules until the bridging stone reaches the top of the underdrain modules. Once bridging stone is level with the top of the underdrain, place 6" of bridging stone (or as specified) on top of underdrain modules (Fig 20).

Figure 19: Compaction of side is critical in order to keep soils from settling around the tank.

Figure 20 (Above): Place 6" of bridging stone on top of Microgrid Mesh

Figure 21 (Right): Use Inspection Port as marker for bridging stone depth

9 PLACE HIGH PERFORMANCE BIOFILTRATION SOILS

Level bridging stone and, place 6" of high flow media on top. Use marked stakes to ensure elevations. Once 6" of media has been placed, set Gabions (if applicable). Once Gabions have been installed, continue placing media until it is at the specified depth, (typically 18"). The top of the media should be 6" below the top of the gabion wall (if specified).

TIP: Before you place bridging stone use your inspection port to mark the different levels of fill as specified (Figure 20)

WARNING High Flow Media is a highly engineered soil - do not mix media with any other site, fill or excavated soils.

Figure 22: Place biofiltration soils, being careful not to mix with any other site soils, to specified depth

Figure 23: Level Soils once they are filled to specified depth

10 PLACE & FILL GABION (IF SPECIFIED)

(If gabion surround or leading edge is not specified continue to step 11)

Gabions are an optional feature that may not be included on your installation. If they are not included, skip this step and proceed to Step 11.

The gabion baskets are 12" tall. The interior dimensions of the gabion baskets needs to be equal to the exterior diameter of the underdrain unless specified otherwise. The top of the gabion should rise 6" above the top of the high flow media and 3" above the bark mulch.

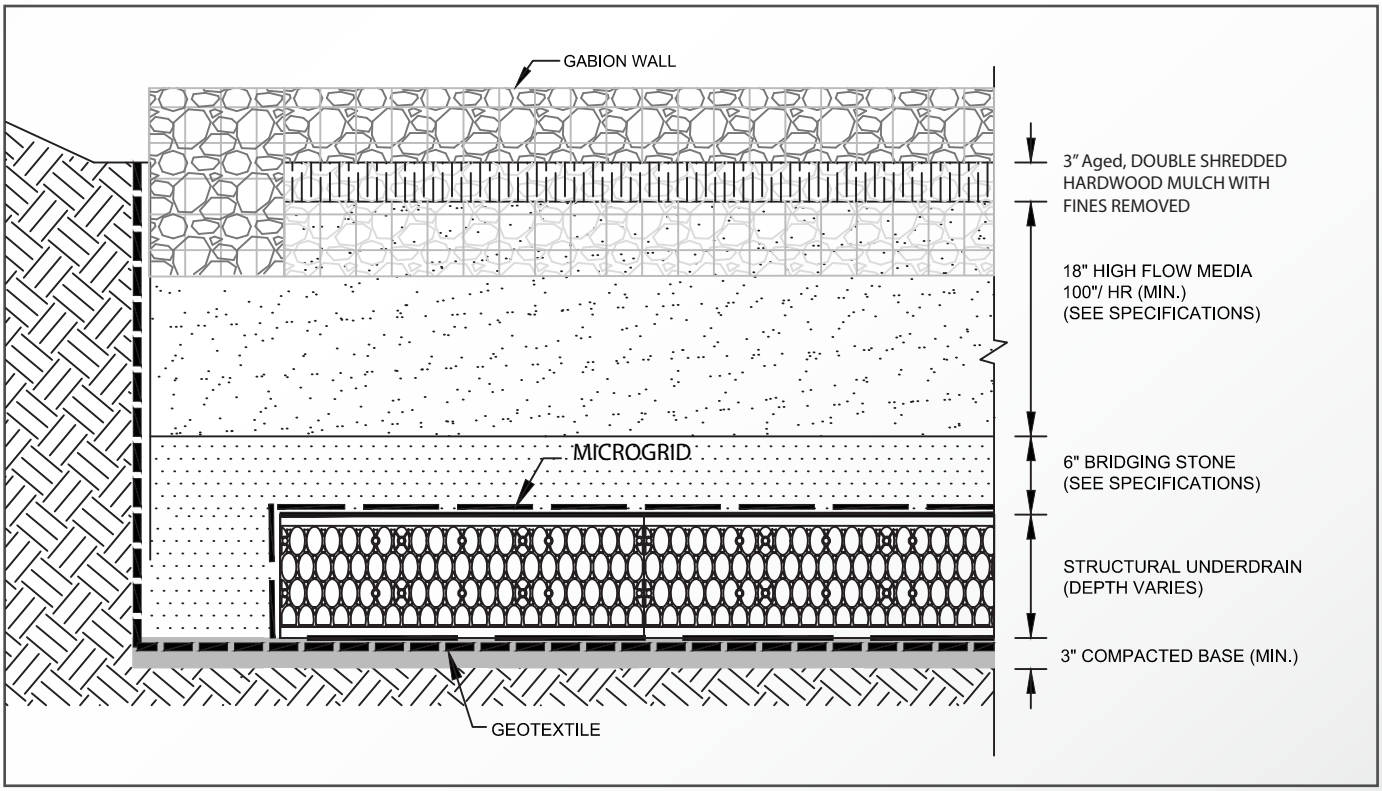
Place a geotextile separation barrier between the gabion and existing site soils as well as the gabion and media so that soil will not migrate into the rock creating a void. (Figure 24).

Once the gabion baskets are placed, overfill the gabions with 3" x 5" washed bull rock, or other specified material Once filled, seal the baskets with hog rings placed every three inches so that rock cannot be removed.

Figure 24: Place gabion wall so that it is square and level

Figure 25: Overfill rock into gabion and seal tight to prevent sagging. Rock will settle over time.

Figure 26



11 CAP & SEAL

This step protects the system if it is not to be immediately activated. The system should not be activated (plantings and mulch placed, and stormwater allowed to flow into system) until the surrounding drainage area reaches at least 90% stabilization. Premature activation and/or failure to carry out this 'cap & seal' step may invalidate the warranty on this system.

Protecting the FocalPoint HPMBS during construction is of the utmost importance. The sediment contained in the runoff from an un-stabilized drainage area may contaminate the biofiltration media, reduce the effectiveness of the FocalPoint HPMBS or cause failure.

WARNING

FAILURE TO INSTALL AND MAINTAIN ADEQUATE ESC PROTECTION FOR THE FOCALPOINT MAY VOID THE WARRANTY AND PERFORMANCE GUARANTEES.

Figure 30: A hose extension added to a blow torch.

TIP: If you add a hose extension onto the torch, it makes the procedure much easier.

Figure 29: Geotextile being melted together with a torch.

Cut an appropriately sized piece of impermeable material (10-33mm) to fit the surface of the media bed. If multiple pieces are required, weld/glue them together to create an impermeable seal over the media bed.

Place the impermeable cover over the media bed.

Pull excess Geotextile Excavation Liner (see step 4) over the top of the FocalPoint System, fully cover the impermeable seal, overlapping the geotextile to fully prevent silt and sediment from reaching the seal and underlying media. Using a portable blow torch to 'heat weld' the geotextile and prevent the geotextile from moving or opening. You should practice this procedure on scrap material away from the system prior to attempting to do it over the system. Non-woven geotextiles are flammable and you must take extreme caution in doing this so that you do not leave the torch on the geotextile for too long. This procedure will create a perfect seam that will prevent sediment from bypassing the geotextile (Figure 29). If you cut your fabric too short, just make a patch for the uncovered area with another piece of geotextile, welding it all the way around.

Once the system is capped and sealed, use a sign or any other warning mechanism to warn other contractors not to remove the cover until activation is authorized (Figure 31). This will protect the system until final stabilization. Other erosion control mechanisms may be required upstream of the FocalPoint HPMBS such as check dams, erosion control blankets, wattles or other best management practices. Please contact your local Convergent Value Added Reseller for suggestions.

Figure 31: FocalPoint Warning Sign

12 ACTIVATE THE SYSTEM

Once 90% stabilization has been achieved; contact your local Convergent Water Technologies Value Added Reseller (www.convergentwater.com) for activation. Activation includes removing the protective 'cap and seal' cover on the biofiltration media bed and in situ testing of the media to insure that it meets performance specifications by means of an hydraulic conductivity test. This activation is provided by Convergent's VAR at no additional charge. At this time you may add specified plants to the media bed and the 3" non-floatable mulch layer if indicated (typical).

IMPORTANT:
The FocalPoint HPMBS should always remain capped until 90% stabilization is achieved and be the last thing planted to ensure that construction sediment does not enter the system.

Figure 33: Planted FocalPoint HPMBS

Figure 32: Protected FocalPoint HPMBS

WARNING

FAILURE TO CONFORM TO THIS STEP MAY VOID THE WARRANTY AND PERFORMANCE GUARANTEE. FOR THE FOCALPOINT HPMBS ACTIVATION CHECKLIST, CONTACT YOUR VALUE ADDED RESELLER.

13 PLANTINGS & MULCH

Placing the Plants:

1. Dig planting holes the depth of the root ball and two to three times as wide as the root ball. Wide holes encourage horizontal root growth that plants naturally produce.

2. With trees, you must ensure you are not planting too deep!! Don't dig holes deeper than root balls. The media should be placed at the root collar, not above the root collar; otherwise the stem will be vulnerable to disease.

Planting:

1. Remove plastic containers from container-grown plants. For plants in fiber pots, break away the top or remove the pot entirely.

2. If roots are circling around the root ball exterior, cut through the roots in a few places and remove the first inch of roots and planting material around the root ball. Cutting helps prevent circling roots from eventually girdling the trunk. If roots are not circling, the root ball should still be rubbed to loosen roots and promote growth into the media.

SPACING		
Type of Planting	**Rootball Size**	**Spacing on Center**
Shrubs	< 1 gallon	24 inches
Shrubs	5 gallons	42 inches
Shrubs	15 gallon	60 inches
Clump Grasses		24 inches
Small Trees		12 feet

3. Remove tags and labels from plants.

4. Prune broken branches or suckers.

5. Only stake trees with large crowns, or those situated on windy sites or where people may push them over. Stake for a maximum of one year. Allow trees a slight amount of flex rather than holding them rigidly in place. Use guying or attach material that won't damage the bark. To prevent trunk girdling, remove all guying material after one year. Insure that stakes do not penetrate the bridging stone or underlying modular drainage system.

6. Plants should be watered at planting, especially during drought periods.

DO NOT:

- Mulch in excess of 3 inches
- Compact media around the root ball
- Do not use annuals
- Keep in mind that some perennials (i.e. daylilies, hostas, etc…) die back in fall and re-emerge in spring. If you want greenery year round, be mindful of the perennials used.

Mulching:

Cover the exposed root ball top with mulch. No mulch volcanoes! Mulch should not touch the plant base because it can hold too much moisture and invite disease and insects. Evenly place 3 inches of double shredded, aged hardwood mulch which has been screened to remove fines, on the surface of the media (if specified).

Erosion Control:

Where water is entering a focal point in one location, be sure to place erosion control stones or other scour prevention BMP to prevent scouring

14 PERFORMANCE VERIFICATION

The Rub-I Infiltrometer is the most effective way to field verify engineered soil performance, construction and long term verification of performance. The Rub-I was designed to test the effectiveness of high flow soils and to ensure post control. Current ASTM standards for infiltration testing are not valid for flow rates exceeding 16 in/hr. To ensure the highest level of effectiveness, Convergent specifies that the FocalPoint HPMBS be tested within 60 days of installation and we recommend the system be tested annually thereafter to provide ongoing quality assurance.

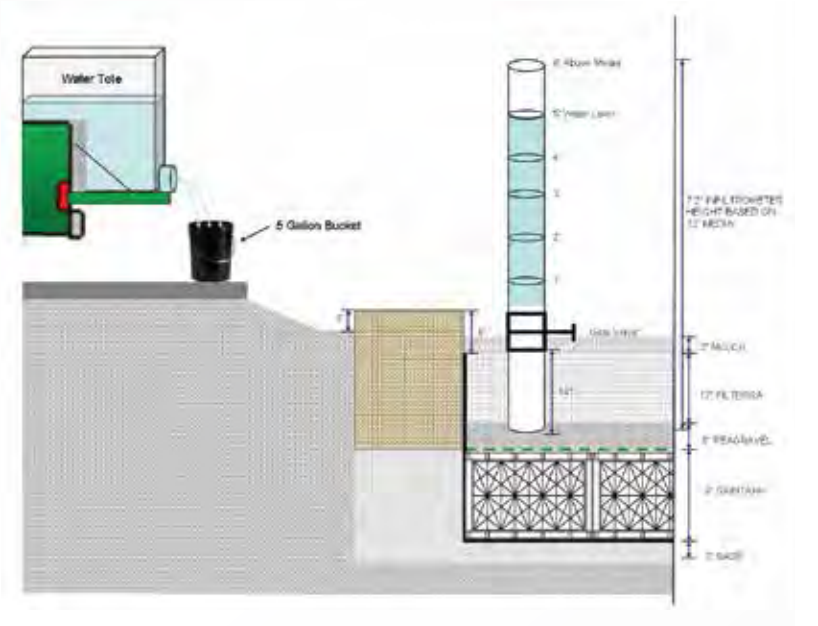
Objective:

To provide as-built confirmation of proper installation and hydraulic performance, to meet minimum high flow rate Infiltration rate requirements, of bioretention media on newly-placed bioretention systems. This procedure measures the entire media profile under saturated conditions to insure a reliable and accurate result.

Example Site Test Layout and Design Schematic:

(FSA = filter surface area, DA = drainage area)

For bioretention systems with a surface area less than 538 sf, in situ hydraulic testing should be conducted at one to three points that are spatially distributed. For systems with a surface area greater than 50 sf, an extra monitoring point should be added for every additional 1076 sf. (Values are based on recommendations from the Facility for Advancing Water Biofiltration.) Testing should be performed near the perimeter since this is the area most likely to be impacted by sediment in the runoff.



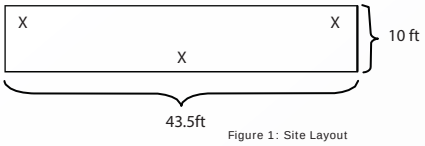


Figure 1: Site Layout

Media Depth (inches)	Max Drawdown Time (min:sec)
12	18:18
14	21:24
16	24:18
18	27:00
20	29:30
22	31:54
24	34:06
26	36:12
28	38:12
30	40:00
32	41:42
34	43:24
36	44:54
38	46:18
40	47:42
42	49:00
44	50:12
46	51:24
48	52:30

Test Methodology:

In an area near the location you plan to test, gently scrape away any material covering (e.g. mulch, gravel, leaves) filter media surface and confirm media profile depth by using a shovel to dig to under drain stone and place measuring tape in hole to determine depth from top of under drain stone to top of media bed. A flash light may be needed to ensure the under drain stone has been reached before a depth measurement is taken. Make every effort to minimize disturbance of surrounding media and underlying bridging stone.

Figure 3: Hammering Pipe Into Media

Figure 4: Pipe Installed Into Media

Figure 5: Oil Application

Figure 6: Dissipater Stones

1. At the test location carefully clear away mulch without disturbing the underlying media and place base component of the Rub-I infiltrometer, a 6" PVC pipe (beveled end down), on the surface of the media. Ensure testing is not too close to vegetation. Place the wooden board over the pipe and then gently pound with the sledge hammer on top of the board (Figure 3). Hammer the PVC pipe into the entire media profile based on the depth previously determined, until it just breaches into the bridging stone. Drive the pipe straight down, avoiding tilt in any direction (Figure 4). Check with level. Note: It is important that the pipe is driven in slowly and carefully to minimize disturbance of the filter media profile. The media may slightly move downward in the pipe during hammering, but not more than 1 inch, and will not significantly affect hydraulic performance.

2. If pipe is less than 3 inches from media surface, remove media around outside of pipe so that the pipe has 3 inches of freedom from the media bed so that the infiltrometer gate valve coupling will properly slide onto the pipe.

3. Remove board and rub mineral oil on outside of PVC pipe above media (Figure 5).

4. Place 2 inch dissipater stones into pipe (Figure 6).

5. Slide gate valve with clear PVC cylinder down onto the PVC pipe in the media (Figure 7). Note: Disregard black coupling on clear pipe as well as pipe plug in this image.

6. Measure from the original surface of the media within the column to 1 ft, 2 ft, 3 ft, 4 ft and 5 ft gradations, and mark them on the clear PVC cylinder (Figure 8). The 1 ft and 5 ft marks are the critical marks, since the time to fall between these two intervals will provide the pass/fail time for the test. (The time at other intervals between 1 ft and 5 ft can be recorded for additional information, but will not be used in the pass/fail criteria).

7. Fill a 5 gallon bucket with 3 gallons of water.

8. Ensure the gate valve to the infiltrometer is closed. Fill with the 3 gallons of water (Figure 9). To create a worst case flow rate scenario (i.e. saturated condition), an initial wetting of the media using the infiltrometer is conducted by opening up the gate valve completely. The gate valve should be slowly opened by tapping on the handle with a hammer or wrench to prevent disturbance of the media surface by a sudden high flow of water. Pulling open by hand tends to force the valve open too quickly.

9. After the water level disappears from the clear column, a drain down time of 25 minutes is allowed to ensure free water has drained through the media.

10. After 25 minutes, ensure the gate valve is closed. Fill the 5 gallon bucket with water and continue to fill the column until water level reaches the very top of the clear pipe. Water is then re-introduced by opening the gate valve slowly by tapping the handle. A stopwatch should be started as the water level reaches 5 ft gradation and recorded at every 1 ft gradation. The stopwatch is stopped when the water level reaches the 1 ft mark.

11. Pass/fail criteria is based on maximum drawdown times (Table 1). For example, a media profile depth of 12 inches should not exceed a drawdown time of 18 minutes and 18 seconds between the 5 ft and 1 ft gradations.

For bioretention systems with a surface area less than 538 sf, in situ hydraulic testing should be conducted at one to three points that are spatially distributed. For systems with a surface area greater than 50 sf, an extra monitoring point should be added for every additional 1076 sf. These values are based on recommendations from the Facility.

Figure 7: Infiltrometer Placement

Figure 8: Gradation of Clear Pipe

Figure 9: Filling Infiltrometer with Water

For information on components & assembly of Rub - I Infiltrometer see the SOP (Standard Operating Procedure) document available from your Convergent VAR

FocalPoint

BIOFILTRATION SYSTEMS

HIGH PERFORMANCE MODULAR BIOFILTRATION SYSTEM (HPMBS)

Operations & Maintenance

ACF ENVIRONMENTAL

Customer Focused, Environmentally Committed

GENERAL DESCRIPTION

The following general specifications describe the general operations and maintenance requirements for the FocalPoint® High Performance Modular Biofiltration System (HPMBS). The system utilizes physical, chemical and biological mechanisms of a soil, plant and microbe complex to remove pollutants typically found in urban stormwater runoff. The treatment system is a fully equipped, modular, constructed in place system designed to treat contaminated runoff.

Stormwater enters the FocalPoint® HPMBS, is filtered by the High Flow Biofiltration Media and passes through to the underdrain/storage system where the treated water is detained, retained or infiltrated to sub-soils, prior to discharge to the storm sewer system of any remaining flow.

Higher flows bypass the FocalPoint® HPMBS via a downstream inlet or other overflow conveyance. Maintenance is a simple, inexpensive and safe operation that does not require confined space entry, pumping or vacuum equipment, or specialized tools. Properly trained landscape personnel can effectively maintain FocalPoint® HPMBS by following instructions in this manual.

BASIC OPERATIONS

FocalPoint® is a modular, high performance biofiltration system that often works in tandem with other integrated management practices (IMP). Contaminated stormwater runoff enters the biofiltration bed through a conveyance swale, planter box, or directly through a curb cut or false inlet. Energy is dissipated by a rock or vegetative dissipation device and is absorbed by a 3-inch layer of aged, double shredded hardwood mulch, with fines removed, (when specified) on the surface of the biofiltration media.

As the water passes through the mulch layer, most of the larger sediment particles and heavy metals are removed through sedimentation and chemical reactions with the organic material in the mulch. Water passes through the biofiltration media where the finer particles are removed and numerous chemical reactions take place to immobilize and capture pollutants in the soil media.

The cleansed water passes into the underdrain/storage system and remaining flows are directed to a storm sewer system or other appropriate discharge point. Once the pollutants are in the soil, bacteria begin to break down and metabolize the materials and the plants begin to uptake and metabolize the pollutants. Some pollutants such as heavy metals, which are chemically bound to organic particles in the mulch, are released over time as the organic matter decomposes to release the metals to the feeder roots of the plants and the cells of the bacteria in the soil where they remain and are recycled. Other pollutants such as phosphorus are chemically bound to the soil particles and released slowly back to the plants and bacteria and used in their metabolic processes. Nitrogen goes through a variety of very complex biochemical processes where it can ultimately end up in the plant/bacteria biomass, turned to nitrogen gas or dissolves back into the water column as nitrates depending on soil temperature, pH and the availability of oxygen. The pollutants ultimately are retained in the mulch, soil and biomass with some passing out of the system into the air or back into the water.

DESIGN AND INSTALLATION

Each project presents different scopes for the use of FocalPoint® HPMBS. To ensure the safe and specified function of this stormwater BMP, Convergent Water Technologies and/or its Value Added Resellers (VAR) review each application before supply. Information and design assistance is available to the design engineer during the planning process. Correct FocalPoint® sizing is essential to optimum performance. The engineer shall submit calculations for approval by the local jurisdiction when required. The contractor and/or VAR is responsible for the correct installation of FocalPoint® HPMBS units as described in approved plans. A comprehensive installation manual is available at www.convergentwater.com.

MAINTENANCE

Why Maintain?

All stormwater treatment systems require maintenance for effective operation. This necessity is often incorporated in your property's permitting process as a legally binding BMP maintenance agreement. Other reasons for maintenance include:

- Avoid legal challenges from your jurisdiction's maintenance enforcement program.
- Prolong the lifespan of your FocalPoint® HPMBS.
- Avoid costly repairs.
- Help reduce pollutant loads leaving your property.

Simple maintenance of the FocalPoint® HPMBS is required to continue effective pollutant removal from stormwater runoff before any discharge into downstream waters. This procedure will also extend the longevity of the living biofiltration system. The unit will recycle and accumulate pollutants within the biomass, but may also subjected to other materials entering the surface of the system. This may include trash, silt and leaves etc. which will be contained above the mulch and/or biofiltration media layer. Too much silt may inhibit the FocalPoint's® HPMBS flow rate, which is a primary reason for system maintenance. Removal of accumulated silt/sediment and/or replacement of the mulch layer (when specified), is an important activity that prevents over accumulation of such silt/sediment.

When to Maintain?

Convergent Water Technologies and/or its VAR includes a 1-year maintenance plan with each system purchased. Annual included maintenance consists of two (2) scheduled maintenance visits. Additional maintenance may be necessary depending on sediment and trash loading (by Owner or at additional cost). The start of the maintenance plan begins when the system is activated for full operation. Full operation is defined as when the site is appropriately stabilized, the unit is installed and activated (by VAR), i.e., when mulch (if specified) and plantings are added.

Activation should be avoided until the site is fully stabilized (full landscaping, grass cover, final paving and street sweeping completed). Maintenance visits are scheduled seasonally; the spring visit aims to clean up after winter loads including salts and sands. The fall visit helps the system by removing excessive leaf litter.

A first inspection to determine if maintenance is necessary should be performed at least twice annually after storm events of greater than (1) one inch total depth (subject to regional climate). Please refer to the maintenance checklist for specific conditions that indicate if maintenance is necessary.

It has been found that in regions which receive between 30-50 inches of annual rainfall, (2) two visits are generally required. Regions with less rainfall often only require (1) one visit per annum. Varying land uses can affect maintenance frequency.

Some sites may be subjected to extreme sediment or trash loads, requiring more frequent maintenance visits. This is the reason for detailed notes of maintenance actions per unit, helping the VAR/Maintenance contractor and Owner predict future maintenance frequencies, reflecting individual site conditions.

Owners must promptly notify the VAR/Maintenance contractor of any damage to the plant(s), which constitute(s) an integral part of the biofiltration technology. Owners should also advise other landscape or maintenance contractors to leave all maintenance of the FocalPoint® HPMBS to the VAR/Maintenance contractor (i.e. no pruning or fertilizing).

EXCLUSION OF SERVICES

It is the responsibility of the owner to provide adequate irrigation when necessary to the plant(s) in the FocalPoint® HPMBS.

Clean up due to major contamination such as oils, chemicals, toxic spills, etc. will result in additional costs and are not covered under the VAR/Maintenance contractor maintenance contract. Should a major contamination event occur, the Owner must block off the outlet pipe of the FocalPoint® (where the cleaned runoff drains to, such as drop-inlet) and block off the point where water enters of the FocalPoint® HPMBS. The VAR/Maintenance contractor should be informed immediately.

MAINTENANCE VISIT SUMMARY

Each maintenance visit consists of the following simple tasks (detailed instructions below).

1. Inspection of FocalPoint® HPMBS and surrounding area
2. Removal of debris, trash and mulch
3. Mulch replacement
4. Plant health evaluation (including measurements) and pruning or replacement as necessary
5. Clean area around FocalPoint® HPMBS
6. Complete paperwork, including date stamped photos of the tasks listed above.

MAINTENANCE TOOLS, SAFETY EQUIPMENT AND SUPPLIES

Ideal tools include: camera, bucket, shovel, broom, pruners, hoe/rake, and tape measure. Appropriate Personal Protective Equipment (PPE) should be used in accordance with local or company procedures. This may include impervious gloves where the type of trash is unknown, high visibility clothing and barricades when working in close proximity to traffic and also safety hats and shoes.

MAINTENANCE VISIT PROCEDURE

Inspection of FocalPoint® HPMBS and surrounding area

Record individual unit before maintenance with photograph (numbered). Record on Maintenance Report (see example in this document) the following:

- Standing Water yes | no
- Is Bypass Inlet Clear? yes | no
- Damage to HPMBS System yes | no
- to Overflow conveyance yes | no

Removal of Silt / Sediment / Clay

Dig out silt (if any) and mulch and remove trash & foreign items.

- Silt / Clay Found? yes | no
- Cups / Bags Found? yes | no
- Leaves? yes | no
- Volume of material removed _____ (volume or weight)

Removal of debris, trash and mulch

After removal of mulch and debris, measure distance from the top of the FocalPoint® HPMBS engineered media soil to the flow line elevation of the adjacent overflow conveyance. If this distance is greater than that specified on the plans (typ. 6" - 12"), add media (not top soil or other) to recharge to the distance specified.

- Distance to media surface to flow line of overflow conveyance (inches) _____
- # of Buckets of Media Added _____

Mulch Replacement

Most maintenance visits require only replacement mulch (if utilized) which must be, aged, double shredded hardwood mulch with fines removed. For smaller projects, one cubic foot of mulch will cover four square feet of biofiltration bed, and for larger projects, one cubic yard of mulch will cover 108 square feet of biofiltration bed. Some visits may require additional FocalPoint® HPMBS engineered soil media available from the VAR/Contractor.

- Add double shredded, aged hardwood mulch which has been screened to remove fines, evenly across the entire biofiltration media bed to a depth of 3".
- Clean accumulated sediment from energy dissipation system at the inlet to the FocalPoint® HPMBS to allow for entry of trash during a storm event.

Plant health evaluation and pruning or replacement as necessary

Examine the plant's health and replace if dead or dying.
Prune as necessary to encourage growth in the correct directions

- Height above Grate (feet) _____
- Width at Widest point (feet) _____
- Health alive | dead
- Damage to Plant yes | no

Clean area around FocalPoint® HPMBS

- Clean area around unit and remove all refuse to be disposed of appropriately.

Complete paperwork

- Deliver Maintenance Report and photographs as appropriate.
- Some jurisdictions may require submission of maintenance reports in accordance with approvals.
- It is the responsibility of the Owner to comply with local regulations.

FocalPoint Warranty

Seller warrants goods sold hereunder against defects in materials and workmanship only, for a period of (1) year from date the Seller activates the system into service. Seller makes no other warranties, express or implied.

Seller's liability hereunder shall be conditioned upon the Buyer's installation, maintenance, and service of the goods in strict compliance with the written instructions and specifications provided by the Seller. Any deviation from Seller's instructions and specifications or any abuse or neglect shall void warranties.

In the event of any claim upon Seller's warranty, the burden shall be upon the Buyer to prove strict compliance with all instructions and specifications provided by the Seller.

Seller's liability hereunder shall be limited only to the cost or replacement of the goods. Buyer agrees that Seller shall not be liable for any consequential losses arising from the purchase, installation, and/or use of the goods.

Maintenance Checklist

Element	Problem	What To Check	Should Exist	Action
Inlet	Excessive sediment or trash accumulation	Accumulation of sediment or trash impair free flow of water into FocalPoint	Inlet free of obstructions allowing free flow into FocalPoint System	Sediments or trash should be removed
Mulch Cover	Trash and floatable debris accumulation	Excessive trash or debris accumulation.	Minimal trash or other debris on mulch cover	Trash and debris should be removed and mulch cover raked level. Ensure that bark nugget
Mulch Cover	Ponding of water on mulch cover	Ponding in unit could be indicative of clogging due to excessive fine sediment accumulation or spill of petroleum oils	Stormwater should drain freely and evenly over mulch cover.	Contact VAR for advice.
Plants	Plants not growing, or in poor condition	Soil/mulch too wet, evidence of spill. Pest infestation. Vandalism to plants.	Plants should be healthy and pest free.	Contact VAR for advice.
Plants	Plant growth excessive	Plants should be appropriate to the species and location of FocalPoint		Trim/prune plants in accordance with typical landscaping and

APPENDIX J

CASE STUDIES

PROJECT: BELLE SHERMAN KENDALL LIBRARY

CLIENT: CITY OF HOUSTON

DATE: NOVEMBER 2010

Kendall Library

The new three-story Belle Sherman Kendall Library at 609 N. Eldridge not only replaces the existing Bell Sherman Kendall Library on Memorial, but it also serves as a community center, complete with a classroom, after school and summer recreational programs, and a fully equipped half-gym. The new Kendall Library will also acquire a LEED® Silver Certification. Contributing to that certification is an underground water harvesting system which is fed by a series of bioswales that that is then used to irrigate the surrounding landscape.

Architect
English + Associates Architects
Houston, TX

Civil Engineer
Othon Engineering
Houston, TX

Landscape Architect
Asakura Robinson
Houston, TX

Installer
Construction EcoServices
Houston, TX


BEFORE: Slow Flow Engineered Media Clogged Bioretention System


AFTER: FocalPoint Biofiltration System eliminates sub surface clogging

LOW IMPACT DEVELOPMENT

As an alternative to traditional parking where the parking spaces slope away from head-in parking medians and toward a series of drive lane drains and catch basins, the Kendall parking spaces were graded toward the head-in parking medians. The medians are comprised of two 100 foot long by 12 foot wide bio-swales which receive run-off from the surrounding parking lot, where an engineered soil matrix was placed on the entire surface area of each swale to filter hydrocarbons and TSS found in storm water runoff prior to being stored in a 30,000 gallon rainwater harvesting system which are directly infiltrated without the need for inlets, and located beneath the swales where the stored water awaits reuse for landscape irrigation.

LESSONS LEARNED

Within six months of the completion of the bioswales, it was learned that high organic content in the soils had clogged the geotextile fabric separating the soils from the underdrain/storage system drastically reducing flow and backing water up into the parking lot to a depth that was deemed intolerable by the library and it's clients. Construction related issues were also suspected of reducing infiltration in the bioswale. The only option appeared to be to completely tear out each of the bioswales and reconstruct them using less organic content in the mix and improved construction oversight in hopes of preventing similar problems in the future. When Construction EcoServices (a Convergent Water Technologies VAR) became involved, the FocalPoint Biofiltration System was presented as an alternative design that would not only solve the problem definitively, but save thousands of dollars in redesign and construction work.

FOCALPOINT BIOFILTRATION SYSTEM

The FocalPoint Biofiltration System is a combination of a High Performance, flat pipe underdrain, a bridging mesh that is clog proof, bridging stone, and an advanced high performance biofiltration media that flows at a rate of over 100" per hour. What this unique combination of parts creates is a system that provides unsurpassed water quality and drainage characteristics. The FocalPoint was able to meet the needs at Kendall Library in 70SF what the traditional bioswale unsuccessfully attempted to do in 1200 SF. With a simple retrofit of the two swales, placing the FocalPoint at the lowest elevation in each, Construction EcoServices was able to solve Kendall Library's drainage problem with a simple, quick, cost-effective retrofit.

FocalPoint
BIOFILTRATION SYSTEMS

CONVERGENT
WATER TECHNOLOGIES

(p) 800.711.5428 | www.convergenetwater.com

PROJECT: GREEN ROADWAY

CLIENT: HARRIS COUNTY PUBLIC INFRASTRUCTURE DEPARTMENT

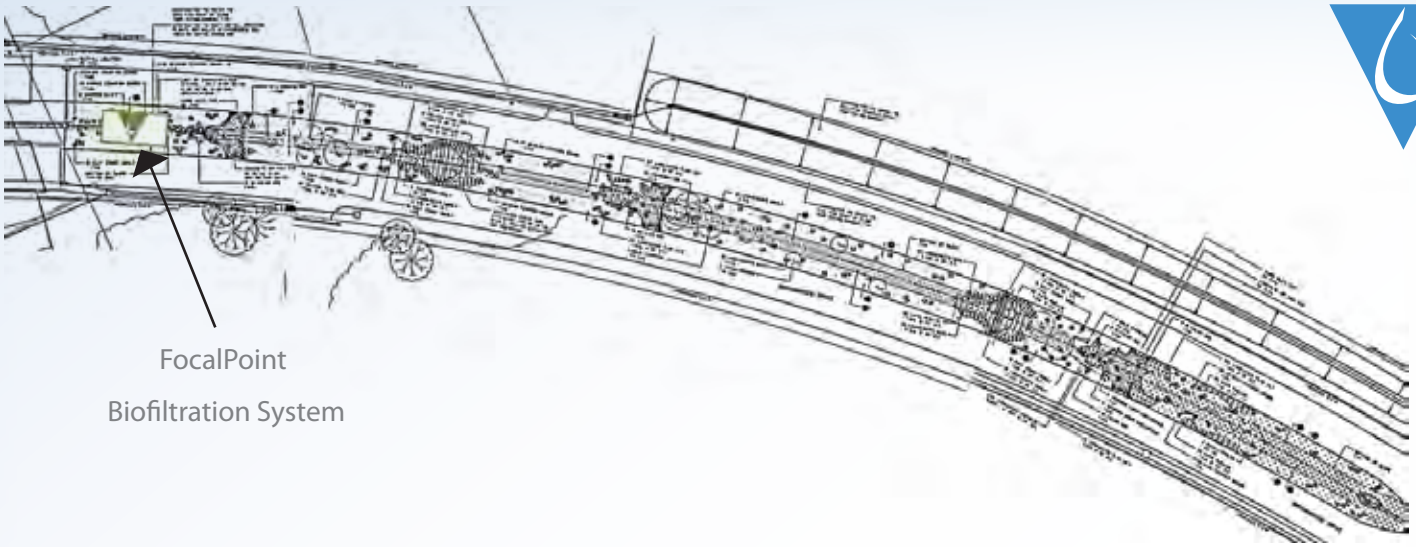
DATE COMPLETED: JUNE 2012

PROJECT BACKGROUND

Birnamwood Drive is located in northern Harris County, east of Spring, Texas. The existing roadway runs north/south between Fern Hill Drive and intersects Cypresswood Drive. The new section of Birnamwood is approximately 0.68 miles in length and extends from Fern Hill Drive north to Spring Creek Drive. This project is the first roadway project in the Houston area to implement Low Impact Development (LID) techniques and is viewed by Harris County as a stepping stone to implementing LID as its default roadway design approach throughout the County.

Design Team
Landscape Architect
Knudson Landscape Architecture
Civil Engineer
Klotz & Associates

Construction Team
Installer
Construction EcoServices
Landscape Contractor
Bio Landscaping



During the design and consultation phase of Birnamwood Drive, it was important to consider all possible problems that might arise in the construction and maintenance of the roadway. Utilizing a dry swale as the primary conveyance feature, the design team explored the various biofiltration medias available for filtering vegetated pollutants.

Option 1: Typical Low Flow Media

The design team first examined typical engineered biofiltration medias that have a flow rate of less than 5" per hour and are relatively inexpensive to make and supply. However, due to the low flow rate a designer is required to use almost 900 SF of bioretention surface area per acre of impervious drainage surface. This requires a lot of space, and extensive costs related to excavation, stone, underdrain, and media. The upkeep of these larger systems are also much more difficult due to the roadway maintenance organization's sensitivity to specialized maintenance needs.

Option 2: High Flow Media

High performance media design which offers a flow rate of 100" per hour was a better answer. For the needs of Birnamwood Drive, only 70 SF of infiltration bed surface area per acre treated was required. The small footprint, allowed the design team to use two small Biofiltration systems, one in each of the two swales in the center median of the roadway, leaving everything upstream of the systems to be designed with traditional landscaping and maintained without LID related considerations. Lower construction and maintenance costs, along with improved constructability made the high flow media design the logical choice for Birnamwood Drive.

FocalPoint Biofiltration System

The FocalPoint Biofiltration System is a combination of a high performance flat pipe underdrain, a bridging mesh that is clog proof, bridging stone, and a high performance biofiltration media that flows at a rate of over 100" per hour. What this unique combination of parts creates is a system that provides unsurpassed water quality and drainage characteristics. For the purpose of Birnamwood Drive, FocalPoint was able to do in 2,000 SF what the traditional bioswale design would have required a full acre of biofiltration surface area to accomplish.

Low Impact Development

Several Low Impact Development practices were utilized within the Birnamwood Drive depressed center median, including native landscaping, check dams, and the FocalPoint Biofiltration systems adjacent to each of the extreme event outfalls. The plantings were chosen based on their ability to maximize the filtration of larger debris particles, to adapt to the conditions for this area, and to minimize maintenance. The earthen check dams were designed to slow down the velocity of water flowing through the swale and extend time of concentration while the FocalPoint Biofiltration System was in place to filter contaminates out of the water prior to discharge into Spring Creek. In extreme rainfall events, runoff not filtered through the FocalPoint Biofiltration System is designed to bypass through an extreme event overflow directly to the outfall. The detention capacity of the center swale which can manage the 100 year storm, eliminated the need for offsite detention, an important but often uncalculated cost savings on LID-based roadways.

Case Study

Reveille United Methodist Church

Location: *Richmond, VA*
Engineer: *Hulcher & Associates, Inc.*
Architect: *Jimmy Shepherd*
www.shepherdlp.com
Contractor: *Taylor & Parrish*

The Problem

While constructing a major addition to the historic property (original buildings constructed around 1720), two critical goals were identified:

1) Mitigating the impacts to the historic gardens
2) Minimizing total costs

The two large concrete boxes specified to bring the site into compliance with newer stormwater quality requirements were seen as a hindrance to both goals. The concrete structures were disruptive to the gardens, and with a total installed price of nearly $50,000, they consumed significant resources.

The Solution

Led by efforts from landscape architect Jimmy Shepherd (www.shepherdlp.com), the two larger concrete systems were replaced with four smaller biofiltration systems called FocalPoint. These high-performance systems are engineered to be roughly 1/15th the size of traditional biofiltration, which allowed them to be easily integrated into the facility. What's more, they softened the appearance of the stormwater treatment BMP's and reduced total in-place costs by more than $25,000.

ACF Environmental
2831 Cardwell Road
Richmond, VA 23234
800-448-3636
www.acfenvironmental.com

CASE STUDY
STORMWATER MANAGEMENT

REVEILLE UNITED METHODIST CHURCH FOCAL POINT

Richmond, VA

Engineer: Hulcher & Associates, Inc.
Architect: Jimmy Shepherd
www.shepherdlp.com
Contractor: Taylor & Parrish

THE PROBLEM:

While constructing a major addition to the historic property (original buildings constructed around 1720), two critical goals were identified:

1) Mitigating the impacts to the historic gardens
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ACF ENVIRONMENTAL
LET'S GET IT DONE

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