Stormwater Management Solutions

High Performance Modular Biofiltration Systems: A "2nd Generation" Solution

W. Scott Gorneau, P.E., CPSWQ
sgorneau@acf-cwt.com
207-831-2795

Convergent + VAR = A Strategic Partnership

- The combination of Convergent technologies and the solutions oriented services of our VARs, provides engineers with a complete menu of high performance options from pretreatment to primary treatment thru to detention or infiltration.

=

High Performance, Cost Effective, Easy to Maintain Stormwater Management Systems

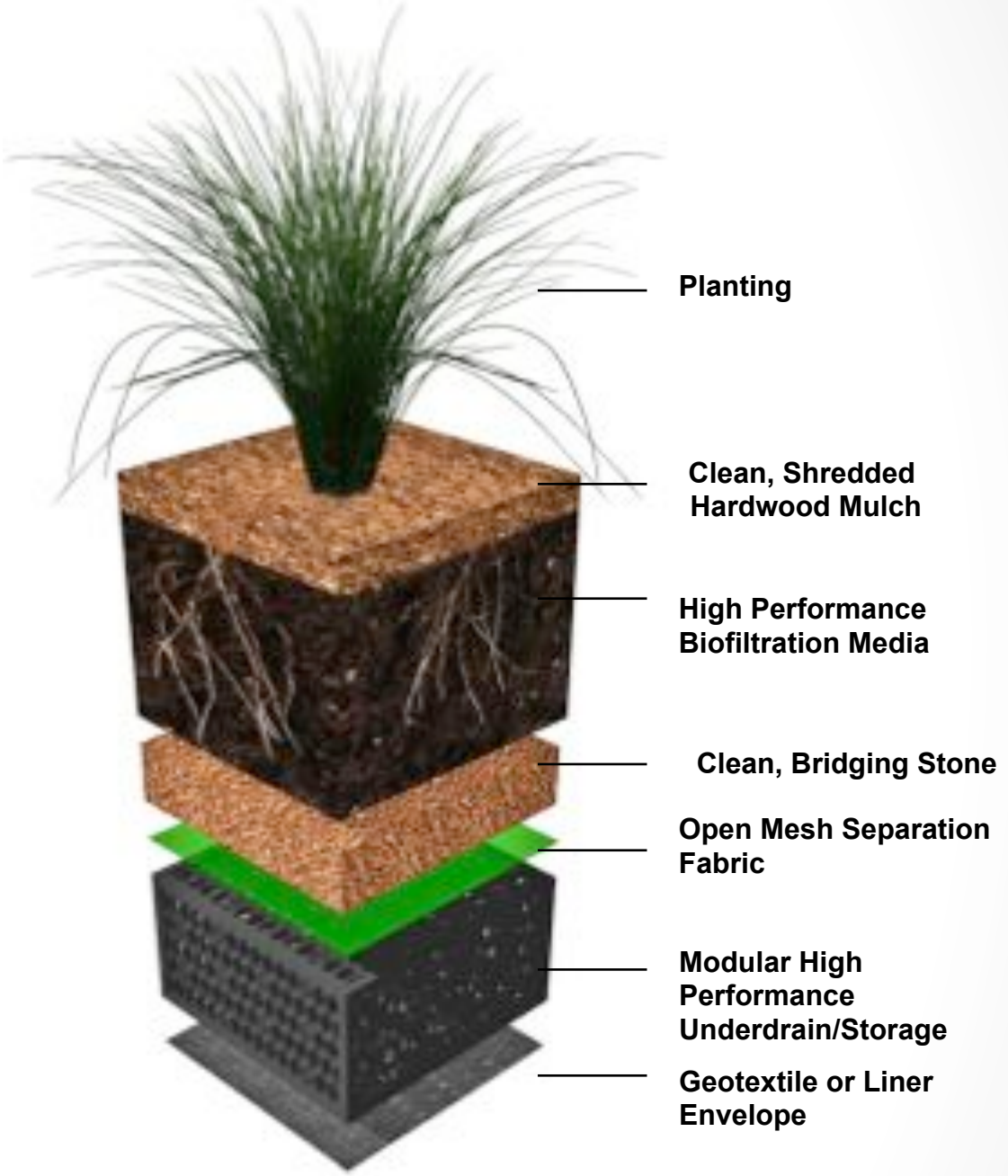
CONVERGENT WATER TECHNOLOGIES

What is the HPMBS?

HIGH PERFORMANCE MODULAR BIOFILTRATION SYSTEM

(HPMBS)

Filters Stormwater Using the Physical, Chemical and Biological Mechanisms of a Soil, Plant and Microbe Complex to Remove Pollutants Typically Found in Urban Runoff.



CONVERGENT WATER TECHNOLOGIES

Next Generation Bioretention

High Performance Modular System

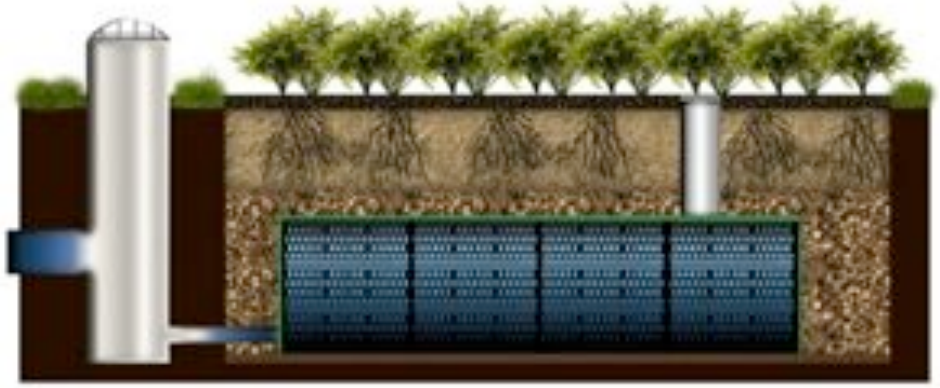
PRIMARY GOALS

- Reduce Peak Flow
- Reduce Pollutant Load
- Reduced Infrastructure Cost
- Reduced Overall Maintenance Cost

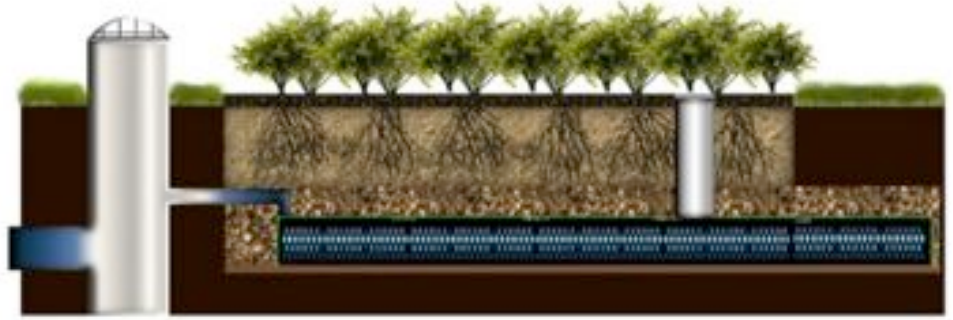
SECONDARY GOALS

- Public Eduction
- Economic Stimulus
- Green Cities
- Sustainability

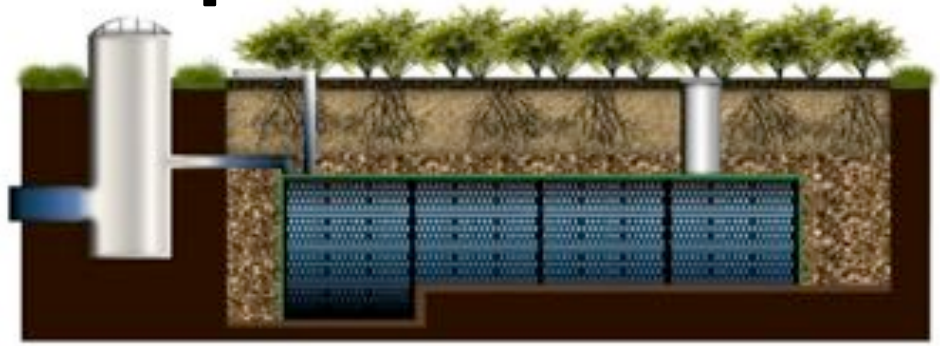
Underdrain MPMBS gives designers maximum flexibility in meeting both water quality and water volume requirements.



Expanded Detention



Expanded Infiltration



Rain Water Harvesting

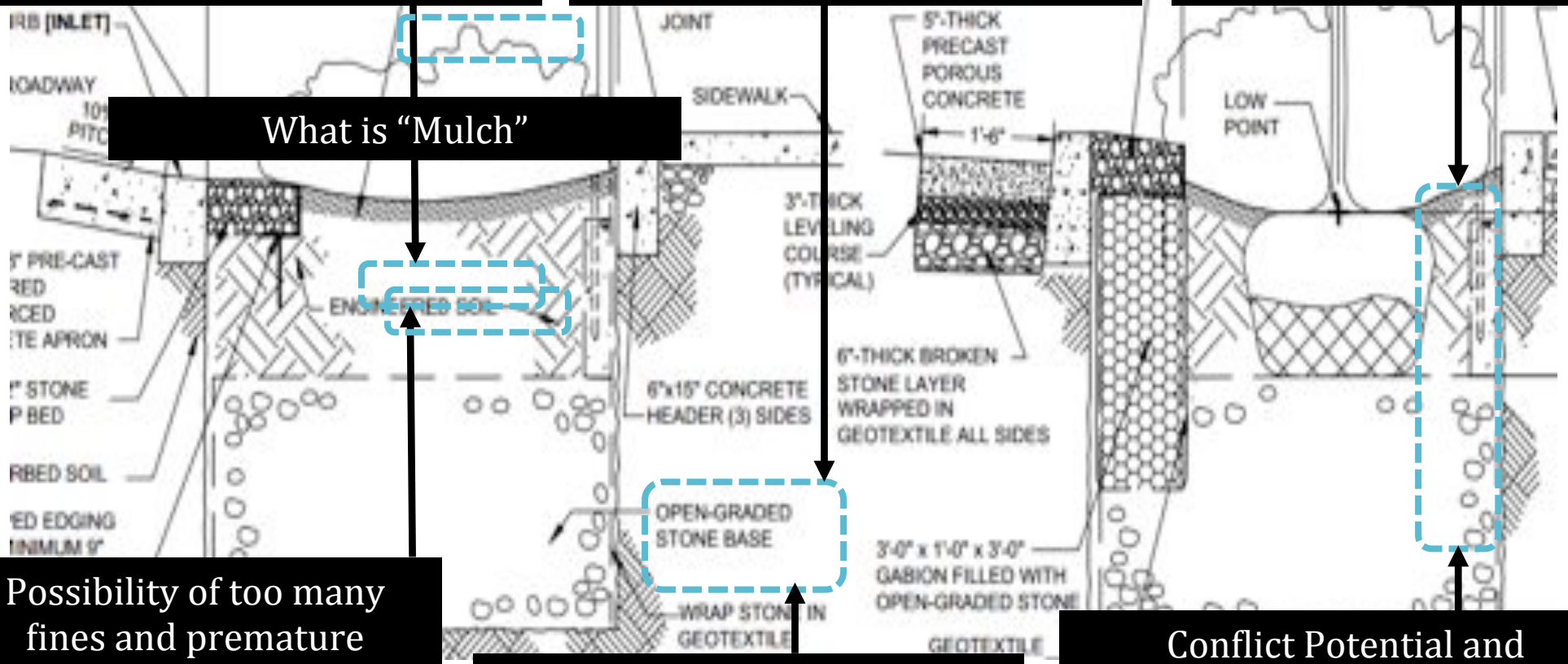
Current Bioretention Section Observations

What is “Engineered Soil”? Is this material consistent from one system to the next.

There is fabric between the soil and stone.

4’-6” depth must be a challenge with existing utilities in the roadway and require a trench box

What is “Mulch”



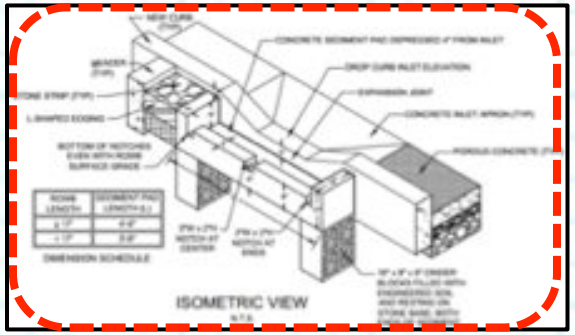
Possibility of too many fines and premature clogging. Unknown media treatment efficiencies

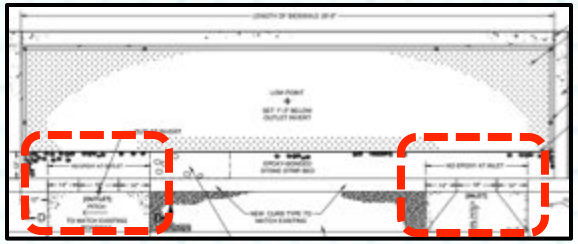
High likelihood of “blinding” fabric.

Conflict Potential and Excavation difficulty – could the system be shallower?

Current Entry Points:

Challenges with Pretreatment are capture of trash and gross pollutants.





Pretreatment Enhancement / Improvements:

- Collection of trash and debris entering planting area/bump out.
- Debris drains and dries between storm events.
- Easy access and simple maintenance.
- Low capital cost.
- Perfect for urban ROW locations.

3” La… Ha…

- Act… me… sec… pol…
- Re… of … bul… ma…

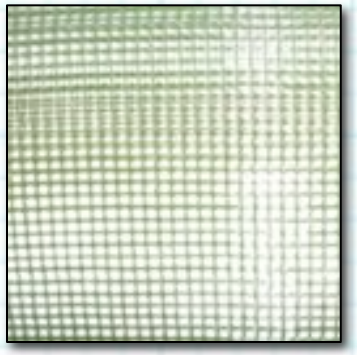
18” High Performance Media:

- Flows at 100” Per Hour
- Flows Faster With Age as Root System Grows
- Resistant to Clogging

Pollutant Removal:

- TSS = > 80%
- Nitrogen = > 40%
- Phosphorus = > 50%

6” Bridging Stone & Separation Layer:

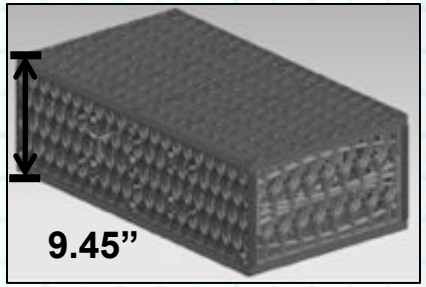


Clean Stone & Micro-Mesh Replace Traditional Geotextile Layer

No Geotextile = No Clogging

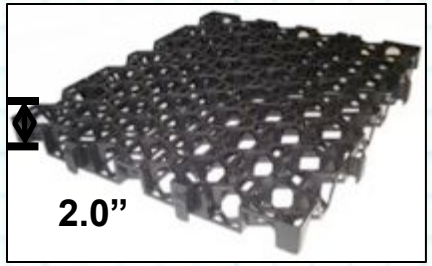
High Performance Underdrain:

9.45” Modular Tank, or “Flat Pipe” w/95% Open Surface Collects Water Efficiently.



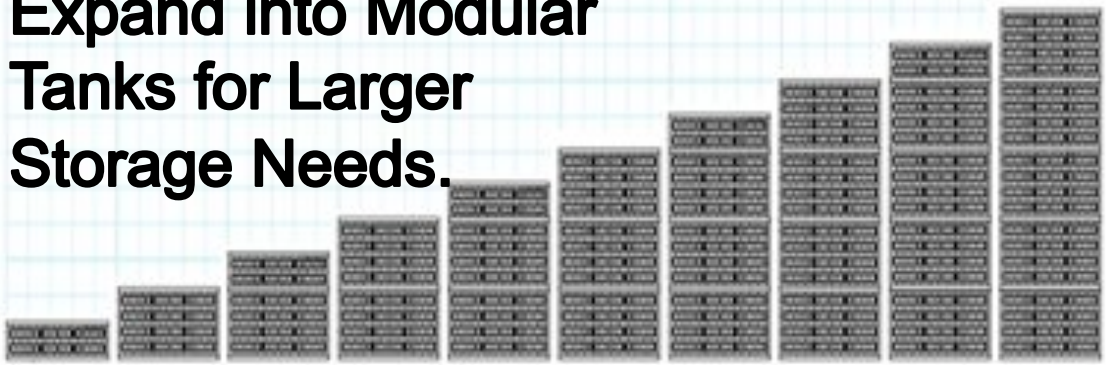
System Depth 36

2” Low-Profile Panel Addresses Shallow Applications.



System Depth 29

Expand into Modular Tanks for Larger Storage Needs.



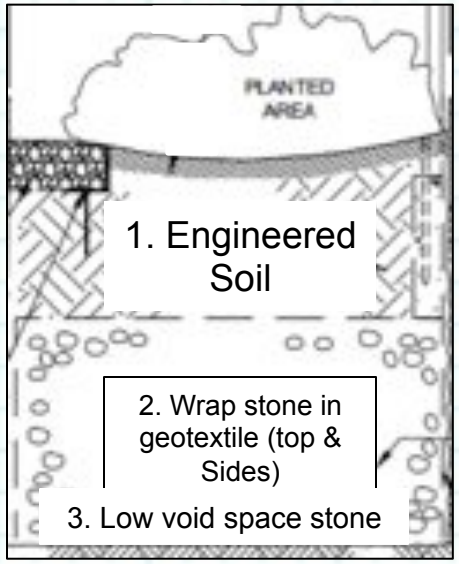
Quality Assurance/ Quality Control (QA/QC):

- All Components of the HPMBS System are sold as a bundle to provide raw material quality control
- Media Certification
- 1st Yr Maintenance included along with Performance Guarantee backed by in-situ hydraulic test

Bioswale Profile

Long Term Challenges:

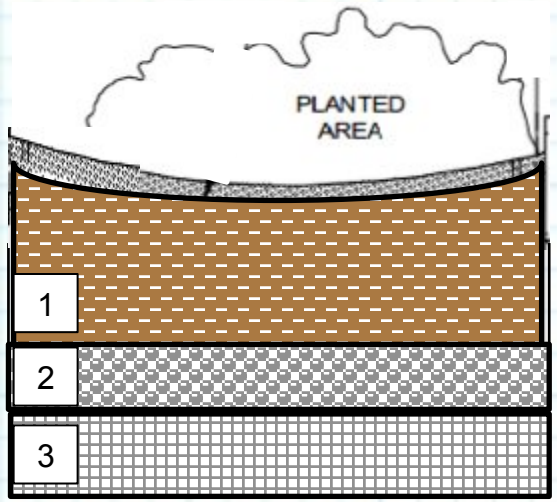
1. MEDIA = Standard (low-flow) 2” to 5” per hr, lack of QA/QC = Inconsistent mix
2. Geotextile Fabric Layer – high likelihood of blinding
3. Minimal void space in stone/underdrain layer

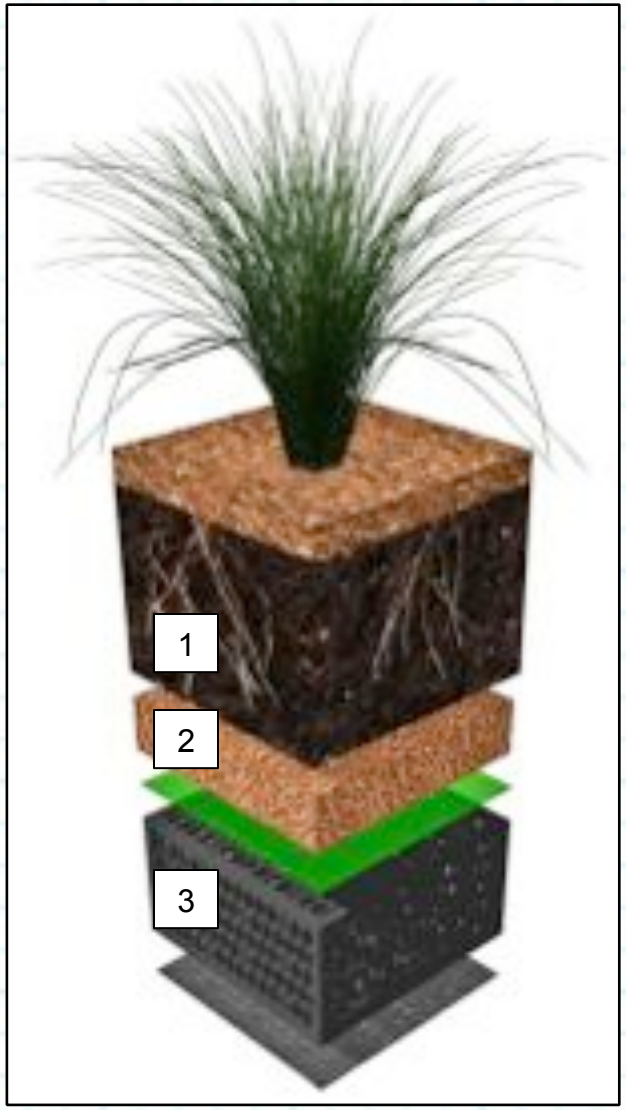


Section A-A

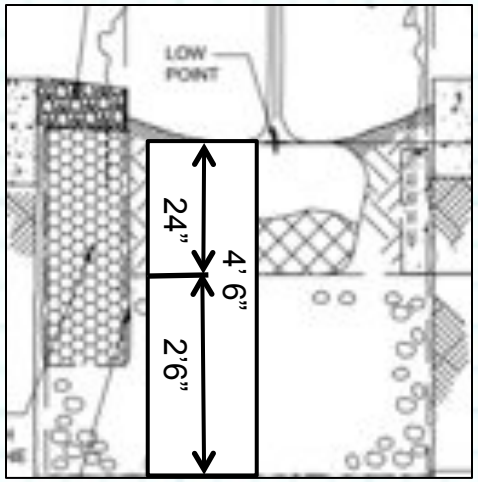
PROPOSED HIGH PERFORMANCE MODULAR BIOFILTRATION SYSTEM Enhancement / Improvements:

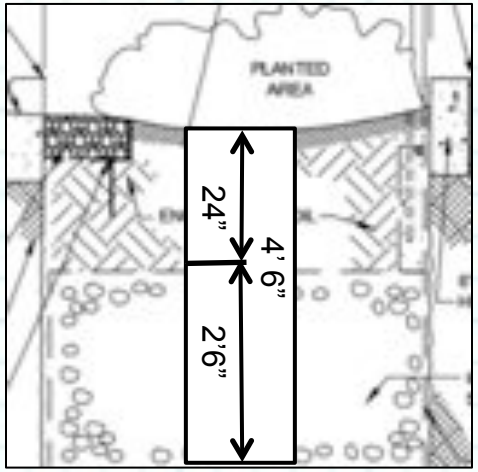
1. High Performance Media: 100” per hour increases efficiency, premixed and certified
2. Clog-proof separation fabric and stone replaces geotextile
3. 95% void modular under-drain replaces stone and pipe (expandable if needed)



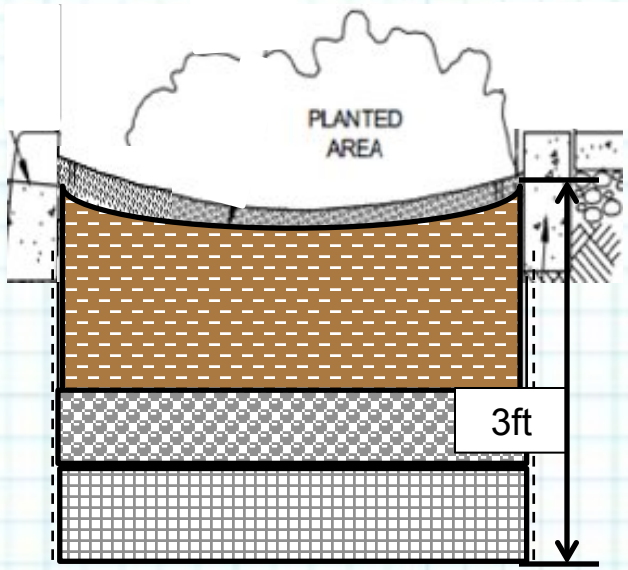


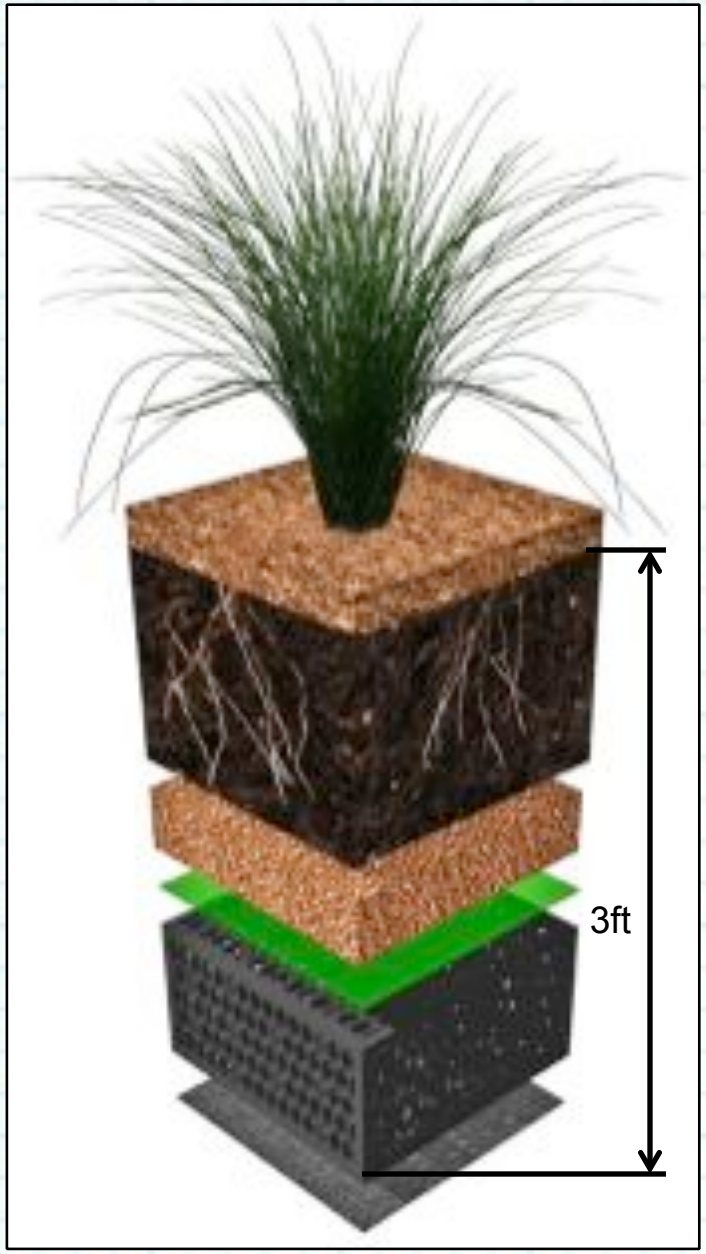
4’-6” Required Depth:
Challenge with existing utilities in the roadway and requires a trench box





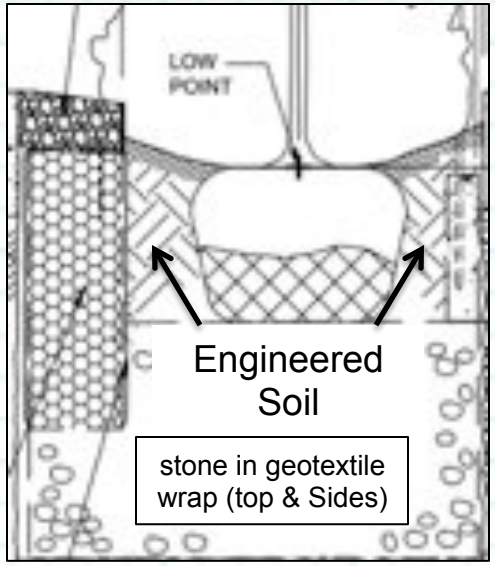
PROPOSED HIGH PERFORMANCE MODULAR BIOFILTRATION SYSTEM
Enhancement / Improvements:
SYSTEM ONLY REQURES 3 ft TOTAL DEPTH.

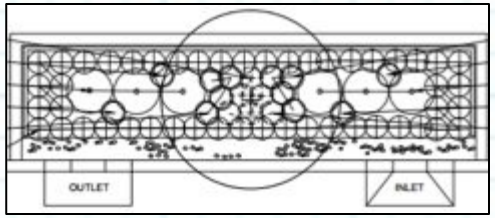




Current Tree Planting Detail Challenges and Limitations:

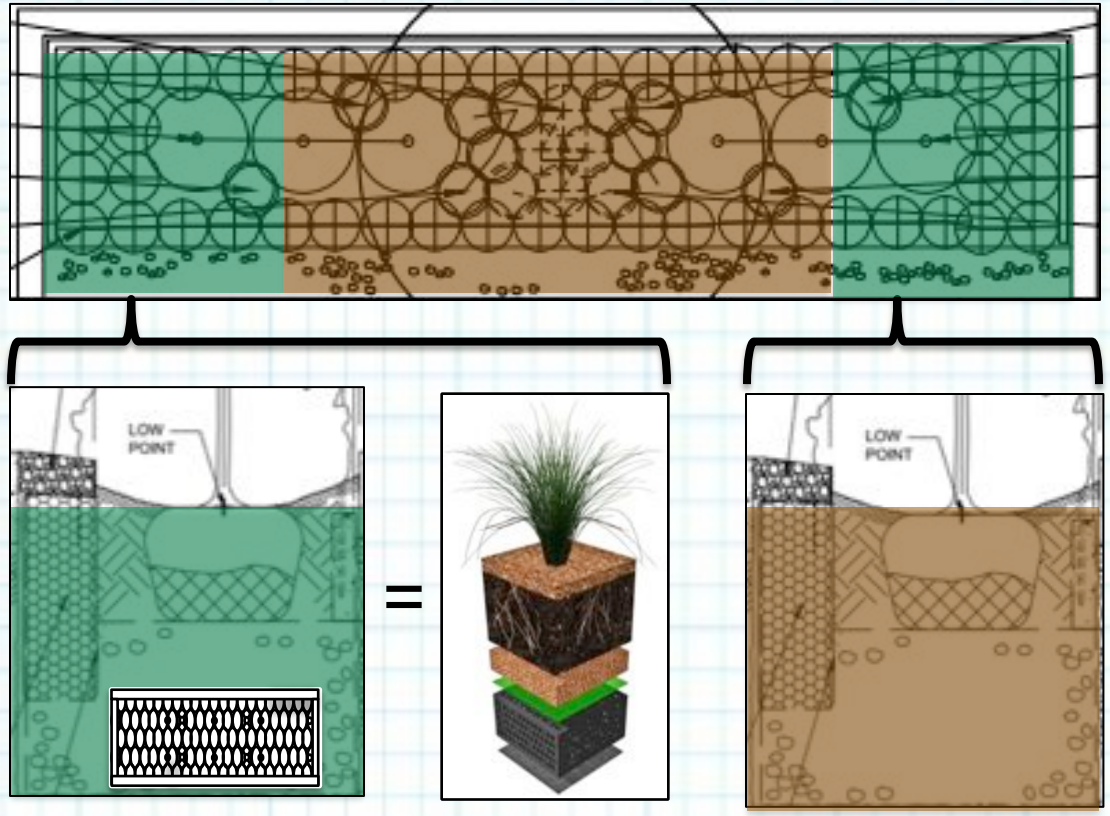
Plant Health - Establishing and maintaining healthy tree life in 24 inches of standard media (engineered soil) over the life of the bioswale.





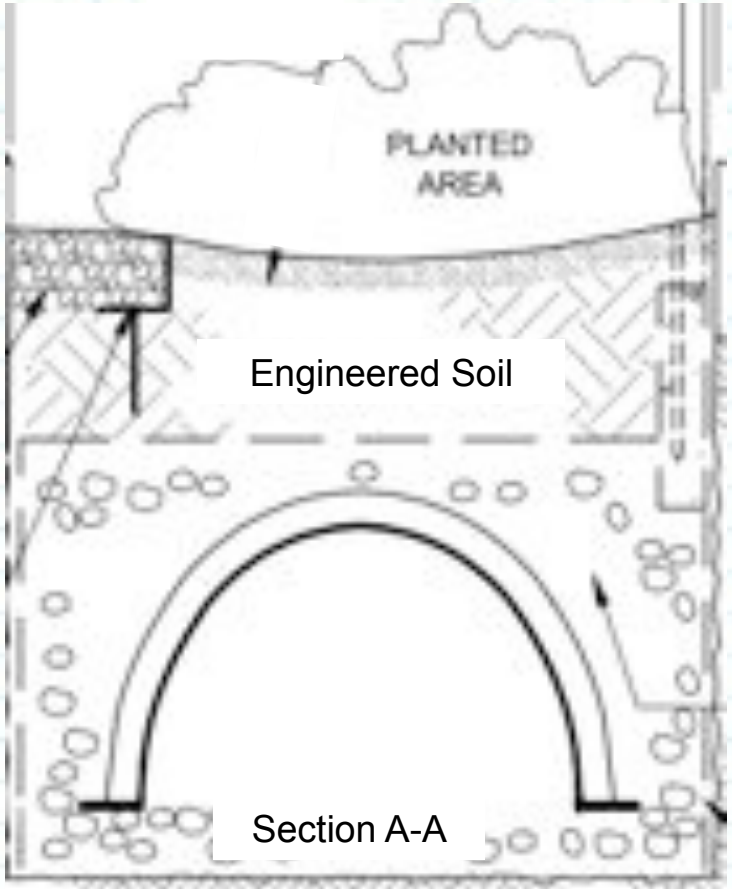
PROPOSED HIGH PERFORMANCE MODULAR BIOFILTRATION SYSTEM Enhancement / Improvements:

1. Plant grass plugs/shrubs/perennials in high flow media that are drought tolerant but can also handle heavy inundation.
2. Plant trees in deeper planting soil area (adjacent to media), rich in organic content for tree/plants to survive and thrive.



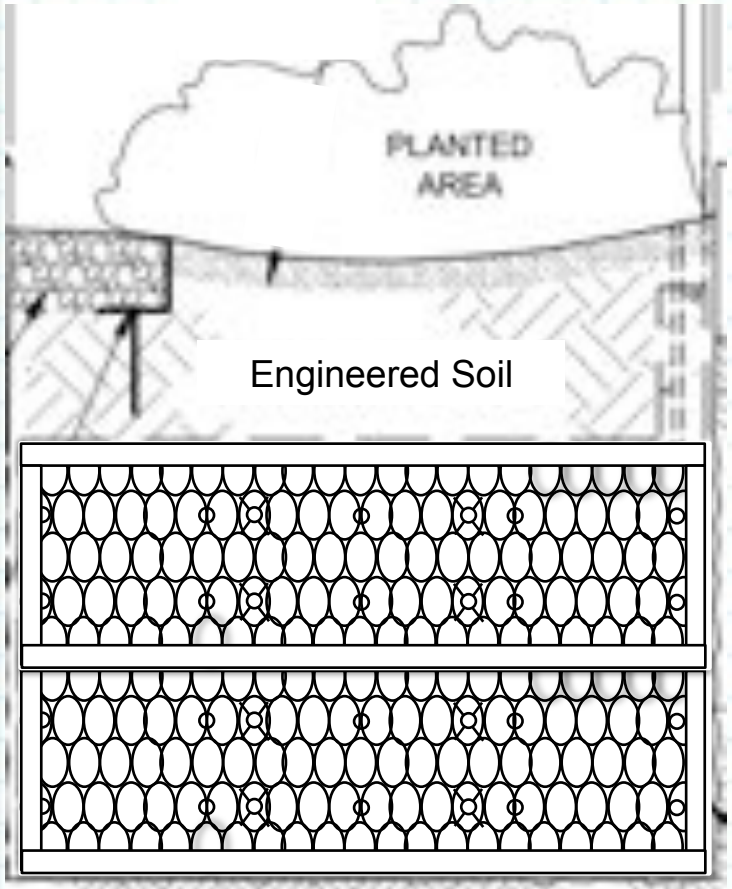
Current BIOSWALE WITH STORMWATER CHAMBER Detail Challenges and Limitations:

- Irregular shape requires low void space backfill component.
- Limited arch chamber sizes limit design/ application flexibility.

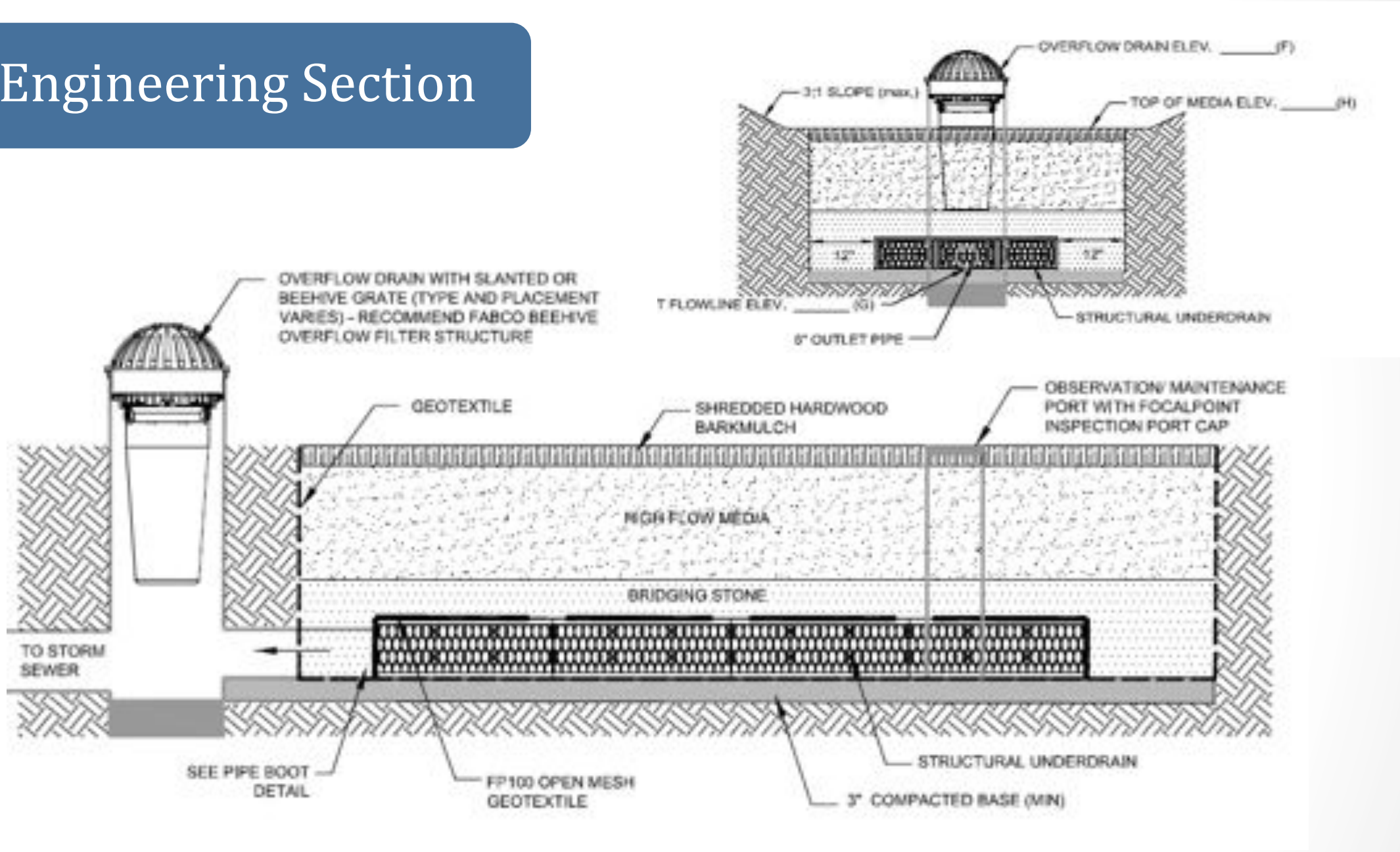


PROPOSED MODULAR PLASTIC STORAGE SYSTEM Enhancement / Improvements:

- Modular units can be used and placed in 9.5” increments for design/application flexility.
- “Square peg for square holes” design eliminates need for low void space baackfill.



Engineering Section



CONVERGENT WATER TECHNOLOGIES

HPMBS Installation

HPMBS Installation

Construction Sequencing

CONVERGENT WATER TECHNOLOGIES

Construction Sequencing

Performance Certification

- Post Contstruction verification of system performance.
- Infiltration rate testing – verification of 100”/hr flow rate


HYDRAULIC CONDUCTIVITY REPORT

fabco

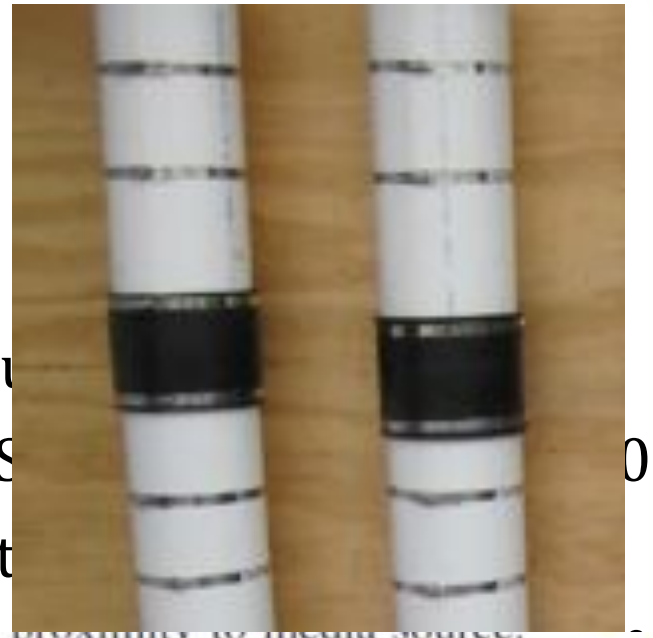
HPMBS Maintenance

- Simple Maintenance.
- Annual Removal and Replacement of Mulch – some sites may require more.
- Cleaning of stone energy apron.
- Plant health evaluation.
- Regular cleaning of overflow catch basin.
- Inspection Port in each unit to observe standing water in Rtank.
- First year or maintenance included in price of unit.
- Free Training to public works/ maintenance crew.

CONVERGENT WATER TECHNOLOGIES

Performance

- Media conveys runoff at 100 in/hr – i.e. high rate biofiltration **NOT** slow rate bioretention (subject to clogging)
- The scientific literature on which local governments base their bioretention standards clearly distinguishes what sort of pollutant removal efficiencies can be expected of any sand-based media and are within the general parameters of our media as well as their own.



Pollu

- TSS
- Tot
- Ni
- M
- Oi
- Ba

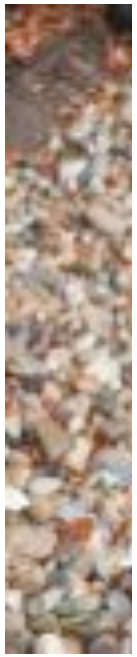
Water quality column studies by Hsieh and Davis (2005
have shown that bioretention media characteristics do not app
to play a significant role in the removal of particula
particulate-bound material (metals and some phosphorus),
oil/grease. The bioretention media, even media with a high in
tration rate, readily filters and removes all of these polluta

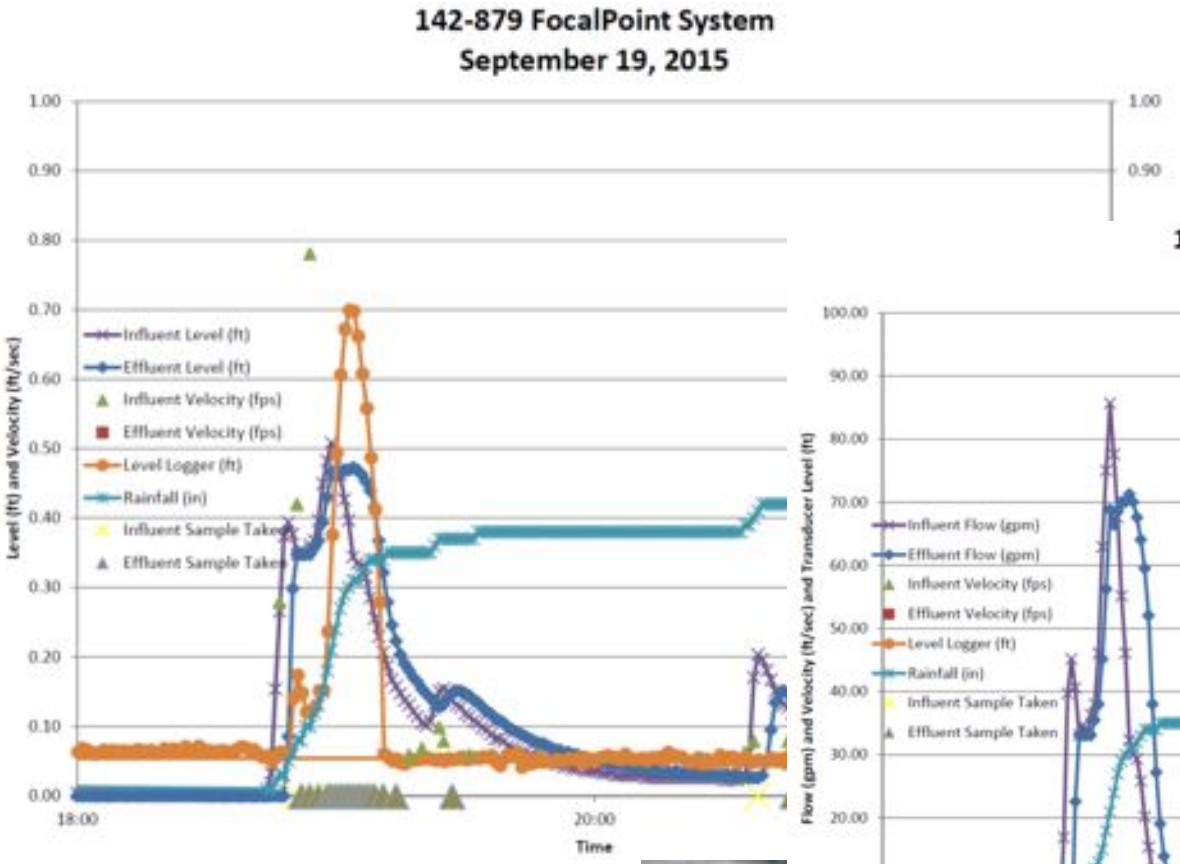
Davis et. al, Bioretention Technology: Overview of Current Practice and Future Needs, Journal of Enviornmental Engineering, 2009

CONVERGENT WATER TECHNOLOGIES

Performance

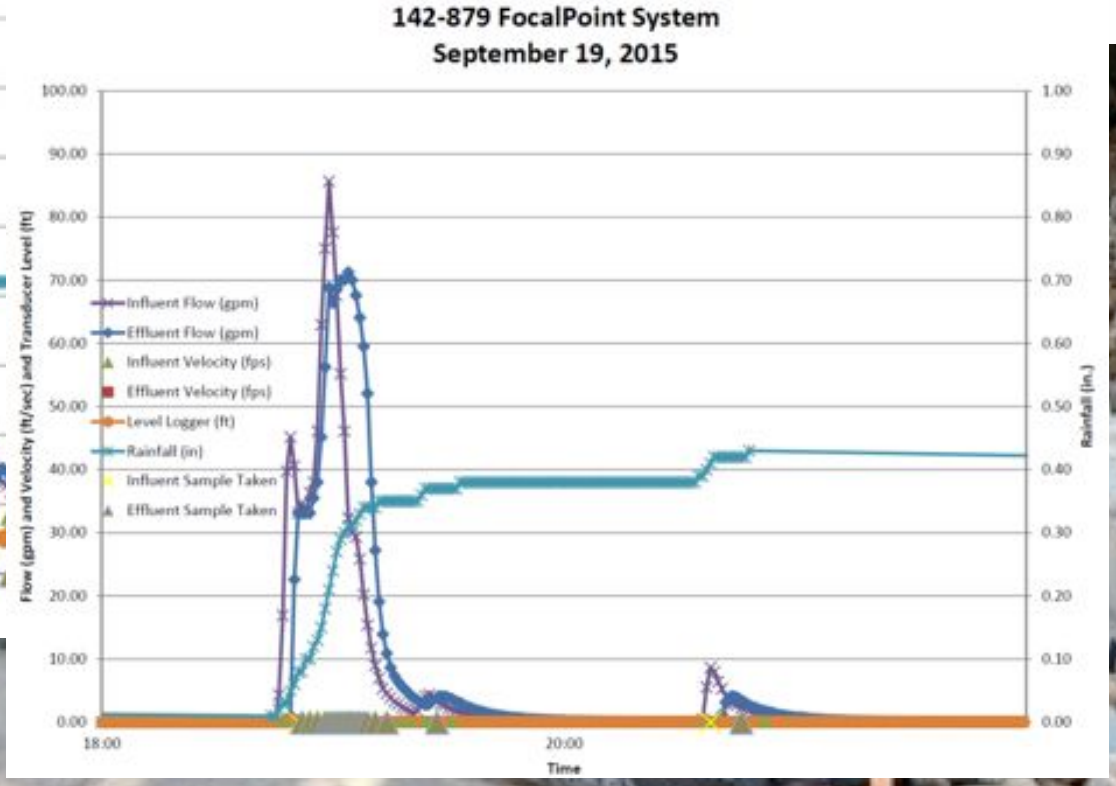
Performance

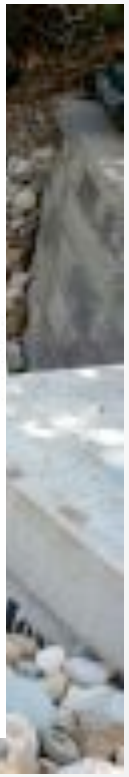




Removal:

0% (Influent 100-300





CONVERGENT WATER TECHNOLOGIES

Sizing

Required Elements

- The entire treatment system (including pretreatment) shall be sized to temporarily hold at least 75% of the WQ, prior to filtration.
- The filter media shall consist of a medium sand (meeting ASTM C-33 concrete sand). Media used for organic filters may consist of peat/sand mix or leaf compost. Peat shall be a reed-sedge horatic peat.
- Bioretention systems shall consist of the following treatment components: A four foot deep planting soil bed, a surface mulch layer, and a six inch deep surface ponding area. Soils shall meet the design criteria outlined in Appendix H.

Design Guidance

- The filter bed typically has a minimum depth of 18". The perimeter filter may have a minimum filter bed depth of 12".
- The filter area for sand and organic filters should be sized based on the principles of Darcy's Law. A coefficient of permeability (k) should be used as follows:

Sand:	3.5 ft/day (City of Austin 1988)
Peat:	2.0 ft/day (Galli 1990)
Leaf compost:	8.7 ft/day (Clayton and Schueler, 1996)
Bioretention Soil:	0.5 ft/day (Clayton and Schueler, 1996)

The required filter bed area is computed using the following equation:

$$A_f = \frac{WQ_v d_f}{k(h_f + d_f)t_f}$$

Where:

Af	=	Surface area of filter bed (ft2)
WQv	=	Water Quality Volume(cf)
df	=	Filter bed depth (ft)
k	=	Coefficient of permeability of filter media (ft/day)
hf	=	Average height of water above filter bed (ft)
tf	=	Design filter bed drain time (days) (1.67 days or 40 hours is recommended maximum t/for sand filters, two days for bioretention)

hours]

Sizing

Rain Gardens/Bioretention Areas	• 100%, if no underdrain or underdrain is above the water level of the WQv stored in the stone or soil media • 60%, if underdrain is below the water level of the WQv stored in the stone or soil media and drains in 24 to 48 hours • 30%, if underdrain is below the water level of the WQv stored in the stone or soil media and drains in less than 24 hours

Design Parameter	Criteria
Size (Area & Depth)	Based upon the design storage capacity and the following equation: $A = (WQv)/[(d)(P)+h]$, where • A = surface area of the ponding area of the rain garden (ft^2) • WQv = required water quality volume (ft^3) • d = depth of any amended soils (ft) • P = porosity of any amended soils (% void) • h = average height of water above the amended/in situ soils during WQv rain event (ft)

HPMBS Sizing

There are three primary variables we need to know to run a sizing comp:

- Tributary Area to HPMBS
- Treatment Depth (i.e. 0.5”, 1.0”?)
- Available Temporary Storage at 6” depth above HPMBS, 24 hr drain down time

I. The Larger the temporary storage volume available, the smaller the HPMBS footprint.
II. The smaller the temporary storage volume available, the larger the HPMBS footprint.
III. As such – the sizing is often an iterative process – with the most cost effective systems being those that have a large bowl of temporary storage around them.
IV. Filter bed ratio of 0.33 to 0.5% of the trib area.
V. Ponding volume above at least 25% of the WQV

Sizing

SITING

- Flow-through and infiltration stormwater planters should not receive drainage from impervious areas greater than 15,000 square feet.
- Infiltration planters should be located a minimum distance of ten feet from structures.
- To prevent erosion, splash rocks should be placed below downspouts or where stormwater enters the planter.

SIZING

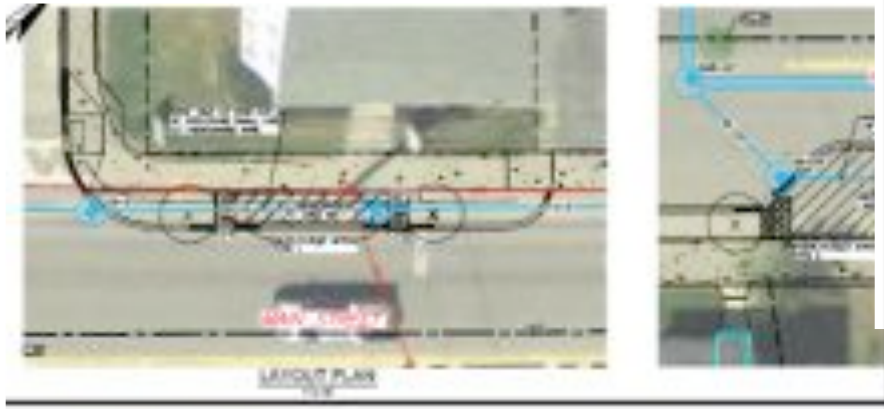
- Stormwater planters should be designed to pond water for less than 12 hours, with a maximum ponding depth of 12 inches.
- An overflow control should redirect high flows to the storm drain system or an alternative treatment facility.
- Generally, flow-though and infiltration planters should have a minimum width of 1.5 and 2.5 feet, respectively.

Municipal Retrofits

CSO\Green Infrastructure

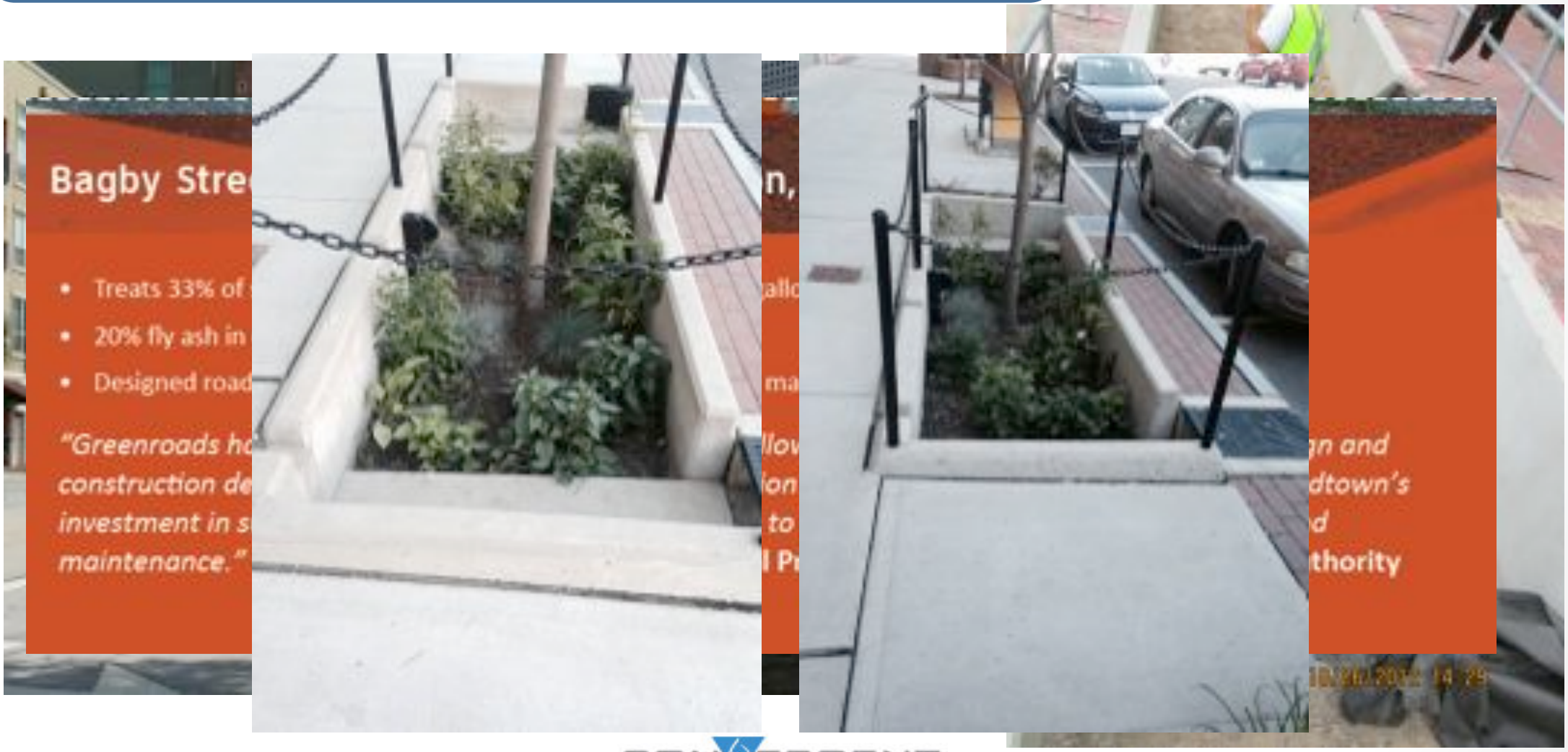
Main St Infrastructure Project, South Portland, ME

- Twelve (12) HPMBS.
- In esplanade behind curb.
- Public Works to maintain.



CONVERGENT WATER TECHNOLOGIES

Bagby Street Reconstruction Project
Houston, TX



CONVERGENT WATER TECHNOLOGIES

LID Development

LID Development

CONVERGENT WATER TECHNOLOGIES

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LID Development

CONVERGENT WATER TECHNOLOGIES

Integrated Infrastructure with HPMBS

Integrated Infrastructure with HPMBS

CONVERGENT WATER TECHNOLOGIES

Integrated Infrastructure: HPMBS HPMBS

CONVERGENT WATER TECHNOLOGIES

Challenging Site – Flexible Solution

Municipal Projects

Route One Infrastructure Project, Falmouth ME

- Sixteen (16) HPMBSs.
- In esplanade behind curb.
- Portland Water District and Falmouth Sanitary Sewer Dept – OK with HPMBSs installed over sewer and water mains.
- Public Works to maintain.

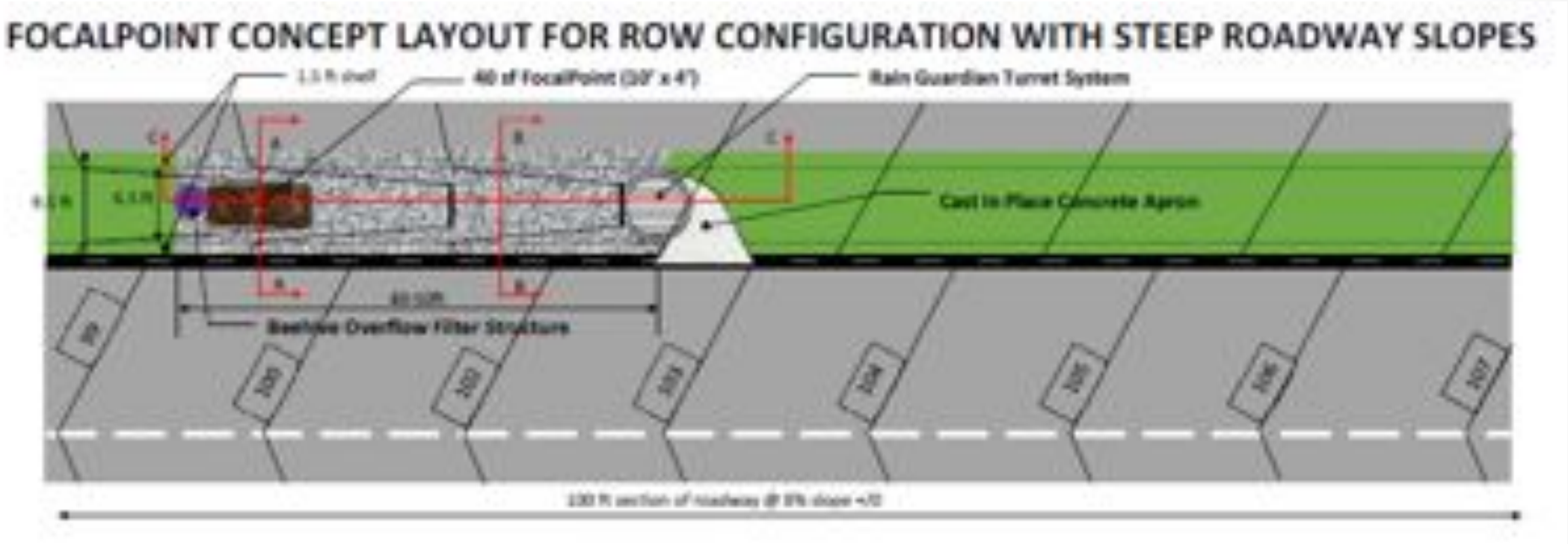
Focal point was a preferred choice over the structural types of treatment systems for a number of reasons:

Ease of maintenance. Public Works crews can perform the short term maintenance protocols, rather than having to subcontract the maintenance out to 'structure-specific' companies. Better accessibility on the road edges/above ground versus in the roadway in a confined space…….

Jay Reynolds, Public Works Director, Falmouth ME

CONVERGENT WATER TECHNOLOGIES

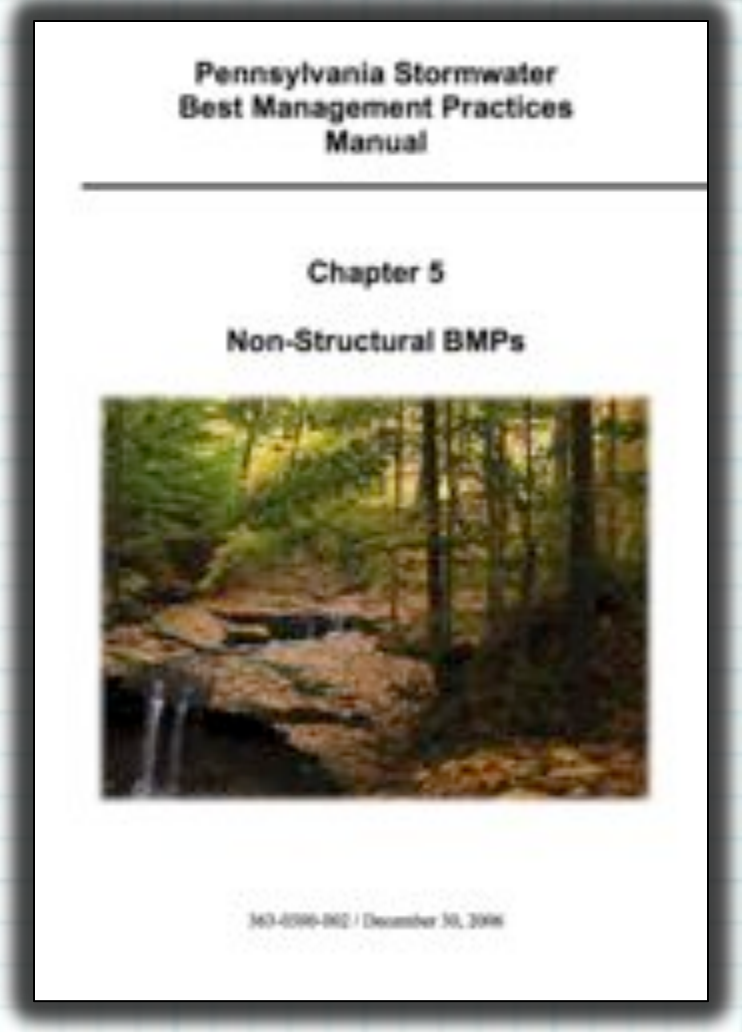
Sample Projects



The ACF products presented can be used to meet the criteria in Maryland's Stormwater Design Manual, including the more recent Environmental Site Design (ESD) requirements.

These same design concepts are often referred to as Low Impact Development (LID) and Green Infrastructure (GI).

HPMBS meets the basic requirements for Pa DEP Manual “Constructed Filter” concept.



Pennsylvania Stormwater
Best Management Practices
Manual

Chapter 5

Non-Structural BMPs

363-0300-002 / December 30, 2006

BMP 6.4.7: Constructed Filter

Filters are structures or excavated areas containing a layer of sand, compost, organic material, peat, or other filter media that reduce pollutant levels in stormwater runoff by filtering sediments, metals, hydrocarbons, and other pollutants.

Key Design Elements

- Follow Infiltration Systems Guidelines in Appendix C
- Drain down – should empty within the guidelines in Chapter 3
- Minimum permeability of filtration medium required
- Minimum depth of filtering medium = 12"
- Perforated pipes in stone, as required
- May be designed to collect and convey filtered runoff down-gradient
- May be designed to infiltrate
- Pretreatment for debris and sediment may be needed
- Should be sized for drainage area
- Regular inspection and maintenance required for continued functioning
- Positive overflow is needed

Potential Applications

Residential: Limited
Commercial: Yes
Ultra Urban: Yes
Industrial: Yes
Retrofit: Yes
Highway/Road: Yes

Stormwater Functions

Volume Reduction:	Low-High*
Recharge:	Low-High*
Peak Rate Control:	Low-High*
Water Quality:	High

* Depends on if infiltration is used

Water Quality Functions

TSS: 85%
TP: 85%
NOX: 50%

HPMBS Scalable Biofiltration System Application Concepts:

- ***Traditional SWM***
- ***Green Infrastructure***
- ***Low Impact Development***

Plant recommendations are available from local nurseries as well as the manufacturer

Focalpoint Biofiltration System Plant recommendations

Intensive / Semi-Intensive / Extensive

Intensive Category Plants

ensive = Higher end plants - more decorative, may need more main

Agastache 'Purple Haze' Hyseop

Deschampsia cespitosa 'Goldtau' Tufted hairgrass

Eupatorium dubium 'Little Joe' Joe Pye weed

Helenium 'Moerheim Beauty' Sneezeweed

PINELANDS NURSERY & SUPPLY

Suggestions for Focalpoint Plantings

Native plant suggestions are listed below. There is some overlap between zones and those species listed with an * are ornamental. Please note there are plenty of other species that are suitable for both the "semi-intensive" and "extensive" zones. We always go into the spring with tens of thousands of each species on my list, but in the event we are sold out of something there are plenty of good substitutions.

Intensive / Semi-Intensive: more middle of the road in terms of decorative value and additional maintenance

Blueflag Iris - Iris versicolor*
Swamp Milkweed - Asclepias incarnata*
Cardinal Flower - Lobelia cardinalis*
Cutleaf Coneflower - Rudbeckia laciniata*
New York Ironweed - Vernonia noveboracensis*
Lurid Sedge - Carex lurida
Fringed Sedge - Carex crinita
Switchgrass - Panicum virgatum

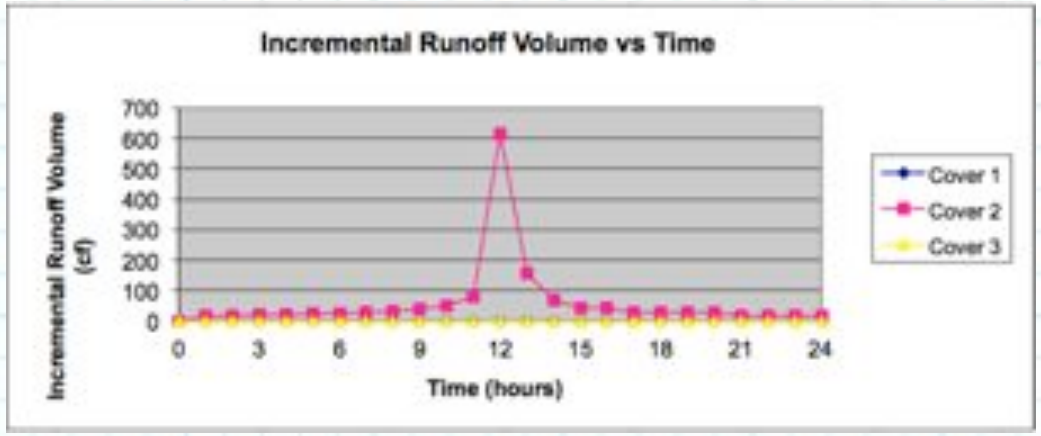
Extensive: Lower end applications like industrial parks or some highway applications where less decorative value is needed and less maintenance is desired. Plants should be more friendly to longer time of inundation.

Blueflag Iris - Iris versicolor*
Cardinal Flower - Lobelia cardinalis*
New York Aster - Aster novi-belgii*
Woolgrass - Scirpus cyperinus
Tussock Sedge - Carex stricta
Rice Cutgrass - Leersia oryzoides
Green Bulrush - Scirpus atrovirens
Fowl Mannagrass - Glyceria striata

Pinelands Nursery, Inc. / 323 Island Road / Columbus, New Jersey / 08022
Phone: (609) 291-9466 (800) 667-2729 Fax: (609) 298-8939
Website www.pinelandsnursery.com
E-Mail sales@pinelandsnursery.com

The HPMBS System Footprint is based on:

- Water Quality Volume (WQv)
- WQv as Percentage of Design Rainfall Event (either entire volume or 1st Flush)
- Runoff Distribution
- Available Surface Ponding Volume



Design With A Low Cost and Easy to Maintain Surface Depression to Implement Low Impact Development:

CONVERGENT WATER TECHNOLOGIES

“Next Generation” Solutions for Stormwater Management: A Brief Overview

Learning Assessment – True\False

1. High Performance Modular Biofiltration Systems (HPMBS) can be utilized as an alternative to traditional concrete based structures for many water quality treatment applications?
2. A HPMBS may be sized as flow through device or used in combination with surface storage/ponding to reduce the total footprint needed for biofiltration applications.
3. A HPMBS has limited value in urban retrofit applications?
4. HPMBS are susceptible to clogging because of the geotextile component in the cross section?
5. Modular Plastic Storage System (MPSS) Modules are filled with stone or other backfill materials?