

## Description:

Biofilters or biofiltration systems are a suite of BMPs that use engineered media, such as Biosorption Activated Media (BAM), to enhance nutrient removal when native soils cannot provide adequate pollutant removal. Another use is where the native soils do not have an adequate infiltration rate. They also are used in Sensitive Karst Areas to remove nitrates where the sandy soils (without clay) allow nitrate movement into the ground water. Another use is along coastal areas where protection of estuary waters is needed. Commonly used BAM is at the bottom of retention basins or in filters after wet detention ponds. It has been shown that retention basins and detention ponds may use filters on the discharge from the ponds to further remove nutrients, usually the nitrate form of Nitrogen and Phosphorus (Chang, N, Dan Wen, Andrea Valencia, William Colona, and Martin Wanielista. (2019). *Comparison of Biological Nutrient Removal via Two Biosorption Activated Media between Laboratory-scale and Field-scale Linear Ditch for Stormwater and Groundwater Co-Treatment*. Water, Air and Soil Pollution Journal).

Small catchment areas can discharge into depression areas or rain gardens and tree wells that have BAM. Typically, these are either offline retention BMPs or online stormwater detention BMPs that serve small drainage areas. The annual water quality effectiveness is based on the volume that passes through the filter. Not all-runoff water (high rainfall events) will pass through the filter; thus, the annual removal is less than the filter removal effectiveness.

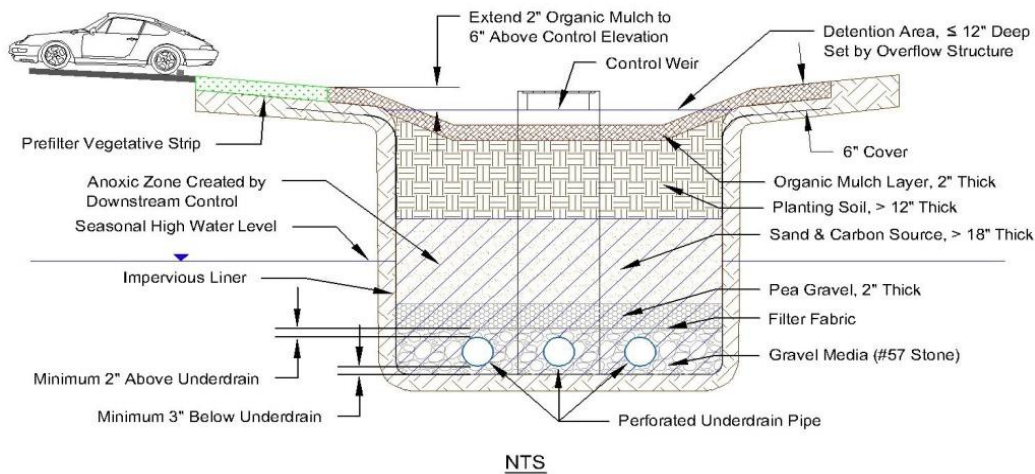
Biofiltration systems with BAM can incorporate natural soils, recycled materials, cellulose, or other materials. For the removal of Phosphorus, BAM has to have a Phosphorus sorption capacity. For removal of nitrate, the BAM must retain moisture to promote a near zero oxygen zone. Planted vegetation to facilitate treatment for removal of nutrients is common. The use of BAM will also reduce toxic compounds and organisms in the discharge waters.

There are many opportunities for biofiltration systems (Wanielista, et.al., 2014) making them a superior choice for onsite treatment in urban development, especially in areas undergoing redevelopment (Wanielista, M.P., and Mark Flint. (2014a) *Up-flow Filtration for Wet Detention Pond*. Florida Stormwater Association Annual Meeting. Sanibel Fl, June). The USEPA (United States Environmental Protection Agency (USEPA). (2023). Green Infrastructure, April 24. <https://www.epa.gov/green-Infrastructure/what-green-infrastruture>) has defined on-site filters as Green Stormwater Infrastructure devices, or GSIs. They can have an underdrain for surface water discharge and are classified as detention. However, they are frequently designed to function as retention systems. BMPs including GSIs that can use BAM are listed as:

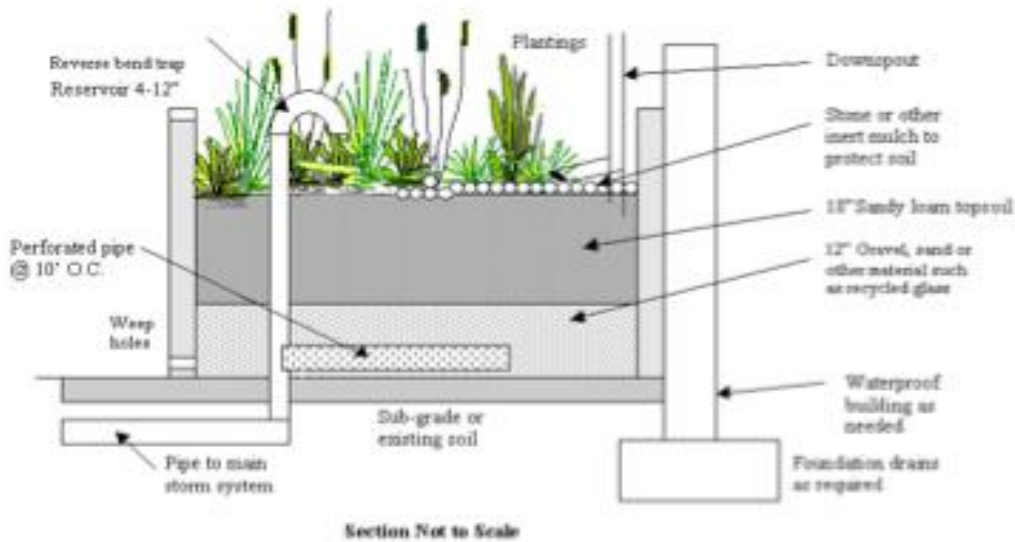
- Detention rain gardens
- Retention rain gardens
- Landscape planter boxes
- Tree wells or tree box filters
- Side-Bank Filters after wet detention
- Up-Flow Filters after wet detention
- Up-Flow Filters after baffle box chambers
- Regional Retention Basins

- Exfiltration systems (vaults, or pipe and rock)
- Vegetated Filter Strips

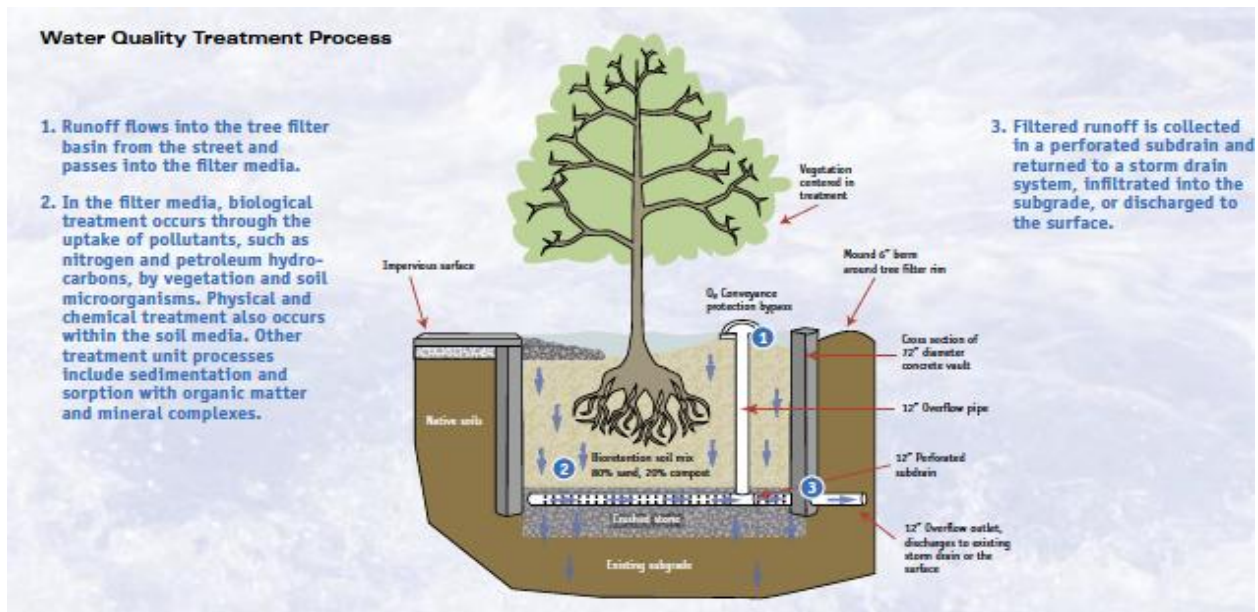
Before a BAM is used in any BMP within the State of Florida, acceptance must be granted by the review or regulatory agency. Those BAM currently used (January 2026) within the State in BMPs or GSIs are listed within the **BMPFast** software. If not in the software as a specific entry, a “User Defined” option is available. The user of the software is encouraged to contact the review and regulatory agency to validate assumptions on design parameters such as treatment rate as well as to use acceptable removal rates or procedures to document average annual removal effectiveness.



Example of a Cross section of Depression area or a Pavement Biofiltration System (Depths and Types of Media will Differ with Applications, see Regulatory Requirements)



Example of a Cross section of Landscape Planter Biofiltration System (Depths and Types of Media will Differ with Applications, see Regulatory Requirements)



Cross section of Tree Well (Box) Filter with Underdrain (Depths and Types of Media will Differ with Applications, see Regulatory Requirements)

### Additional information and data on BAM used for pollution control:

As with any BMP, a filter only removes the pollutants that it was certified as measured to remove. An example is a filter that removes 80% of the particulate in TP and 25% of the dissolved TP when the input is runoff. If that same filter is used downstream of a detention pond which removes most of the particulate, the TP removal is reduced and frequently estimated for the dissolved fraction of TP. In many cases, it is recommended to conduct field measurements to determine the removal effectiveness.

The removal of TN and TP within **BMPFast** includes currently (January, 2026) used BAM mixes with specified authenticity and field sample performance. It is understood additional media mixes will be developed or are being used on a limited basis, thus there are options to add other BAMs, identified as User Defined Media (UDM). All media mixes should be certified for removal performance. Once permits are issued, the media type is included in software by name as has been the practice. If design changes or performance numbers are changed after the permit is issued, they can be made within the software at the recommendation of the user and acceptance by the review agency.

Usually, the media is mixed in a central facility. If not mixed in a central facility, then samples to verify the mix percentages during on-site mixing must be available. The pollution removal now in use assumes design criteria that must be used. Thus, follow the examples and design and maintenance information within this manual.

Design information includes filtration (treatment) rates. These rates are determined by laboratory measures and validated from field operation under strict maintenance criteria. The rates used in the software have a safety factor of two, or the minimum field or lab rates are reduced by a factor of two to allow for operation difficulties.

| Media <sup>1</sup>    | Minimum<br>Depth<br>(in) | Treatment <sup>2</sup><br>Rate<br>(GPM/SF) | Treatment<br>Efficiency <sup>3</sup> |                    | Sustain<br>Void % <sup>4</sup> | OP<br>Removal <sup>5</sup><br>Rate<br>(mg/g) | Density <sup>6</sup><br>Lbs/CF |
|-----------------------|--------------------------|--|--------------------------------------|--------------------|--------------------------------|--|--------------------------------|
|                       |                          |  | TN (%)                               | TP(%)              |                                |  |                                |
| B&G ECT3<br>or ECT    | 24                       | 1  | 45/25 <sup>7</sup>                   | 45/25 <sup>7</sup> | 30                             | 0.2  | 43                             |
| ICS                   | 24                       | 0.104                                      | 80                                   | 95                 | 30                             | 0.6  | 105                            |
| User Defined          | 24                       |  |                                      |                    |                                |  |                                |
| B&G<br>CTS12          | 12                       | 0.052                                      | 60                                   | 90                 | 30                             | 0.2  | 95                             |
| B&G<br>CTS24          | 24                       | 0.052                                      | 75                                   | 95                 | 30                             | 0.2  | 95                             |
| Per Pave <sup>8</sup> | 3-12                     | 0.052                                      | 60                                   | 90                 | 30                             | 0.2  | 95                             |
| SAT <sup>9</sup>      | 24                       | 0.02                                       | 20                                   | 45                 | 30                             | 0  | 100                            |

1. January 2025 commonly used. Others can be included as user defined.
2. Treatment Rate including a factor of safety equal to 2.
3. Average annual concentration reduction;  
mass reduction is the product of concentration and water passing through filter.
4. Percent of water in the media after loading with stormwater equal to 10 years of operation.
5. Measured dissolved fraction usually as Ortho-Phosphate (OP) in (mg OP/g of media).
6. Dry densities at operating density, will vary with source materials.
7. 45/25 (stand-alone BMP/downstream of another BMP) average annual efficiencies.
8. Limited to the bottom of a 3 to 12-inch-deep pervious pavement reservoir.
9. Limited to a stand-alone BMP or first in a series of BMPs, reflecting particulate removal.

Notes: 1. Average annual concentration reduction values are for a 50% mix of particulates.

2. Efficiencies are for stormwater runoff events with dry periods (no rainfall).

3. Continuous application of runoff may affect the concentration reduction.

4. Species mix for TN has DON less than 20% of TN.

A - Demonstration Bio Media for Ultra-urban Stormwater Treatment, Wanielista, et.al. FDOT Project BDK78 977-19, 2014  
B - Optimal Recipe Assessment of Iron-Filling Based..., Valencia, et.al., Environmental Engineering Science, 36, 10, 2019  
C - Up-Flow Filtration for Wet Detention Ponds, Wanielista and Flint, Florida Stormwater Association, June 12, 2014.  
D - City of Austin Environmental Criteria Manual, Section 1.6.5, Texas, 2012  
E - Nitrogen Transport and Transformation in Retention Basins, Marion Co, Fl, Wanielista, et al, State DEP, 2011  
F - Improving Nitrogen Efficiencies in Dry Ponds, Williams and Wanielista, Florida Stormwater Association, June 18 2015

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Filter media used to remove a pollutant will have a design life expectancy, called service life. The service life for nutrient removal is based on the capacity to remove OP that includes the media volume and treatment rate for OP in a year. Service life can be calculated for all of the media used within this manual.

It is also noted that BAM can be used for the removal of other pollutants such as some metals, solids, toxic compounds, bacteria including some pathogens and emerging contaminants. There are no suggested data on removal of other than Total Nitrogen and Total Phosphorus within the **BMPFast** software.

In Florida, the CTS12 media has been tested with VFS and in filters under pavements. The BAM Per Pav media is composed of the same media mix as CTS but has been used at 2, 3- and 12-inch depths in the reservoir of permeable pavement. Also note the removal of nutrients by some media filters after a wet detention pond is less than the removal if the media is used as a stand-alone BMP. An example would be ECT3 media which has a stand-alone removal percentage of 45%, but when used in combination with a wet detention pond, the removal percentage is 25% (Wanielista, M.P., and Mark Flint. (2014a) *Up-flow Filtration for Wet Detention Pond*. Florida Stormwater Association Annual Meeting. Sanibel Fl, June).

Caution: As with any BMP, the input water quality must be stormwater related within the EMC concentration values as well as the species distribution within, such as the amount of dissolved organic nitrogen (DON) must be less than about 10% of the total. For DON greater than 10%, consult the supplier of the BAM for removal effectiveness.

Input data:

Data to define the type and characteristics of a BAM media are to simply define the media type. This is shown as a menu item within the software:

The type of media is selected and the TN and TP maximum reduction % is noted. Not all of the annual flow of runoff water will go through the filter, thus the % reduction is not attained, but only that water passing through the filter will receive the maximum reduction. If 80% of the water passes through the filter in a year, then the pollutant reduction would be 80% of the maximum.

design residence time more than 2 hours?

Select Media Mix:

runoff are treated:

- Not Specified
- ICS
- B&G ECT Mixes
- SAT
- B&G CTS12
- B&G CTS24
- Permeable Pavement
- User Defined

A selection of B&G CTS24 media is shown below, the removal time is greater than 2 hours, thus allowing maximum removal of TN. The removal time is calculated as the filter depth (inches) divided by the treatment rate (inches/hour). The CTS treatment rate is 5 inches per hour (0.052 GPM/SF), thus for 24 inches of BAM, the residence time is 4.8 hours. The ECT mixes have a faster treatment rate and their residence time is less than 2 hours, resulting in an efficiency of 25%.

design residence time more than 2 hours?

Select Media Mix:

runoff are treated: {

|                  |    |
|------------------|----|
| TN Reduction (%) | 75 |
| TP Reduction (%) | 95 |

An example of using a BAM B&G24 filter in a side bank drain after a wet pond is shown below. The quantity of water passing through the filter was about 82% of the annual runoff which in this particular site results in a treatment rate of 1 inch. This 1 inch can be determined using the retention BMP worksheet. The average annual removal is also shown as 61% for TN and 78% for TP.

Click Button to Select Media:

Media

B&G CTS24

Treatment Depth (0.0-4.0 inches):

1.0

**Groundwater Discharge (Stand-Alone)**

| Parameter                 | Value |
|---------------------------|-------|
| Treatment Rate (MG/yr)    | 0.669 |
| TN Mass Load (kg/yr)      | 1.435 |
| TN Concentration (mg/L)   | 0.567 |
| TP Mass Load (kg/yr)      | 0.179 |
| TP C Concentration (mg/L) | 0.071 |

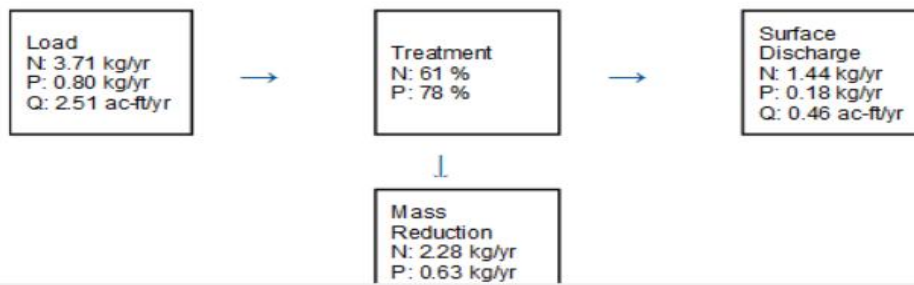
Calculate

Cost

Print

Plot

**Load Diagram for Surface Discharge Filtration (stand-alone)**



Help

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