### 2.4 Channel Protection

**PURPOSE & DESCRIPTION**

The **Filtrexx® Channel Protection** soft armoring system is designed to stabilize and prevent erosion of channel beds and banks used for storm water conveyance and concentrated flow situations. The channel protection technology provides structural protection, erosion control, vegetation growth, and vegetation reinforcement in the same system. The channel protection weight and anchoring system can withstand storm runoff velocities and hydraulic shear stresses similar to traditional soft armoring devices (turf reinforcement mats, rip rap, cellular confinement systems). Channel protection uses GroSoxx® - Filtrexx® Soxx™ mesh, filled with composted Filtrexx® GrowingMedia™.

The vegetated channel protection system is specifically designed to reinforce vegetation against intense hydraulic pressure. Once permanent vegetation is established in the channel protection, the following storm water management parameters are increased:

- structural stability of the channel and protection system,
- reduction of bed and bank erosion,
- protection from scour erosion,
- control of runoff velocity,
- dissipation of runoff energy, and
- sediment, soluble pollutant, and pathogen removal efficiency.

**APPLICATION**

Channel protection is used where storm water is conveyed or channeled and soil erosion and/or vegetation stability is an issue. Channel protection can be used to establish, sustain, and reinforce vegetation in areas of concentrated flow and intense hydraulic pressure that typically undermine vegetation growth. Applications where channel protection is typically required include:

- storm water diversion channels and ditches,
- storm water conveyance channels and ditches,
- channel/ditch bed and bank protection, and
- outlet protection for storm drains, paved channels, and culverts.

Vegetated channel protection can be used to dissipate the energy of storm flows and reduce velocity leaving the locations described above. Reducing runoff velocity will decrease soil erosion and increase pollutant removal through trapping, sediment deposition and plant uptake.

Any storm water conveyance system should direct water outfall to any one of the following areas: storm water collection ponds, infiltration zones, densely vegetated fields, level spreaders, constructed wetlands.

**ADVANTAGES AND DISADVANTAGES**

**Advantages**

- Channel protection reduces erosion of storm water conveyance channels and ditches.
- Channel protection can be used to stabilize channel bed and banks.
- Channel protection can be used in hydraulic shear stresses up to 12 lbs/square ft (59 kg/square m).
- Channel protection can be used on channel bed slopes up to 10%.
- Channel protection can be used on channel bank slopes up to 2:1.
- Channel protection can be used on channel bank slopes up to 3:1 where mowing will be performed to maintain vegetation.

The **ADVANTAGES** of Filtrexx® Channel Protection include:

- **Installation Difficulty**: High
- **Channel Protection**: High
- **Vegetation Establishment**: High
- **Maximum CFS/Shear Stress**: High
- **Runoff Velocity Reduction**: High
- **Sediment Control**: High
- **Soluble Pollutant Control**: High

**Disadvantages**

- Channel protection has greater surface contact with soil, channel bed, and channel banks, relative to rip rap, thereby providing greater protection from erosion.
- Channel protection soft armoring system includes GrowingMedia which establishes, sustains, and provides reinforcement for vegetation, unlike rip rap and other armoring devices.
- Channel protection can be direct seeded at the time of installation.
- Channel protection stability and channel protection/erosion prevention are increased with vegetation establishment within system.
- Vegetable channel protection filters sediment, soluble nutrients, heavy metals, petroleum hydrocarbons, pesticides, and pathogens from storm water flows.
- Vegetated channel protection slows runoff velocity, which can reduce erosion, increase infiltration, and increase sediment deposition and pollutant removal efficiency.
- Vegetated channel protection can remove pollutants from storm water by plant uptake.
- GrowingMedia in channel protection has 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.
- Microorganisms in GrowingMedia have the ability to degrade organic pollutants and cycle captured nutrients into beneficial and/or less toxic forms.
- Contained GrowingMedia in channel protection creates an ideal system for biotechnical engineering projects.
- Humus colloids and organic matter in GrowingMedia provide physical structure for seed, seedlings, and live stakes.
- Humus colloids and organic matter in GrowingMedia provide increased water holding capacity and reduced water evaporation to aid in seed germination, plant sustainability, and the potential for reduced irrigation.
- 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.
• Channel protection is organic, all natural, biodegradable, and locally manufactured.
• Channel protection can be easily designed and incorporated as one treatment in a treatment train approach to site or watershed storm water management.
• Channel protection 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 Channel protection does not use Filtrexx® 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.
• Channel protection should not be the only form of site or watershed storm water management.
• Channel protection may need to be reseeded or reapplied if significant storm flow occurs prior to vegetation establishment or where vegetation fails.
• Channel protection performance is generally lower prior to vegetation establishment and maturity.
• Channel protection installation is a land disturbing activity and can increase sediment loading if appropriate sediment control measures are not established during construction phase.
• Channel protection should not be used on channel bed slopes greater than 10%.
• Channel protection should not be used on channel bank slopes greater than 2:1.
• Channel protection should not be used on channel bank slopes greater than 3:1 where mowing will be performed to maintain vegetation.
• Channel protection may not function in hydraulic shear stresses over 12 lbs/square ft (59 kg/square m).

MATERIAL CHARACTERISTICS
Channel protection uses only Soxx photodegradable or biodegradable netting materials available from Filtrexx International, and are the only mesh materials accepted in creating Filtrexx Channel Protection for any purpose. For Soxx Material Specifications see Table 4.1

GROWINGMEDIA™ CHARACTERISTICS
Filtrexx Channel Protection uses only Filtrexx® GrowingMedia™ which is a composted material that is specifically designed for stability within the system and establishment and sustainability of vegetation growth. GrowingMedia can be third party tested and certified to meet minimum performance criteria defined by Filtrexx International. 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™.

PERFORMANCE
QA/QC material testing of Filtrexx GrowingMedia to ensure specifications are met is conducted by the Soil Control Lab, Inc. Research for channel protection is in progress. Performance testing and scientific research on related practices/technologies - vegetated filter strips, slope protection, and SilSoox™ has been conducted in recent years. Conservative assumptions can be made regarding channel protection in light of performance associated with the previously mentioned practices and applied field research. Filtrexx International has conducted research with the Texas Transportation Institute (TTI) of Texas A.M. University to quantify the performance and design limitations of Channel protection to aid engineering design professionals. See Table 4.3 for a summary of material specifications and Table 4.4 for a summary of performance testing results and design specifications. Note: the Contractor is responsible for establishing a working storm water management system and may, with approval of the Engineer, work outside the minimum construction requirements as needed. Where channel protection fails, it shall be repaired or replaced with an effective alternative.

DESIGN CRITERIA
Function
The primary functions of the channel protection (Figure 4.3) system are to prevent scouring and disperse energy of concentrated storm flow from outlets and culverts; and to stabilize drainage ditch and channel beds and banks to prevent erosion and reinforce vegetation against intense hydraulic pressure. Channel protection is unique in that GrowingMedia and seed are injected and contained within the structural armoring device. This system is ideal for biotechnical engineering and sustaining vegetation. The channel protection system is specifically designed to make contact with 100% of the soil surface in the channel bed and on channel banks, thereby protecting the structural integrity and preventing erosion.

Any storm water conveyance or drainage systems should be designed to lead or direct water outfall to any one of the following areas: storm water collection ponds, infiltration zones, densely vegetated fields, level spreaders, constructed wetlands.

Once vegetated, channel protection (Figure 4.3) is effective at filtering pollutants from storm runoff under sheet flow and concentrated flow conditions due to physical trapping and runoff velocity reduction by the vegetation. Large particles are removed in greater efficiencies than suspended particles. Maintenance is a key consideration, as sediment build-up will significantly reduce the ability of vegetated channel protection to remove pollutants from storm runoff. Pollutant removal efficiency has been correlated to slope degree, area of vegetation, vegetation type, cover, height, and density.

Humus content within the GrowingMedia has the ability to chemically adsorb and bind soluble pollutants such as phosphorus, ammonium-nitrogen, heavy metals, and petroleum hydrocarbons, making them unavailable for plant or animal uptake (Filtrexx Tech Link #3307 and #3308). Additionally, many plants have the ability to take up excess nutrients and pollutants trapped in the vegetation, while microorganisms can decompose and/or incorporate these pollutants, 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.
Planning Considerations
Channel protection should be used as one treatment in a treatment train approach to storm water management. Preconstruction meetings should be conducted to educate construction site personnel about the devices/practices used and acceptable traffic patterns that avoid running over channel protection with vehicles and heavy equipment. Vehicular traffic and heavy equipment may reduce the effectiveness of channel protection and contribute to compaction, which may increase runoff and erosion and reduce vegetation establishment. Note: any natural (not man-made) drainage ditch or channel stabilization and vegetation project requires permit and approval by the US Army Corp of Engineers.

Vegetation Selection
Successful planning for any vegetation establishment project should consider 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, runoff velocity potential, 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 Channel protection will be exposed to prolonged moisture, wetland species may be required. Generally, tall and sturdy grasses are better at sediment removal than low growing, flexible grasses and legumes (Grismert et al., 2006; USDA-NRCS, 2004). Additionally, deep rooted grasses will be more stable under high storm flow velocity and shear stress.

Local landscape architects, NRCS, or cooperative extension should be consulted and used as resources for 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 ditches and 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.

Runoff Velocity & Shear Stress
Channel protection 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. Channel protection provides for a maximum shear stress of 12 lbs/square ft (59 kg/square m).

Traditionally, the flow velocity (ft/sec or m/sec) does not account for the pressure and stress created by depth of concentrated flow within the channel. Because the pressure created by flow depth is an important variable in channel bed erosion, using only ft/sec (m/sec) may not be the best criteria to design for channel bed and bank protection. Permissible shear stress (tractive or frictional force) on channel lining and protection devices may be a better design limit criteria, as shear stress determination includes depth of flow variables. Because shear stress within the area of a channel can be variable, generally the maximum shear stress is used as a design parameter rather than the mean. The area in a channel where shear stress is always greatest is where the depth of flow is greatest (and tractive or frictional force) – the channel bed. Therefore the maximum shear stress of a channel protection device reflects its performance and design limit in the channel bed, which should be sufficient for flow velocity and shear stress along the channel banks within the same channel.

To determine the maximum shear stress in a channel bed use:

\[ T_{\text{max}} = y \times Y \times S \]

Where:
\[ T_{\text{max}} \text{ = maximum shear stress (lb/sq ft, kg/sq m)} \]
\[ y \text{ = density of water (62.4 lb/cu ft, 1011 kg/cu m)} \]
\[ Y \text{ = depth of water (ft, m)} \]
\[ S \text{ = slope of gradient (ft/ft, m/m)} \]

To determine the mean shear stress in a channel use:

\[ T_{\text{mean}} = (y \times A \times S)/P \]

Where:
\[ T_{\text{mean}} \text{ = mean shear stress (lb/sq ft, kg/sq m)} \]
\[ y \text{ = density of water (62.4 lb/cu ft, 1011 kg/cu m)} \]
\[ A \text{ = cross-sectional area (sq ft, sq m)} \]
\[ S \text{ = slope of gradient (ft/ft, m/m)} \]
\[ P \text{ = wetted perimeter} \]

To determine velocity of flow in a channel use Manning’s Equation:

\[ T_{\text{mean}} = (y \times A \times S)/P \]

\[ T_{\text{max}} = y \times Y \times S \]

Table 4.1. FHWA HEC 15 Retardance Class, Stand Height, and Permissible Shear Stress for Grasses used in Channels, Ditches, and Concentrated Flow Applications.

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

(Source: ECTC - Erosion Control Technology Council, 2006)
Channel protection shall be placed underneath culvert piping or other outfall piping devices to ensure point of water contact is on surface of channel protection. Channel protection shall be installed to ensure dimensions of sock are 3 in (75mm) high by 12 in wide (300mm). Alternatively, channel protection may be formed using standard 8 in (200mm) or 12 in (300mm) diameter cones, and compressed once installed. Channel protection shall be placed parallel to flow, with edges fitting tightly together. Channel protection shall be slightly compacted and edges smoothed to create a seamless surface for water flow.

Stakes shall be installed through the middle of the channel protection on 10 ft (3m) centers, using 2 in (50mm) by 2 in (50mm) by 3 ft (1m) wooden stakes. Alternatively, L-shaped rebar may be installed through the middle of the channel protection on 10 ft (3m) centers, where the “L” shall be bent to form a hook over the top of the channel protection and pounded to fit snug. Stakes shall also be placed at the ends of the channel protection to hold it in place. Staking depth for sand and silt loam soils shall be 12 in (300mm), and 8 in (200mm) for clay soils. Channel protection may be seeded at the time of application, seed selection will be determined by the Engineer. Seeded channel protection should not be installed prior to seasons where growing vegetation is difficult. Seed shall be thoroughly mixed with the GrowingMedia prior to construction or injected into GrowingMedia at time of application.

Optional biotechnical engineering with seedlings, tubers, and/or live stakes should be planted after staking. The entire area should be thoroughly watered after seeding and planting. Additional irrigation may be required until vegetation is well established.

See Figures 4.1 and 4.2 for design drawing detail specifications and staking requirements.

**Table 4.2. Flow Dissipater Sizing for Storm Outlets.**

<table>
<thead>
<tr>
<th>Culvert Size</th>
<th>Apron width at pipe</th>
<th>Apron length for low flow</th>
<th>Apron length for high flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 in (200mm)</td>
<td>2-3 ft (0.6-1m)</td>
<td>3-5 ft (1-1.5m)</td>
<td>5-7 ft (1.5-2.1m)</td>
</tr>
<tr>
<td>12 in (300mm)</td>
<td>3-4 ft (1-1.2m)</td>
<td>4-6 ft (1-1.8m)</td>
<td>8-12 ft (2.4-3.6m)</td>
</tr>
<tr>
<td>18 in (450mm)</td>
<td>4-6 ft (1.2-1.8m)</td>
<td>6-8 ft (1.8-2.4m)</td>
<td>12-18 ft (3.6-5.5m)</td>
</tr>
<tr>
<td>24 in (600mm)</td>
<td>6-8 ft (1.8-2.4m)</td>
<td>8-12 ft (2.4-3.6m)</td>
<td>18-22 ft (5.5-6.7m)</td>
</tr>
<tr>
<td>30 in (750mm)</td>
<td>8-10 ft (2.4-3m)</td>
<td>12-14 ft (3.6-4.3m)</td>
<td>22-28 ft (6.7-8.5m)</td>
</tr>
<tr>
<td>36 in (900mm)</td>
<td>10-12 ft (3-3.6m)</td>
<td>14-16 ft (4.3-4.9m)</td>
<td>28-32 ft (8.5-9.8m)</td>
</tr>
<tr>
<td>42 in (1050mm)</td>
<td>12-14 ft (3.6-4.3m)</td>
<td>16-18 ft (4.9-5.5m)</td>
<td>32-38 ft (9.8-11.6m)</td>
</tr>
<tr>
<td>48 in (1200mm)</td>
<td>14-16 ft (4.3-4.9m)</td>
<td>18-25 ft (5.5-7.6m)</td>
<td>38-44 ft (11.6-13.4m)</td>
</tr>
</tbody>
</table>

(Source: Kentucky Erosion Prevention and Sediment Control Field Guide)

**Establishing & Sustaining Vegetation**

Channel protection is seeded at the time of application by injection into GrowingMedia during channel protection construction.

Grasses should be mowed and maintained between 4 and 10 in. high, unless otherwise specified. Taller grasses may have higher sediment removal efficiency and sediment storage capacity, and a greater ability to dissipate runoff energy and reduce storm flow velocity relative to low growing or low maintained grasses.

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.

GrowingMedia supplies humus, organic matter, beneficial microbes, and slow release organic nutrients that can contribute 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. Channel protection 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.
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2.4 Channel Protection

**INSTALLATION**

1. Channel protection shall meet Filtrexx Soxx Mesh Material and Filtrexx Certified GrowingMedia 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. Channel protection will be placed at locations indicated on plans as directed by the Engineer.
4. Channel protection must be installed and stabilized before flow is allowed from culverts and storm outlets.
5. Land surface shall be cleared of debris, including rocks, roots, large clods, and sticks prior to channel protection installation.
6. Channel bed shall be made smooth prior to installation of channel protection.
7. Soil bed may be compacted and graded prior to installation.
8. The upslope end of the channel protection shall be installed under the lip of the culvert or outlet drain to ensure initial storm flow contact is on top of the channel protection, not under or in front of the system.
9. Channel protection will be fabricated on-site or prefabricated and delivered to site for installation.
10. Channel protection will be fabricated to ensure 3 in (75mm) high by 12 in (300mm) wide Soxx construction configuration is met.
11. Channel protection shall be placed parallel to water flow, where socks are tightly abutted to prevent water seepage between and underneath the channel protection.
12. Once in place, channel protection shall be lightly compacted and abutting edges leveled to tighten seal between socks and encourage even water flow over channel protection system.
13. Channel protection shall not be installed on channel bed slopes greater than 10%.
14. Channel protection shall not be installed on channel banks greater than 2:1, and banks 3:1 if mowing will be conducted to manage vegetation.
15. Stakes shall be installed through the middle of the Channel protection on 10 ft (3m) centers, using 2 in (50mm) by 2 in (50mm) by 3 ft (1m) wooden stakes. Top of stakes should be cut off, leaving 3 in (75mm) above the top of the channel protection.
16. Alternatively, L-shaped rebar may be installed through the middle of the channel protection on 10 ft (3m) centers, where the “L” shall be bent to form a hook over the top of the channel protection and pounded to fit snug.
17. Stakes shall also be placed at the ends of channel protection to hold it in place.
18. Staking depth for sand and silt loam soils shall be 12 in (300mm), and 8 in (200mm) for clay soils.
19. Channel protection may be seeded at the time of application, seed selection will be determined by the Engineer.
20. Seeded channel protection should not be installed prior to seasons where growing vegetation is difficult.
21. Seed shall be thoroughly mixed with the GrowingMedia prior to construction or injected into GrowingMedia at time of application.
22. Optional biotechnical engineering with live stakes should be conducted after staking is complete.
23. Seeded channel protection shall be thoroughly watered after installation and allowed to settle for 1 week.

**INSPECTION**

Routine inspection should be conducted within 24 hours of a runoff 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, channel protection should be repaired and/or reseeded. If bank or bed erosion occurs, the area should be repaired immediately. Vegetation practices should always be inspected for noxious or invasive weeds. 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 channel protection in a functional condition at all times and it shall be routinely inspected.
2. Seeded channel protection shall be maintained until a uniform 70% minimum cover of the applied area has been vegetated, permanent vegetation has established, or as required by the jurisdictional agency.
3. Seeded channel protection may need to be irrigated in hot and dry weather and seasons, or arid and semi-arid climates to ensure vegetation establishment.
4. Where channel protection fails or becomes dislodged, the contractor will ensure the product is in good contact with the soil, repair, and use additional staking if necessary.
5. Where bank or bed erosion occurs, the contractor will regrade the soil if necessary and repair or replace the channel protection.
6. Where vegetation does not establish the contractor will reseed, replant, or provide an approved and functioning alternative.
7. No additional fertilizer or lime is required for vegetation establishment and maintenance.
8. No disposal is required for this product/practice.
9. Channel protection shall be left on-site and become part of the permanent landscape, unless otherwise specified by the Engineer.
10. Regular mowing of grass vegetation on seeded channel protection 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, and provide maximum sediment removal efficiency and sediment storage capacity in the vegetation.
11. Storm debris and trash deposited on channel protection should be removed immediately.
12. Sediment shall be removed if 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® Channel Protection/GroSoxx® per square ft, per square yard, or per square meter 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**

Installation of channel protection

Channel protection after

**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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**REFERENCES CITED & ADDITIONAL RESOURCES**


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Environmental effects to applying composted organics to new highway


Table 4.3. Filtrexx® Soxx™ Mesh Material Specifications.

<table>
<thead>
<tr>
<th>Material Type</th>
<th>NATURAL ORIGINAL (Cotton Fiber)</th>
<th>NATURAL PLUS (Wood Fiber)</th>
<th>BASIC (5 mil High Density Polyethylene HDPE)</th>
<th>BASIC PLUS (Multi-Filament Polypropylene MFPP)</th>
<th>DURABLE (Multi-Filament Polypropylene MFPP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Characteristic</td>
<td>Biodegradable</td>
<td>Biodegradable</td>
<td>Photodegradable</td>
<td>Photodegradable</td>
<td>Photodegradable</td>
</tr>
<tr>
<td>Design Diameters*</td>
<td>5 in (125mm), 8 in (200mm), 12 in (300mm)</td>
<td>5 in (125mm), 8 in (200mm), 12 in (300mm)</td>
<td>8 in (200mm), 12 in (300mm), 18 in (400mm), 24 in (600mm), 32 in (800mm)</td>
<td>8 in (200mm), 12 in (300mm), 18 in (400mm), 24 in (600mm), 32 in (800mm)</td>
<td>5 in (125mm), 8 in (200mm), 12 in (300mm), 18 in (400mm), 24 in (600mm), 32 in (800mm)</td>
</tr>
<tr>
<td>Mesh Opening</td>
<td>1/8 in (3mm)</td>
<td>1/8 in (3mm)</td>
<td>3/8 in (10mm)</td>
<td>3/8 in (10mm)</td>
<td>1/8 in (3mm)</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>44 psi (3.09 kg/cm2)</td>
<td>76 psi (5.34 kg/cm2)</td>
<td>26 psi (1.83 kg/cm²)</td>
<td>44 psi (3.09 kg/cm2)</td>
<td>202 psi (14.2 kg/cm²)</td>
</tr>
<tr>
<td>% Original Strength from Ultraviolet Exposure (ASTM G-155)</td>
<td>ND</td>
<td>ND</td>
<td>23% at 1000 hr</td>
<td>100% at 1000 hr</td>
<td>100% at 1000 hr</td>
</tr>
<tr>
<td>Functional Longevity/Project Duration**</td>
<td>up to 12 months***</td>
<td>up to 18 months****</td>
<td>up to 4 yr</td>
<td>up to 4 yr</td>
<td>up to 5 yr</td>
</tr>
</tbody>
</table>

* Channel protection is typically compacted to create a single Soxx™ (as part of the entire system) dimension 3 in (75mm) high by 12 in (300mm) wide.
** Functional longevity ranges are estimates only. Site specific environmental conditions may result in significantly shorter or longer time periods.
*** Data based on Caltrans research and specifications
**** See TechLink #3339 for research & testing

Table 4.4. Filtrexx® Soxx™ Specifications.

<table>
<thead>
<tr>
<th>Design Specification</th>
<th>8 in (200mm)</th>
<th>12 in (300mm)</th>
<th>18 in (450mm)</th>
<th>24 in (600mm)</th>
<th>32 in (800mm)</th>
<th>Testing Lab/Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective Height*</td>
<td>6.5 in (100mm)</td>
<td>9.5 in (125mm)</td>
<td>14.5 in (150mm)</td>
<td>19 in (180mm)</td>
<td>26 in (250mm)</td>
<td>Filtrexx International Field Lab</td>
</tr>
<tr>
<td>Effective Circumference</td>
<td>25 in (63mm)</td>
<td>38 in (96mm)</td>
<td>57 in (145mm)</td>
<td>75 in (190mm)</td>
<td>100 in (250mm)</td>
<td>Filtrexx International Field Lab</td>
</tr>
<tr>
<td>Density</td>
<td>18 lbs/ft² (27 kg/m²)</td>
<td>45 lbs/ft² (68 kg/m²)</td>
<td>100 lbs/ft² (151 kg/m²)</td>
<td>240 lbs/ft² (363 kg/m²)</td>
<td>300 lbs/ft² (450 kg/m²)</td>
<td>Texas Transportation Institute- TX A&amp;M.</td>
</tr>
<tr>
<td>Air Space</td>
<td>Testing in Progress</td>
<td>Testing in Progress</td>
<td>Testing in Progress</td>
<td>Testing in Progress</td>
<td>Testing in Progress</td>
<td>Soil Control Lab, Inc</td>
</tr>
<tr>
<td>Staking Requirement</td>
<td>10 ft (3m)</td>
<td>10 ft (3m)</td>
<td>10 ft (3m)</td>
<td>10 ft (3m)</td>
<td>10 ft (3m)</td>
<td>Filtrexx International Field Lab</td>
</tr>
<tr>
<td>Max. Velocity (ASTM D-6460)</td>
<td>14.5 ft/sec (4.4 m/sec)</td>
<td>14.5 ft/sec (4.4 m/sec)</td>
<td>14.5 ft/sec (4.4 m/sec)</td>
<td>14.5 ft/sec (4.4 m/sec)</td>
<td>14.5 ft/sec (4.4 m/sec)</td>
<td>Texas Transportation Institute- TX A&amp;M.</td>
</tr>
<tr>
<td>Max. Hydraulic Shear Stress (ASTM D-6460)</td>
<td>12 lbs/ft² (59 kg/m²)</td>
<td>12 lbs/ft² (59 kg/m²)</td>
<td>12 lbs/ft² (59 kg/m²)</td>
<td>12 lbs/ft² (59 kg/m²)</td>
<td>12 lbs/ft² (59 kg/m²)</td>
<td>Texas Transportation Institute- TX A&amp;M.</td>
</tr>
<tr>
<td>Manning’s n (roughness coefficient)</td>
<td>Non-vegetated (0.022); Grass (0.035); Grass + Live Stakes/young or thin (0.05); Grass + Live Stakes/mature or dense (0.075)</td>
<td>Non-vegetated (0.022); Grass (0.035); Grass + Live Stakes/young or thin (0.05); Grass + Live Stakes/mature or dense (0.075)</td>
<td>Non-vegetated (0.022); Grass (0.035); Grass + Live Stakes/young or thin (0.05); Grass + Live Stakes/mature or dense (0.075)</td>
<td>Non-vegetated (0.022); Grass (0.035); Grass + Live Stakes/young or thin (0.05); Grass + Live Stakes/mature or dense (0.075)</td>
<td>Non-vegetated (0.022); Grass (0.035); Grass + Live Stakes/young or thin (0.05); Grass + Live Stakes/mature or dense (0.075)</td>
<td>Texas Transportation Institute- TX A&amp;M.</td>
</tr>
<tr>
<td>Slope</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>Texas Transportation Institute- TX A&amp;M.</td>
</tr>
<tr>
<td>Media Type</td>
<td>Growing Media™</td>
<td>Growing Media™</td>
<td>Growing Media™</td>
<td>Growing Media™</td>
<td>Growing Media™</td>
<td>Texas Transportation Institute- TX A&amp;M.</td>
</tr>
<tr>
<td>Sock Material</td>
<td>Multi-Filament Polypropylene</td>
<td>Multi-Filament Polypropylene</td>
<td>Multi-Filament Polypropylene</td>
<td>Multi-Filament Polypropylene</td>
<td>Multi-Filament Polypropylene</td>
<td>Texas Transportation Institute- TX A&amp;M.</td>
</tr>
<tr>
<td>Vegetation Type</td>
<td>Triple Rye; Bermuda + Green Sprangletop</td>
<td>Triple Rye; Bermuda + Green Sprangletop</td>
<td>Triple Rye; Bermuda + Green Sprangletop</td>
<td>Triple Rye; Bermuda + Green Sprangletop</td>
<td>Triple Rye; Bermuda + Green Sprangletop</td>
<td>Texas Transportation Institute- TX A&amp;M.</td>
</tr>
<tr>
<td>Vegetation Cover</td>
<td>70-100%</td>
<td>70-100%</td>
<td>70-100%</td>
<td>70-100%</td>
<td>70-100%</td>
<td>Texas Transportation Institute- TX A&amp;M.</td>
</tr>
</tbody>
</table>

* Typical design height without compaction
1. Soxx™ shall meet Filtrexx Soxx™ Specifications and use Filtrexx GrowingMedia™.
2. Contractor is required to be a Filtrexx Certified™ Installer.
3. Soxx™ must be installed and stabilized before flow is allowed from culverts and storm outlets.
4. Land surface shall be cleared of debris, including rocks, roots, large clogs, and sticks prior to Soxx™ installation.
5. Channel bed shall be made smooth prior to installation of Soxx™.
6. Soil bed may be compacted and graded prior to installation.
7. The upslope end of the Soxx™ shall be installed under the lip of the culvert or outlet drain to ensure initial flow contact is on top of the Soxx™, not under or in front of the system.
8. Soxx™ shall be placed parallel to water flow, where socks are tightly abutted to prevent water seepage between and underneath the Soxx™.
9. Once in place, Soxx™ shall be tightly compacted and abutting edges leveled to tighten seal between socks and encourage even water flow over Soxx™ system.
10. Stakes shall be installed through the middle of the Soxx™ on 10 ft (3m) centers, using 2 in (50mm) by 2 in (50mm) by 3 ft (1m) wooden stakes. Top of stakes should be cut off, leaving 3 in (75mm) above the top of the Soxx™.
11. Soxx™ may be seeded at the time of application, seed selection will be determined by the Engineer.
**Figure 4.2.** Engineering Design Drawing for Filtrexx® Channel Protection - New Channel

**CHANNEL PROTECTION 6' SECTION**

1. Sox™ shall meet Filtrexx Soxx™ Specifications and use Filtrexx GrowingMedia™.
2. Contractor is required to be a Filtrexx Certified™ Installer.
3. Sox™ must be installed and stabilized before flow is allowed from culverts and storm outlets.
4. Land surface shall be cleared of debris, including roots, roots, large cloth, and debris prior to Sox™ installation.
5. Channel bed shall be made smooth prior to installation of Sox™.
6. Soil test may be completed and graded prior to installation.
7. The upgradient end of the Sox™ shall be installed under the fill of the culvert or outlet drain to ensure initial storm flow contact is on top of the Sox™, not under or in front of the system.
8. Sox™ shall be placed parallel to water flow, where sox are tightly abutted to prevent water seepage between and underneath the Sox™.
9. Once in place, Sox™ shall be tightly compacted and splint edges located to tighten seal between sox and encourage even water flow over Sox™ system.
10. Stakes shall be installed through the middle of the Sox™ on 10 ft (3m) centers, using 2 in (50mm) by 2 in (50mm) by 3 ft (1m) wooden stakes. Top of stakes should be cut off, leaving 3 in (75mm) above top of the Sox™.
11. Sox™ may be seeded at the time of application, seed selection will be determined by the Engineer.

**FILTREXX® CHANNEL PROTECTION - NEW CHANNEL**

**Figure 4.3.** Staking Details for Filtrexx® Channel Protection

**FILTREXX® SILT SOXX™**

1. 2" Headwidth wooden stakes placed 10' on center
2. Filtrerexx® Silt Soxx (5”, 8”, 9”, or 12” typical)
3. Area to be protected
4. Section View