DESIGN SPECIFICATION

2.6 Filtration System

PURPOSE & DESCRIPTION

The Filtrexx® **Filtration System** is a temporary or **permanent water or storm water filtration system used to remove sediment and/or soluble pollutants** from water or storm water. This land based system uses organic FilterMedia™, GrowingMedia™, and vegetation to remove pollutants from water and storm water before being discharged into collection ponds, constructed wetlands, infiltration basins, fields, or receiving waters. This filtration system combines the benefits of organic matter, humus, vegetation, and proprietary flocculants to clean point and non-point water sources. Filtrexx flocculants can be used with customizable and easily maintained Filtrexx SiltSoxx® Baffles to create a custom design to target specific pollutants in contaminated water and storm water flows. For a list of Filtrexx additives, see Section 4.0.

APPLICATION

The filtration system can be used for temporary applications during land disturbing/construction activities or for permanent applications where vegetation can be established to create a permanent organic vegetative filter that is designed into the landscape. Typical applications include:

- Pretreatment for temporary sediment detention ponds,
- Post-treatment for temporary sediment detention pond discharge or emergency storm overflow,
- Pretreatment for permanent storm water collection ponds,
- Sediment and soluble pollutant control of storm runoff,
- Sediment and soluble pollution filtration from contaminated effluent.

Vegetated filtration systems can also be used to reduce runoff velocity flowing into surface waters. Reducing runoff velocity will decrease soil erosion and increase pollutant removal through trapping, sediment deposition, and plant uptake.

ADVANTAGES AND DISADVANTAGES

Advantages

- Filtration systems can be used for permanent or temporary pollutant filtration applications.
- Filtration systems are easily installed and can establish vegetation in difficult areas.
- Filtration systems can be easily designed and incorporated as one treatment in a treatment train approach to storm water management.
- Filtration systems can slow down runoff velocity, thereby increasing sediment deposition, reducing the erosive energy of runoff and the potential for soil erosion, and pollutant transport.
- Filtration systems can be used to filter pollutants and infiltrate storm water entering or leaving areas where storm water may pass, collect, drain, or be stored.
- Filtration systems have the ability to bind and adsorb soluble nutrients, metals, and hydrocarbons that may be in storm water runoff, thereby reducing loading to nearby receiving waters.
- Filtration systems can remove pathogens and pesticides from storm runoff preventing pollution of receiving water bodies.
- Filtration systems can be customized to remove target pollutants from contaminated water, such as phosphorus and suspended solids.
- Filtration systems can be customized to handle a variety of water pollutant concentrations, pollutant loads, and water volumes.
- Customization options include: area and perimeter of design footprint, diameter and height of Soxx Baffles and filtration system walls, and hydraulic flow rate of SiltSoxx Baffles.
- Filtration system SiltSoxx Baffles are available in 8in (200mm), 12 in (300mm), 18 in (450mm), 24 in(600mm), and 32 in (800mm) diameters for a variety of flow volumes, flow rates, and/or customized applications.
- Filtration system Baffles are easily maintained and/or replaced for long-term pollutant filtration applications.
- No trenching is required; therefore soil and plant roots are not disturbed upon installation.
- Filtration systems can be installed year around in difficult soil conditions such as frozen or wet ground, and dense and compacted soils, as long as stakes can be driven.
- Filtration systems can be installed on pavement, blacktop, concrete or other hard surfaces as temporary control.
- Filtration systems can be easily installed on top of impervious mats or membranes.
- Organic matter and humus colloids in FilterMedia and GrowingMedia have the ability to bind and adsorb phosphorus, metals, and hydrocarbons that may be present in contaminated water.
- Microorganisms in compost FilterMedia and GrowingMedia have the ability to degrade organic pollutants and cycle captured nutrients from contaminated water.
- Filtrexx mesh netting allows filtration system Soxx Baffles to be used where water pressure may exist, unlike mulch or compost filter berms.
- Filtration systems can be direct seeded at time of application to provide greater stability and pollutant filtration capability once vegetation has established.
- Filtration systems can support a variety of temporary and permanent vegetation.
- FilterMedia and GrowingMedia are organic and can be left on site after permanent stabilization is complete, used in landscape design, and/or seeded and planted with permanent vegetation.
- FilterMedia and GrowingMedia improves existing soil structure if spread out and used as a soil amendment after construction activity is complete.
- Humus colloids and organic matter in filtration systems provide physical structure for seed and establishing seedlings.
- Humus colloids and organic matter in filtration systems provide increased water holding capacity and reduced water evaporation to aid in seed germination and the potential for reduced irrigation.
- Filtration systems can increase ground water recharge by increasing infiltration and percolation.

ADVANTAGES	LOW	MED	HIGH
Installation Difficulty		✓	
Flow Capacity		✓	
Vegetation Establishment			✓
Sediment Control			✓
Soluable Pollutant Control			✓

- Filtration systems are a good option for arid and semiarid regions where germination, moisture management, and irrigation can be difficult.
- GrowingMedia provides organic nutrients that slow release for optimum efficiency to establishing vegetation.
- GrowingMedia provides organic nutrients that are less prone to runoff transport and pollution of surface waters relative to mineral nutrients supplied by fertilizers.
- Filtration systems are organic, all natural, biodegradable, and locally manufactured.
- Filtration systems can be used as an integrated management practice for Low Impact Development (LID) design and for possible point accrual in LEED Green Building Certification programs.
- Filtration system may assist in qualification for LEED® Green Building Rating and Certification credits under LEED Building Design & Construction (BD+C), New Construction v4. Awarded credits may be possible from the categories of Sustainable Sites, Water Efficiency, Materials & Resources, and Innovation. *Note: LEED is an independent program offered through the U.S. Green Building Council. LEED credits are determined on a per project basis by an independent auditing committee. Filtrexx neither guarantees nor assures LEED credits from the use of its products. LEED is a trademark of the U.S. Green Building Council.*

Disadvantages

- If filtration systems do not use Filtrexx® FilterMedia™ and GrowingMedia™, performance may be diminished.
- If not installed correctly, maintained or used for a purpose or intention that does not meet specifications, performance may be diminished.
- If vegetation does not establish or cover density is low, performance may be diminished.
- Filtration systems should not be the only form of site or watershed storm water management.
- Filtration systems may need to be reseeded if significant storm flow occurs prior to vegetation establishment or where vegetation fails.
- Filtration system performance may be lower prior to vegetation establishment and maturity.
- Filtration system performance may be diminished or require frequent maintenance if water/storm water flows are high or exceed the design capabilities of the system.
- Filtration system performance may be diminished or require frequent maintenance if pollutant concentrations or loads are high or exceed the design capabilities of the system.
- Filtration systems should not be installed on slopes greater than 5%.
- Flow velocities within the filtration system should not exceed 4 ft/sec (1.2 m/sec), with a 0.9 ft/sec (0.3 m/sec flow as optimum.

MATERIAL CHARACTERISTICS

Filtration systems use only Soxxtm photodegradable or biodegradable netting materials available from Filtrexx International, and are the only mesh materials accepted in creating filtration systems for any application. For Soxx Material Specifications see Table 6.3.

GROWINGMEDIA™ & FILTERMEDIA™ CHARACTERISTICS

Filtration systems use a combination of Filtrexx GrowingMedia and FilterMedia. GrowingMedia is a composted material that is specifically designed for rapid establishment and sustainability of vegetation growth, water absorption, and pollutant adsorption. FilterMedia is a composted material that is specifically designed for removal of solids and soluble pollutants from storm water runoff by physical trapping, deposition, and chemical adsorption. *FilterMedia can be altered or customized with specific flocculants at the time of installation to target specific pollutants in runoff or effluent, as approved by the Engineer or Filtrexx International.* See Section 4 on complete description of flocculants.

GrowingMedia performance parameters include: percent cover of vegetation, water holding capacity, pH, organic matter, soluble salts, moisture content, biological stability, maturity bioassay, percent inert material, bulk density and particle size distribution. For information on the physical, chemical, and biological properties of GrowingMedia refer to Specification 5.2 Filtrexx® GrowingMedia™.

Filtrexx FilterMedia performance parameters include: hydraulic flow through rate, total solids removal efficiency, total suspended solids removal efficiency, turbidity reduction, nutrient removal efficiency, metals removal efficiency, and motor oil removal efficiency. For information on the physical and chemical characteristics of Certified FilterMedia refer to Specification 5.1 Filtrexx® FilterMedia™. Look for the Filtrexx® Certified℠ Seal from our international network of Filtrexx Certified Installers.

PERFORMANCE

QA/QC material testing of Filtrexx FilterMedia and GrowingMedia to ensure specifications are met is conducted by the Soil Control Lab, Inc. Although little research has been conducted on the filtration system, performance testing and scientific research on vegetated filter strips, slope protection, and compost SiltSoxxtm have been conducted in recent years. Conservative assumptions can be made regarding the filtration system in light of performance associated with the previously mentioned practices. For performance on these practices see Filtrexx® Compost Erosion Control Blanket, Filtrexx® Sediment Control (SiltSoxx), and supporting summaries of technical and research reports in the Appendices. Filtrexx International and Filtrexx Canada are currently conducting research with the School of Engineering Watershed Research Group at the University of Guelph to determine performance, design capacity, and design limitations for the filtration system to aid engineering design professionals in the future. See Table 6.3 for a summary of material specifications and Table 6.4 and Table 6.5 for a summary of performance testing results and design specifications from Filtrexx SiltSoxx Baffles and Diversion SiltSoxx.

Successful bidders will furnish adequate research support showing their manufactured product meets or exceeds performance and design criteria outlined in this standard specification. Research or performance testing will be accepted if it meets the following criteria: conducted by a neutral third party, utilizes standard test methods reported by ASTM or referenced in a peer reviewed scientific journal, product and control treatments are tested in triplicate, performance results are reported for product and control (control should be a bare soil under the same set of environmental and experimental conditions), results are peer reviewed, results indicate a minimum 60% TSS removal efficiency and a minimum hydraulic flow through rate of 5 gpm/ft2. Bidders shall attach a copy of the research report indicating test methodologies utilized and results. *Note: the Contractor is responsible for establishing a working erosion and sediment control, effluent filtration, hydrologic, and/or storm water management system and may, with approval of the Engineer, work outside the minimum construction requirements as needed. Where a filtration system is damaged or ineffective, it shall be repaired or replaced.*

DESIGN CRITERIA

Function

The primary function of the filtration system is to remove sediment and soluble pollutants, such as nutrients, heavy metals, petroleum hydrocarbons, and pesticides from storm runoff or contaminated effluent waters. By using organic matter and humus rich materials the filtration system is able to chemically adsorb pollutants rendering them less toxic and less available to animals and humans (Filtrexx Tech Link #3307 and #3308). Soxx Baffles can be injected with flocculants to allow for custom design to target specific pollutants in water and storm water, thereby reducing their concentration and load exiting the system. The organic and humus rich system is also designed to absorb large volumes of water thereby reducing mass loading of pollutants exiting the system. Flow diverters and filtration baffles also increase the flow path and reduce flow velocities which allows for increased settling of suspended solids, reduction of turbidity, and increased reaction time to adsorb soluble pollutants. The result is systematic reduction of pollutants leaving the filtration system and ultimately migrating to sensitive receiving waters and wetlands.

The vegetated filtration system is effective at filtering pollutants from water and storm water due to flow velocity reduction and physical trapping of pollutants by the vegetation. Vegetation can increase surface roughness (Manning's n), which can reduce flow velocity. Large particles are typically removed in greater efficiencies than suspended particles through reducing flow velocity and constructing/maintaining vegetated filters. Many plants have the ability to take up excess nutrients and other pollutants trapped in the vegetation, while microorganisms can decompose and/or incorporate these pollutants into their biomass, making them less toxic to aquatic ecosystems. Organic matter supplied in GrowingMedia increases the diversity and population of microorganisms that can decompose and incorporate captured pollutants.

Maintenance is a key consideration, as sediment build-up will significantly reduce the ability of a vegetated filtration system to remove pollutants from effluent or runoff water; however, unless sediment accumulation is extreme, Filtration system vegetation will continue to grow in and through deposited sediment.

Planning Considerations

Filtration systems should be used as one treatment in a treatment train approach to storm water management or pollution abatement. Preconstruction meetings should be conducted to educate construction site personnel about the devices/practices used and acceptable traffic patterns that avoid running over the filtration system with vehicles and heavy equipment. Vehicular traffic is not permitted in the filtration system because heavy equipment may reduce the effectiveness.

Infiltration and runoff velocity reduction practices may be installed upslope from the filtration system to reduce runoff peak flows and pollutant loading entering the filtration system.

Discharge from any storm water filtration system should be directed to infiltration basins or fields, level spreaders, constructed wetlands, storm water detention ponds, sediment retention or bioretention ponds.

Vegetation Selection

Successful planning for any vegetation establishment project should consider aesthetics, wildlife habitat, climate, prevailing weather, temperature, sun exposure, prolonged moisture exposure, available moisture/irrigation requirements, topography, soil type, soil pH, soil amendments, nutrient requirements, drought tolerance, time/coordination with construction phases, site preparation/ coordination with construction phases, protection from erosion and sedimentation, concentrated flow and runoff velocity potential, maintenance, and seed mix/plant selection (Fifield, 2001).

Quick establishing annual grasses and legumes are normally specified for temporary and nurse crop applications. Perennial grasses are typically specified for permanent applications, and if possible native grasses should be utilized (Fifield, 2001; USDA-NRCS, 2004) as these will be better adapted to local climate, native soil, and hydrology. If filtration system will be exposed to prolonged moisture, wetland species may be required. Generally, tall and sturdy grasses are better at reducing runoff and flow velocity and increasing sediment removal than low growing, flexible grasses and legumes (Grismer et al., 2006; USDA-NRCS, 2004) - as taller vegetation generally increase surface roughness values (Manning's n). Additionally, deep rooted grasses will be more stable under high storm runoff and, high concentrated flow velocity.

Filtration systems may be designed for biotechnical engineering applications. GrowingMedia fill within the Soxx system creates an optimum fertile and structural environment for establishing and sustaining live stakes, seed, tubers, rhizomes, and plugs. A live stake is a 1 to 3 ft (300-900mm) long cutting from a live hardwood tree or shrub and planted vertically into a GrowingMedia (KYTC, 2006). Typical live stake species include, willow, poplar, maple, cottonwood, dogwood, sycamore, and oak (KYTC, 2006). Drip tape irrigation installed within the filtration system maintains moisture for plants used in biotechnical engineering projects, particularly in drought prone regions and seasons.

Local landscape architects, NRCS personnel, or cooperative extension specialists should be consulted and used as resources for local/regional seed and plant selection. Many state erosion and sediment control and storm water management manuals have specifications for seed and plant selection, seeding rates, and planting requirements. VegSpec, a design program created by the USDA-NRCS, may be a helpful tool for seed and plant selection. It can be accessed at http://plants.usda.gov

The hydraulic properties of grasses commonly used in channels have been characterized and grouped by the United States Department of Agriculture. Each class, A through E, is determined by height, density and stiffness of the vegetative stand. These properties effect the vegetation's surface roughness (Manning's n) and its ability to withstand hydraulic pressure from concentrated flows (ECTC, 2006). Grass retardance classes and their corresponding permissible shear stress values are defined in the Federal Highway Administration HEC 15.

Table 6.1. FHWA HEC 15 Retardance Class, Stand Height, and Permissible Shear Stress for Grasses used in Channels, Ditches, and Concentrated Flow Applications.

Class	Example of Vegetation	Stand Density	Average Stand Height	Permissible Shear Stress
A	Weeping Lovegrass, yellow bluestem	Excellent	>=76.2 cm (>= 30 in)	177 Pascal (PA) (3.7 lbs/ft2, 18 kg/m2)
B	Bermuda, blue grama, and native grass mixtures	Good	30.5 - 61 cm (12 - 24 in)	100 Pascal (PA) (2.1 lbs/ft2, 10 kg/m2)
C	Bermuda, Kentucky blue grass, centipede grass	Good	15 — 30.5 cm (6 - 12 in)	48 Pascal (PA) (1.0 lbs/ft2, 5 kg/m2)
D	Bermuda, buffalo, grass-legume mixture	Good	5 — 15 cm (2 - 6 in)	28 Pascal (PA) (0.60 lbs/ft2, 3 kg/m2)
E	Bermuda, native grass mixture	Good	<5 cm (< 2 in)	16 Pascal (PA) (0.35 lbs/ft2, 2 kg/m2)

(Source: ECTC - Erosion Control Technology Council, 2006)

Establishing & Sustaining Vegetation
Filtration systems may be seeded at the time of application by injection into GrowingMedia during Soxx and cell filling construction (GroSoxx®). Nurse crops, such as annual rye, oats, millet, or wheat may be considered to establish a quick vegetative cover until perennial grasses and/or live stakes are established. Grasses within the filtration system should be mowed and maintained between 4 and 10 in (100-250mm) high, unless otherwise specified. Taller grasses may have higher sediment removal efficiency, sediment storage capacity, and a greater ability to dissipate runoff energy and reduce storm flow velocity relative to low growing or low maintained grasses. Live stakes should be 1 to 3 ft (300-900mm) long and planted vertically with at least 2 in (50mm) of one end planted into GrowingMedia, and spaced 3 to 5 ft (1-1.5m) apart (KYTC, 2006).

Although GrowingMedia typically has a higher water holding capacity than topsoil, irrigation may be required to ensure successful establishment. In arid and semi-arid regions or hot and dry weather regular irrigation may be required. Drip tape irrigation may be installed within the Soxx to maintain moisture within GrowingMedia for establishing vegetation or in drought prone regions and seasons.

GrowingMedia supplies humus, organic matter, beneficial microbes, and slow release organic nutrients that contributes to increased fertility, plant health and sustainability.

Organic vs. Fertilizer Nutrients
Although most specification and design manuals include fertilizer recommendations or requirements for vegetation, mineral nutrients from fertilizers may not be preferable where vegetation sustainability and water quality are a concern. Filtration systems provides organic nutrients which are slow release, provide plant micronutrients, and are less likely to be transported in storm runoff to receiving waters – which can lead to pollution and eutrophication of waterways (Faucette et al, 2005).

Weed Establishment
Invasive weed growth has been more closely associated with mineral fertilizer than organic fertilizer fertility practices (Faucette et al, 2004). Vegetation practices should always be inspected for invasive and noxious weeds. The use of approved Filtrexx products will reduce the chances of noxious weeds being introduced.

Runoff Velocity
Filtration systems should not be used in areas where runoff velocity or shear stresses will damage or undermine the system. For most grasses a maximum velocity of 4 ft/sec (1.2 m/sec) or a maximum hydraulic shear stress of 2 lbs/ft2 (10 kg/m2) is recommended (MD Storm Water Design Manual, 2000) – unless vegetation reinforcement is utilized such as Filtrexx® LockDowntm Netting, turf reinforcement mats, or rolled erosion control blankets are utilized. A flow velocity of 0.9 ft/sec (0.3 m/sec) is optimum to ensure vegetation sustainability.

To determine velocity of flow in a stream, creek, or river use Manning's Equation:

$$V = (\alpha_1/n) \times R^{2/3} \times S^{1/2}$$

Where:
V = mean velocity of flow (ft/sec, m/sec)
R = hydraulic radius = A/P (ft, m)
A = cross-sectional area (sq ft, sq m)
P = wetted perimeter (ft, m)
S = slope of gradient (ft/ft, m/m)
n = roughness coefficient
α_1 = 1.0 for SI units, 1.496 for English units

Point Source & Non-point Source Influent
If influent is from a point-source discharge the area of entry or contact should be stabilized. Options include an impervious ground layer, turf reinforcement mats, Filtrexx® Channel Protection (see Filtrexx Design Manual Section 2.4), or rip rap. For non-point source influent see the following section.

Sheet and Equalized Flow
To maintain sheet flow or create equalized flow conditions, reduce runoff velocity, and to act as a pretreatment system for sediment removal a shallow gravel trench (level spreader) may be constructed directly upslope from (at the entrance) the filtration system (USEPA, 2006). The gravel trench should be a minimum of 12 in (300mm) wide and 12 in (300mm) deep and filled with pea gravel. Alternatively, a flow equalization cell may be design at the influent end of the filtration system. The equalization cell should use a Soxx Baffle that functions as a flow restricting weir, installed perpendicular to flow, to temporarily restrict flow into the main part of the filtration system.

Outfall Flow
A weir or Soxx Baffle should be placed across the entire width of flow path at the exit of the filtration system, perpendicular to flow, to act as a final filtration treatment and to equalize and disperse flow as it exits the filtration system. Depending on slope and discharge angle at outfall, it may be necessary to install turf reinforcement mats, or other stabilization practices, until mature vegetation can provide adequate stabilization.

Construction Design Option
There are two construction design options for filtration systems. Option #1 is to create a sinuous flow system that maximizes surfaces flow area and contact within the filtration system. An example of this design can be found in Figure 6.1. This option is better for maximum adsorption of soluble pollutants to humus particulates within the filtration system. Option #2 is to create a series of closed cells that passively flow by gravitation from one cell to the next through the SiltSoxx Baffles. Performance and design criteria of SiltSoxx Baffles can be found in Table 6.4. An example of this construction design can be found in Figure 6.2. This option is better for increasing detention time within the filtration system to target fine sediments, suspended solids, turbidity, and when using polymers to target specific pollutants.

Slope Degree/Orientation
Filtration systems should be placed on modest slopes and oriented in the direction of flow. Filtration systems are most effective on slopes between 1 and 5%. Designers should consider that water will move faster through the system as slope increases, which will reduce pollution removal efficiency. Vegetated filter strips perform best at slopes below 2 and 6% (USEPA, 2006). Additionally, if water accumulates along inside edges of filtration system for prolonged time periods undercutting of Soxx is more likely to occur.

Sizing Option
There are several options for sizing filtration systems, ultimately it depends on the goal of the application. The area, slope degree, and slope length of the contributing drainage area, as well as water

volume, water influent rate, pollutant concentration, pollutant load, and type of pollutants can all affect the size of a filtration system.

As each of these parameters increase the pressure on the filtration system increases, therefore the functional size of the system should be increased. Additionally, vegetation density and height will reduce flow velocities and increase pollutant removal efficiencies within the filtration system.

Design by Slope Length

The principle design criterion for vegetated filter strips is length of contributing slope, not the contributing area, as the slope length will determine whether concentrated runoff flows, interrill erosion, and destructive runoff velocities will undermine the performance of the vegetated filtration system. For impervious services, runoff concentrates at approximately 75 ft (23m) of slope length, and for pervious surfaces at 150 ft (45m) of slope length. Using these criteria, a 25 ft (8m) wide vegetated filtration system 580 ft (177) long will treat 1 acre (0.4 ha) of contributing runoff from an impervious surface (USEPA, 2006).

Design by Contributing Area

If sediment removal is the principle objective, the USDA-NRCS (2004) recommends that if RUSLE R factors (soil erodability) of the contributing area are 0-35, the ratio of contributing area to vegetated filter system should be 70:1. R factors between 35 and 175 should have a ratio of 60:1; and R factors above 175 should have a ratio of 50:1.

Design by Slope Degree

Pollutant removal efficiency of a vegetated filtration system increases with increasing width of the system; therefore, vegetated filtration systems should be constructed as wide as possible. The specifications in Table 6.2 should be used as a minimum requirement.

Table 6.2. Minimum Width Requirements by Slope Degree for Vegetated Filtration Systems.

Slope	w/ Filtration Baffle	Minimum Width
1-3%	Yes	15 ft (5m)
1-3%	No	25 ft (8m)
4-7%	Yes	25 ft (8m)
4-7%	No	35 ft (11m)
8-10%	Yes	35 ft (11m)
8-10%	No	50 ft (15m)
11-15%	Yes	75 ft (23m)
11-15%	No	100 ft (30m)

Source: USEPA, 2006; USDA-NRCS, 2004.

Design by Flow Rate

Using a known flow rate (Q), the Rational Formula (shown below) can be used to determine the maximum allowable drainage contributing to a filtration system. A runoff coefficient (C) for compost blankets has been estimated between 0.26 to 0.35 (See Filtrexx Tech Link #3306).

$$Q = C*I*A$$

Where:

Q = peak flow rate (cfs, cms)

C = runoff coefficient (0.26 - 0.35)

I = rainfall intensity (in/hr, mm/hr)

A = drainage area (acres, hectares)

Design by Volume Reduction

GrowingMedia fill blankets are designed to absorb water. For every 1% of soil organic matter, the soil will hold approximately 16,500 gal (2206 cubic ft, 62 cubic m) of water per acre ft (1233 cubic m) of soil (Breedlove, 2006). Alternatively, GrowingMedia typically holds approximately 1.6 oz (45 g) of water per 3.6 oz (100 g) of GrowingMedia (dry weight); 1 gal (0.004 cubic m) of water per 20 lbs (9 kg) of GrowingMedia (dry wt) or per 30 lbs (14 kg) of GrowingMedia (wet wt). This equates to approximately 40 gal (0.15 cubic m) of water per cubic yard (0.76 cubic m) of GrowingMedia and 5,400 gal (722 cubic ft, 20 cubic m) of water per acre inch (0.01 ha meter, 103 cubic m) of GrowingMedia, and 10,800 gal (1444 cubic ft, 41 cubic m) of water for a 2 in (50mm) GrowingMedia; An acre inch (0.01 ha meter) of GrowingMedia requires approximately 135 cubic yards (103 cubic meters) of material.

Design by Pollutant Removal

See Table 6.3 for various pollutant removal efficiency rates of a single SiltSoxx Baffle. Pollutant removal efficiency is generally determined by reduction of pollutant concentration. To determine the removal efficiency of pollutant loading, multiply the pollutant concentration by the water volume both entering and leaving the system; then divide the load exiting the system by the load entering the system; then subtract from 1.

Design by Hydraulic Residence Time

To determine the hydraulic residence time within the filtration system:

$$R = V/Q$$

Where:

R = hydraulic residence time

V = spillway volume (cubic ft, cubic m)

Q = flow rate (cubic ft/sec, cubic m/sec)

Where:

V = length * width * height

INSTALLATION

1. Filtrexx® Filtration systems shall meet Filtrexx SiltSoxx Mesh Material and Filtrexx Certified GrowingMedia and FilterMedia specifications.
2. Call Filtrexx at 877-542-7699 or visit www.filtrexx.com for a current list of installers and distributors of Filtrexx products.
3. Filtration systems will be placed at locations indicated on plans as directed by the Engineer.
4. Filtration systems shall be placed perpendicular to water flow in a manner that allows water or storm water to flow, percolate, and/or gravitate through the system.
5. Filtration systems must be installed and stabilized before water flow is allowed to enter the filtration system.
6. Land surface shall be cleared of debris, including rocks, roots, large clods, and sticks prior to filtration system installation.
7. Land surface may be lightly compacted and graded prior to installation.

8. Filtration systems shall be placed on slopes between 1 and 5%.
9. Filtration systems will be fabricated on-site.
10. On-site fabrication of filtration systems will ensure a continuous length SiltSoxx system. Upon completing one section of SiltSoxx filling (approximately 100-200 ft [30-60m]), the next section shall be 'sleeved' over the completed section by a minimum of 1 ft (300mm). A stake shall be placed in the overlap section, securing the two sections.
11. A minimum 18 in (450mm) diameter SiltSoxx will be used to construct the perimeter enclosure of the filtration system.
12. The perimeter Soxx shall be injected with seeded GrowingMedia at the time of installation.
13. SiltSoxx Baffles injected with seeded FilterMedia shall be installed so that the end where water flow initiates contact shall abut the perimeter wall, while the opposite end shall be left open to direct and allow flow passage.
14. Alternatively, SiltSoxx Baffles may be installed across the entire width of the flow path to force water flow through the Baffle instead of around.
15. SiltSoxx Baffles or weirs shall be installed perpendicular to flow across the entire width of the flow area at or near filtration system entrance and at the exit.
16. SiltSoxx Baffles may also be injected with Filtrexx additives (along with FilterMedia) to target specific pollutants at time of installation. See a list of additives in Section 4.
17. Runoff Diversion injected with seed and GrowingMedia shall be placed along perimeter walls and at perimeter wall/SiltSoxx Baffle intersects to direct flow and to reinforce walls and baffles.
18. Once in place, Soxx shall be lightly compacted to prevent water undercutting of Soxx.
19. Stakes shall be installed through the middle of the SiltSoxx on a minimum of 10 ft (3m) centers, using 2 in (50mm) by 2 in (50mm) by 3 ft (1m) wooden stakes.
20. Stakes shall also be placed at the ends of SiltSoxx to hold them in place.
21. Minimum staking depth for sand and silt loam oils shall be 12 in (300mm), and 8 in (200mm) for clay soils.
22. Once all SiltSoxx are in place a turf reinforcement mat (TRM), rolled erosion control blanket (RECB), or LockDown Netting may be placed on the soil surface.
23. TRMs and RECBs should follow manufacturers' installation and stapling procedures.
24. LockDown Netting shall be anchored to the soil using 6-8 in (150-200mm) sod staples to be driven along the entire perimeter of the net and netting area.
25. Staples for LockDown Netting shall be spaced no more than 24 in (600mm) apart on all sides.
26. Where more than one roll of LockDown Netting is required for area width or area length, netting edges shall be overlapped by a minimum of 6 in (150mm).
27. LockDown Netting shall be installed from top to bottom (never across) on the slope.
28. LockDown Netting shall be installed under the entire area of the fill blanket.
29. Fill blanket shall use GrowingMedia applied to 100% of the TRM, RECB or LockDown Netting fill blanket area.
30. Fill blankets shall be 2 to 4 in (50-100mm) deep.
31. Fill blankets may be seeded at the time of application; seed selection will be determined by the Engineer.
32. Seeded filtration systems should not be installed prior to seasons where growing vegetation is difficult.
33. Seed shall be thoroughly mixed with the GrowingMedia prior to construction or injected into GrowingMedia at time of application.
34. After fill blanket has been applied another RECB or LockDown Netting may be installed on top of the fill blanket to prevent GrowingMedia transport and wash.
35. Installation procedures for RECBs and LockDown Netting used on top of the GrowingMedia fill blanket shall be the same as the installation underneath the fill blanket.
36. Optional biotechnical engineering with live stakes, tubers, seedlings, or plugs should be conducted after staking of Soxx is complete.
37. Live stakes should be from a live hardwood species and cuttings should be 1 to 3 ft (300-900mm) long.
38. Live stakes should be spaced 3 to 5 ft (1-1.5m) apart, and planted vertically with one end planted through the FilterSoxx and at least 2 in (50mm) into GrowingMedia.
39. Seeded and/or live staked Filtration systems shall be thoroughly watered after installation and allowed to settle for 1 week.
40. Drip tape may be installed within the Soxx during construction to provide irrigation for establishing vegetation.
41. If drip irrigation system is installed a reliable water source should be located and secured.
42. If drip irrigation system is installed and municipal water or a pump will be utilized, a pressure reducer may be required to manage flow and prevent drip tape from bursting.

INSPECTION

Routine inspection should be conducted within 24 hours of a runoff or flow event for the first year after installation, until permanent vegetation has established, or as designated by the regulating authority. If product dislodgement occurs, or vegetation does not establish, Soxx and GrowingMedia fill blanket should be repaired, reseeded, or restaked. If GrowingMedia has washed or gullies have established in the cells, GrowingMedia should be raked or additional GrowingMedia should be applied. Vegetation practices should always be inspected for noxious or invasive weeds. If sediment accumulation is 50% of the height of the Soxx Baffle, sediment removal is recommended. If sediment accumulation is 25% of the height of the vegetation, sediment removal is recommended. Storm debris and trash should be removed immediately.

MAINTENANCE

1. The Contractor shall maintain the filtration system in a functional condition at all times and it shall be routinely inspected.
2. If the filtration system has been damaged, it shall be repaired, or replaced if beyond repair.
3. The Contractor shall remove sediment at the base of the upslope side of the SiltSoxx Baffle when accumulation has reached 1/2 of the effective height of the Soxx, or as directed by the Engineer.
4. If a filtration system becomes clogged with debris or solids, they shall be maintained so as to assure proper hydraulic flow through. Overflow or undercutting of contaminated water is not acceptable.
5. If SiltSoxx baffle becomes clogged with sediment or hydraulic flow is significantly reduced it may be replaced with a new SiltSoxx Baffle.
6. If minor undercutting occurs, the areas may be plugged with sand or additional FilterMedia. If undercutting continues,

leveling or minor grading of ground surface may be required to increase surface contact with SiltSoxx.

7. Filtration systems shall be maintained until disturbed area above the device has been permanently stabilized and construction activity has ceased.
8. Filtration systems shall be maintained until contaminated water has fully percolated through the device.
9. The FilterMedia, GrowingMedia, sediment, and filtrate may be dispersed on site once solids separation is complete and if there are no concerns with soil and water contamination, or as determined by the Engineer.
10. If a filtration system is to be vegetated, the Contractor shall maintain the vegetation in the filtration system in a functional condition at all times and it shall be routinely inspected.
11. Vegetated filtration systems shall be maintained until a uniform minimum cover of 70% of the applied area has been vegetated, permanent vegetation has established, or as required by the jurisdictional agency.
12. Vegetated filtration systems may need to be irrigated in hot and dry weather and seasons, or arid and semi-arid climates to ensure vegetation establishment.
13. Where filtration system vegetation does not establish, it fails, or rilling occurs, the Contractor will repair, reseed, or provide an approved and functioning alternative.
14. No additional fertilizer or lime is required for vegetation establishment and maintenance.
15. Regular mowing of filtration system vegetation to a minimum height of 4 in (100mm) and a maximum height of 10 in (250mm) will deter invasive weeds, allow sunlight to kill captured pathogens.
16. Sediment shall be removed once it reaches 25% of the height of the vegetation (mowed) to prevent diversion of storm runoff and reduction of vegetation health and cover.

METHOD OF MEASUREMENT

Bid items shall show measurement as Filtrexx® Filtration System per square ft, per square yd, or per square m installed. Alternatively, bid items may show measurement as Filtrexx® Diversion and/or Filtrexx SiltSoxx® Filtration Baffle installed, as part of the Filtration system, per linear ft or linear meter installed, per diameter (8 in [200mm], 12 in [300mm], 18 in [450mm], 24 in [600mm]), or 32 in (800mm) as specified by the Engineer. Additionally, backfill media for cells shall show measurement as Filtrexx® GrowingMediatm, used as part of the filtration system, per cubic yard or cubic meter of material installed.

Engineer shall notify Filtrexx of location, description, and details of project prior to the bidding process so that Filtrexx can provide design aid and technical support.

FIELD APPLICATION PHOTO REFERENCES

Filtration system installation

Filtration "cell" system installation

ADDITIONAL INFORMATION

For other references on this topic, including additional research reports and trade magazine and press coverage, visit the Filtrexx website at filtrexx.com

Filtrexx International, Technical Support
877-542-7699 | www.filtrexx.com | info@filtrexx.com
Call for complete list of international installers and distributors.

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Table 6.3. Filtrexx SiltSoxx® Mesh Material Specifications.

Material Type	**NATURAL ORIGINAL** (Cotton Fiber)	**NATURAL PLUS** (Wood Fiber)	**BASIC** (5 mil High Density Polyethylene HDPE)	**BASIC PLUS** (Multi-Filament Polypropylene MFPP)	**DURABLE** (Multi-Filament Polypropylene MFPP)	**ORIGINAL / DURABLE PLUS / DURASOXX HD** (Multi-Filament Polypropylene MFPP)	**EXTREME** (Multi-Filament Polypropylene MFPP)
Material Characteristic	Biodegradable	Biodegradable	Photodegradable	Photodegradable	Photodegradable	Photodegradable	Photodegradable
Design Diameters	5 in (125mm), 8 in (200mm), 12 in (300mm)	5 in (125mm), 8 in (200mm), 12 in (300mm)	8 in (200mm), 12 in (300mm), 18 in (400mm)	8 in (200mm), 12 in (300mm), 18 in (400mm), 24 in (600mm), 32 in (800mm)	5 in (125mm), 8 in (200mm), 12 in (300mm), 18 in (400mm), 24 in (600mm), 32 in (800mm)	5 in (125mm), 8 in (200mm), 12 in (300mm), 18 in (400mm), 24 in (600mm)	8 in (200mm), 12 in (300mm)
Mesh Opening	1/8 in (3mm)	1/8 in (3mm)	3/8 in (10mm)	3/8 in (10mm)	1/8 in (3mm)	1/8 in (3mm)	1/16 in (1.5mm)
Tensile Strength (ATSM D4595)[1]	MD: 193 lbs TD: 158 lbs	MD: 210 lbs TD: 289 lbs	MD: 211 lbs TD: 79 lbs	MD: 236 lbs TD: 223 lbs	MD: 545 lbs TD: 226 lbs	MD: 670 lbs TD: 423 lbs	MD: 1062 lbs TD: 797 lbs
% Original Strength from Ultraviolet Exposure (ASTM G-155)	ND	ND	23% at 1000 hr	100% at 1000 hr	100% at 1000 hr	100% at 1000 hr	100% at 1000 hr
Functional Longevity/ Project Duration[2]	up to 12 months[3]	up to 18 months[4]	up to 4 yr	up to 4 yr	up to 5 yr	up to 5 yr	up to 5 yr

[1] Tensile Strength is based on 12" diameter using ATSM D4595. See Filtrexx TechLink #3342 for full tensile strength testing.
[2] Functional longevity ranges are estimates only. Site specific environmental conditions may result in significantly shorter or longer time periods.
[3] Data based on Caltrans research and specifications
[4] See TechLink #3339 for research & testing

Table 6.4. Filtration System, Filter Baffle Performance and Design Specifications Summary.

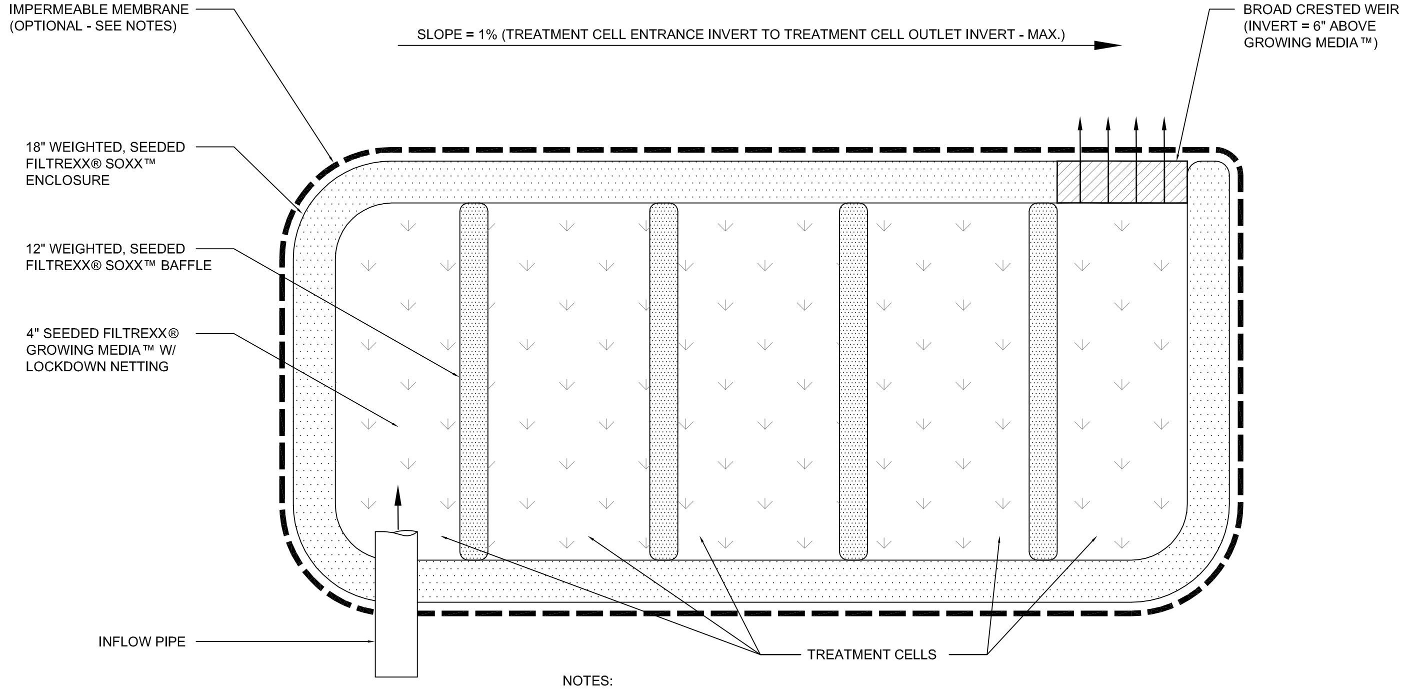
Design Diameter / Design & Performance	8 in (200mm)	12 in (300mm)	18 in (450mm)	24 in (600mm)	32 in (800mm)	Testing Lab/ Reference	Publication(s)
Effective Height	6.5 in (160mm)	9.5 in (240mm)	14.5 in (360mm)	19 in (480mm)	26 in (650mm)	The Ohio State University, Ohio Agricultural Research and Development Center	Transactions of the American Society of Agricultural & Biological Engineers, 2006
Effective Circumference	25 in (630mm)	38 in (960mm)	57 in (1450mm)	75 in (1900mm)	100 in (2500mm)		
Density (when filled)	13 lbs/ft (20 kg/m)	32 lbs/ft (50 kg/m)	67 lbs/ft (100 kg/m)	133 lbs/ft (200 kg/m)	200 lbs/ft (300 kg/m)	Soil Control Lab, Inc	
Air Space	20%	20%	20%	20%	20%	Soil Control Lab, Inc	
Maximum continuous length	unlimited	unlimited	unlimited	unlimited	unlimited		
Staking Requirement	10 ft (3m)	10 ft (3m)	10 ft (3m)	10 ft (3m)	10 ft (3m)		
Maintenance Requirement (sediment accumulation removal at X height)	3.25 in (80mm)	4.75 in (120mm)	7.25 in (180mm)	9.5 in (240mm)	13 in (325mm)		
Initial Maintenance Requirement based on Rainfall-Runoff*	22 in (55 cm); 1109 L/linear m	32 in (80 cm); 1388 L/linear m	42 in (105 cm); 1825 L/linear m	64 in (160 cm); 2776 L/linear m	86 in (215 cm); 3885 L/linear m	The University of Georgia & Auburn University	
Functional Longevity**	6 mo – 5 yr	6 mo – 5 yr	6 mo – 5 yr	6 mo – 5 yr	6 mo – 5 yr		
Maximum Slope Length (<2%)	600 ft (183m)	750 ft (229m)	1000 ft (305m)	1300 ft (396m)	1650 ft (500m)	The Ohio State University, Ohio Agricultural Research and Development Center	Filtrexx Design Tool, Filtrexx Library #301, Filtrexx Tech Link #3304 & #3311
Hydraulic Flow Through Rate	7.5 gpm/ft (94 L/min/m)	11.3 gpm/ft (141 L/min/m)	15.0 gpm/ft (188 L/min/m)	22.5 gpm/ft (281 L/min/m)	30.0 gpm/ft (374 L/min/m)	The Ohio State University, Ohio Agricultural Research and Development Center; University of Guelph, School of Engineering/ Watershed Research Group	Filtrexx Tech Link #3311 & #3313, #3308; American Society of Agricultural & Biological Engineers Meeting Proceedings, 2006, Second Interagency Conference on Research in Watersheds, 2006
P Factor (RUSLE)	0.1-0.32	0.1-0.32	0.1-0.32	0.1-0.32	0.1-0.32	USDA ARS Environmental Quality Lab/ University of Georgia	American Society of Agricultural & Biological Engineers Meeting Proceedings, 2006
Sediment Storage Capacity***	174 cu. in (2850cc)	396 cu. in (6490cc)	857 cu. in (14040cc)	1631 cu. in (26840cc)	2647 cu. in (43377 cc)		Filtrexx Tech Link #3314
Total Solids Removal	98%	98%	98%	98%	98%	Soil Control Lab, Inc	International Erosion Control Association, 2006
Total Suspended Solids Removal	78%	78%	78%	78%	78%	USDA ARS Environmental Quality Lab	Filtrexx Tech Link #3308; American Society of Agricultural & Biological Engineers Meeting Proceedings , 2006
Turbidity Reduction	63%	63%	63%	63%	63%	USDA ARS Environmental Quality Lab	Filtrexx Tech Link #3308; American Society of Agricultural & Biological Engineers Meeting Proceedings , 2006
Clay (<0.002mm) Removal	65%	65%	65%	65%	65%	USDA ARS Environmental Quality Lab	Filtrexx Tech Link
Silt (0.002-0.05mm) Removal	64%	64%	64%	64%	64%	USDA ARS Environmental Quality Lab	Filtrexx Tech Link

* Based on rainfall intensity of 12.5 cm (5 in)/hr applied to a bare clay loam soil at a 10% slope; runoff flow rate of 108 ml/sec/linear m (0.52 gpm/linear ft); and mean runoff volume of 230 L/m2 (6.3 g/ft2).

** Functional Longevity is dependent on mesh material type, UV exposure, freeze/thaw frequency, region of US/Canada, runoff-sediment frequency/durtion/loading, and adherence to specified maintenance requirement. Functional longevity ranges are estimates only. Site specific environmental conditions may result in significantly shorter or longer time periods.

*** Sediment Storage Capacity = sediment accumulation behind (directly upslope) + within the device.

Figure 6.1. Engineering Design Drawing for Filtrexx Filtration System - Option 1



NOTES:

1. Filtrexx® enclosure dimensions and baffle/flow diverter quantities and spacings to be varied as necessary to accomodate site conditions and to meet the design flow rate and hydraulic residence time requirements.
2. Impermeable liner may be required for point-source discharges.
3. All Soxx™ to be seeded per Landscape Architect's specifications.
4. All Filtrexx® Growing Media ™ blankets to be seeded per Landscape Architect's specifications.
5. System can be modified for constant (point-source) discharge or intermittent (nonpoint-source, construction, site, etc.) discharges.

FILTREXX® FILTRATION SYSTEM

NTS

Figure 6.2. Engineering Design Drawings for Filtrexx Filtration System - Sinuous Option

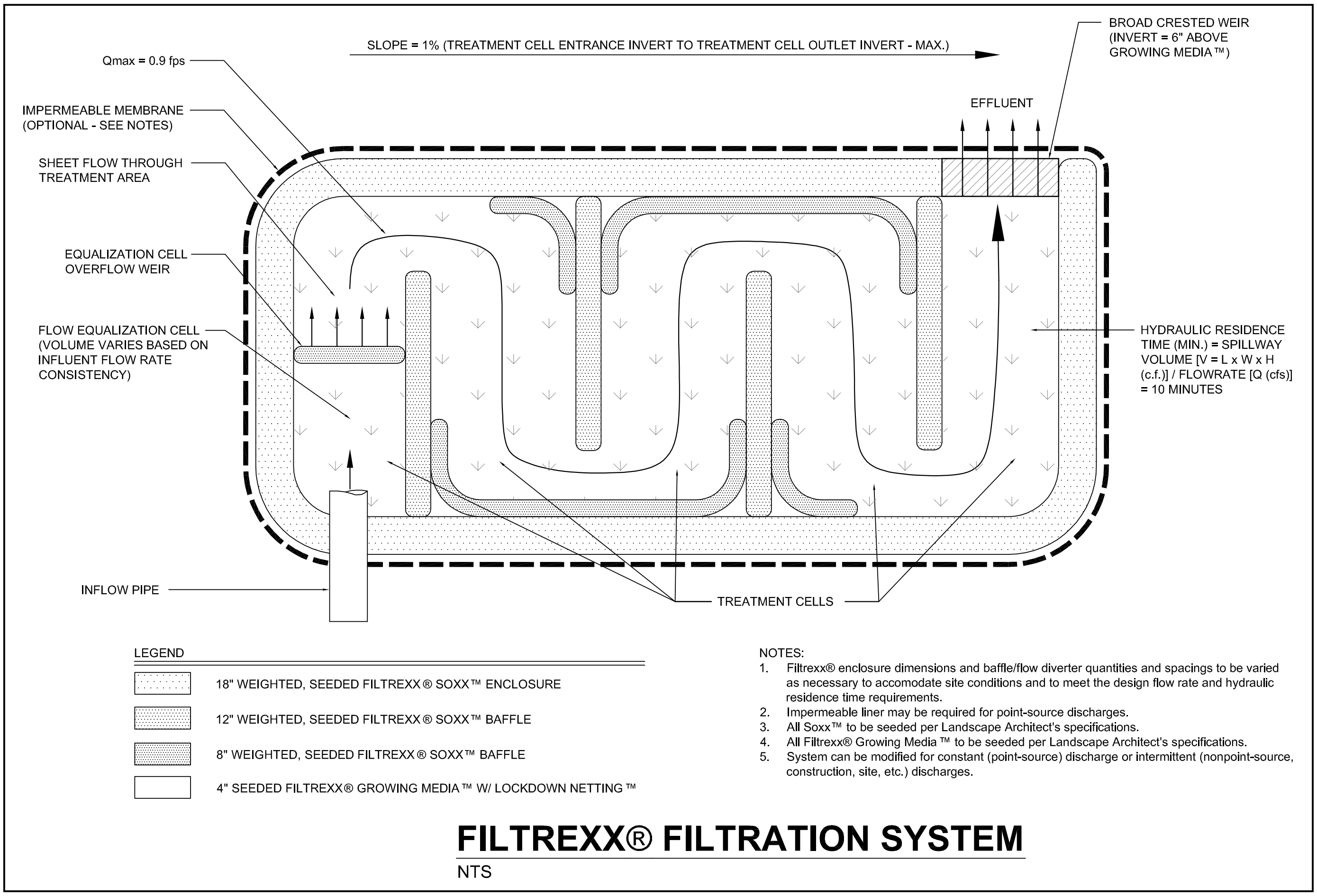


Figure 6.3. Staking Details for Filtrex Filtration System