eljen CORPORATION

GSF™

Geotextile Sand Filter
Design & Installation Guidelines

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Geotextile Sand Filter

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General Description of the Geotextile Sand Filter

Eljen's Geotextile Sand Filter (GSF) system is based upon 30 years of success, following research by nationally recognized engineering scientists from the University of Connecticut. With over 50,000 systems in use today, the GSF is recognized by regulatory officials and experts in the industry as the most reliable pretreatment technology in the marketplace today. The system specification is based on this research and history. While many products are based on claims of increased efficiency, the GSF is based on sound research and validation that improved effluent quality provides increased soil absorption rates. Papers on the fundamental research as well as testimonials from state officials on performance history are listed in the Reference Library and may be acquired from Eljen Corporation. Visit www.eljen.com for details.

The GSF system is a cost-effective, upgrade from conventional septic technology with the prefiltration process enhancing aerobic pretreatment in the soil. The Eljen Geotextile Sand Filter design is based on research and documentation on how this system improves water quality.. The system applies a better than secondary aerobic effluent to the soils following a two stage treatment process. Septic effluent is first filtered through an extensive geotextile membrane sized for filtration of septic effluent. This geotextile filter module exceeds surface area for soil infiltration with 1440 square feet of required by Eljen Corporation. Sand filtration completes the process with effluent moving into the soil through an unsaturated sand layer. Complete nitrification of the effluent in the sand reduces oxygen demand in the soil and thereby minimizes soil clogging by anaerobic bacteria. Very simply, the GSF increases the ability of the soil to accept the pretreated effluent. The geotextile filter modules also protect the specified sand fill from fines that can clog the sand. In turn, the sand filtration layer above the soil protects the soil from compaction and helps maintain cracks and crevices in the soil. This preserves the soils natural infiltration area. This later feature of the system is especially important in finer textured soils, where these large channels are critical to long-term performance

The GSF cross section shows a sand placement and dimensions of the B43 module. Each filter module is 4 feet long with a 6-inch layer of specified sand surrounding the geotextile row. Each filter module contains a series of corrugations that create vertical filtering surfaces that are equal to eight times the basal area. Each linear foot provides a 24 Square foot geotextile interface..

Trench Cross Section B43
Description and Dimensions

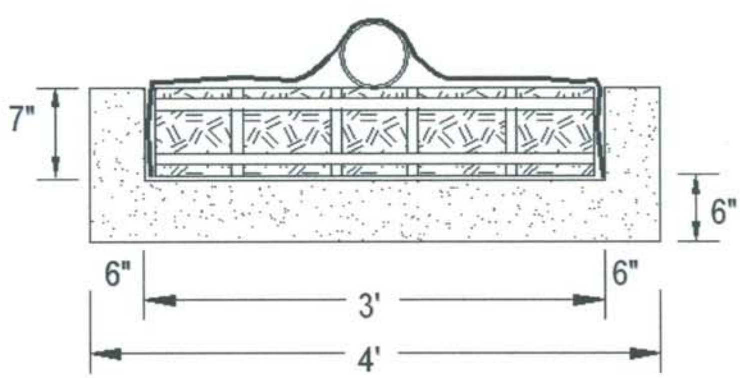

Figure 1

Most importantly, as shown in Figure 2 (below), an air channel backs corrugation, supporting aerobic bacteria that grow on the geotextile interface. Perforated pipe centered above the media distributes septic effluent over and into the geotextile corrugations. A geotextile fabric covers the geotextile modules and maintains effluent storage within the modules. A sand layer above the media is covered with soil backfill.

Performance Features of GSF

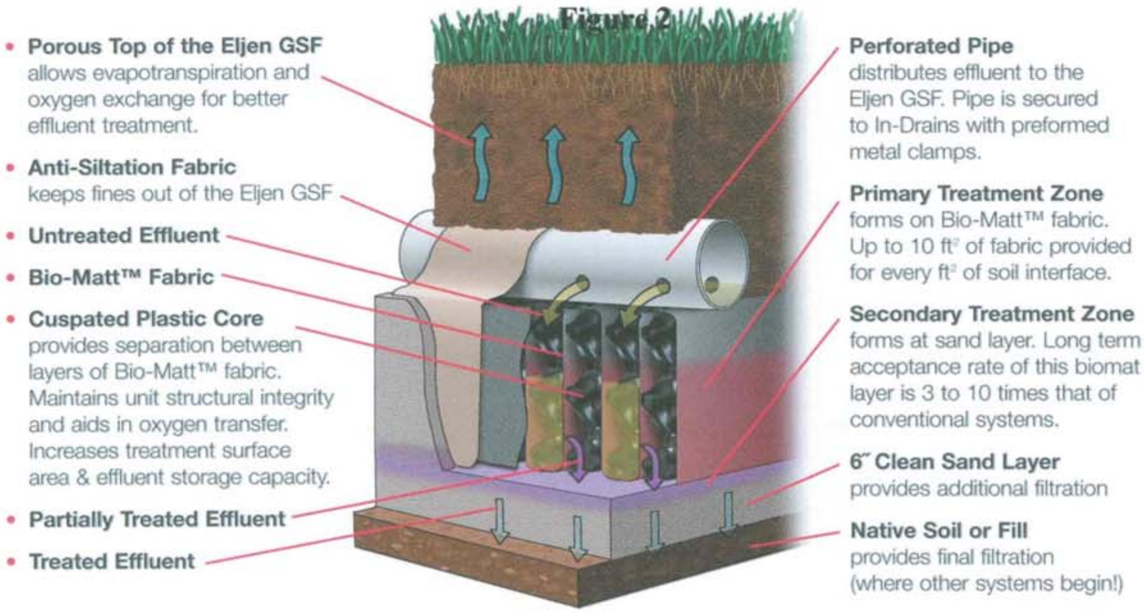

Figure 2

The GSF System contains a series of 4-foot long B43 modules. Each row of media is encased in 6 inches of specified sand, including the ends of each row. For example a minimum 15 B43 module trench is 4 feet wide and 61 feet long with pipe invert 13 inches above the soil excavation as shown below. The product can be used in trenches or beds with (see Table 1 and 2 for effective leaching area). This manual shows possible layouts using sequential, equal or dosed distribution designs. Unique design and construction procedures for this pretreatment system are included.

Single Trench Layout

15 B43 Geotextile Filter Modules / 61 x 4 Foot Wide GSF Trench

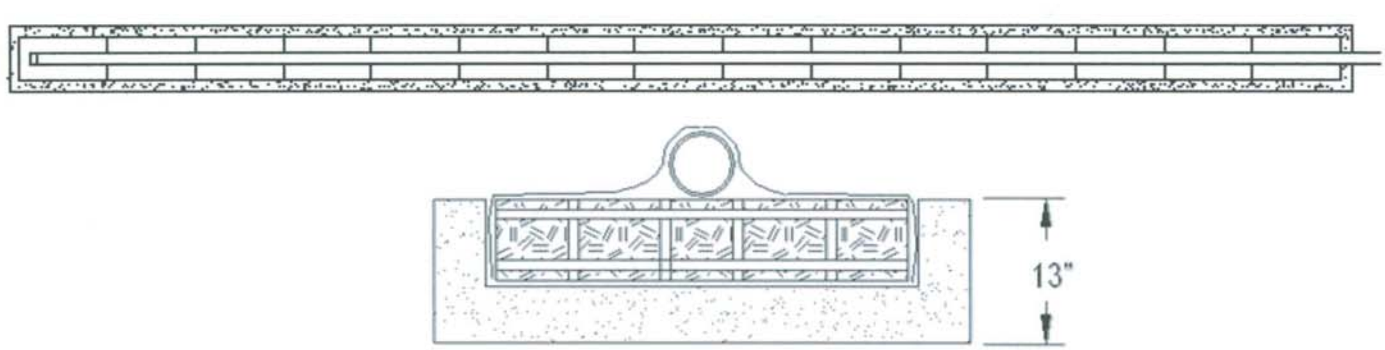

Figure 3

Terms and Definitions

B43:	Geotextile Filter Module, measuring 36" x 48" x 7".
Cover Fabric	Geotextile cover fabric (provided by manufacture) placed over modules

Weight	ASTM D 5261	oz/sq. yd	5.0
Grab Tensile	ASTM D 4632	Lbs	130
Grab Elongation	ASTM D 4632	%	50
Trap Tear	ASTM D 4533	Lbs	55
Puncture	ASTM D 4833	Lbs	75
Mullen Burst	ASTM D 3786	Psi	265
Permittivity	ASTM D 4491	1/sec	1.7
Water Flow	ASTM D 4491	gpm/sft	115
A.O.S.	ASTM D 4751	U.S. sieve	70
U.V. Resistance after 150 hours	ASTM D 4355	% Strength retained.	70

Cuspated Core:	Rigid plastic core used to separate geotextile and create downward infiltration channels and upward aeration channels for primary filtration and biological treatment of the septic effluent.
Design Flow:	Estimated peak flow gallons per day per bedroom for residential systems or as specified in Appendix 75-A.
Distribution Box	A concrete box that receives effluent from a septic tank and splits the flow to pipes above the geotextile filter modules all at the same elevation unless pressure dosed. For equal distribution, such as after a pump, the pipe inlet orifices are frequently set at the same elevation to equalize the flow to each line. The D-box method of distribution is only used where the receiving filter modules are of equal length or looped at the distal end with less than 6 inch drop from the box to GSF to insure equalizes flow to other lines.
EHGWT:	Estimated High Ground Water Table is the elevation of saturated condition as measured or as estimated from evaluation of soil color
ELA:	Effective Leaching Area – equivalent soil infiltration area receiving the GSF effluent.
GSF System:	Geotextile Sand Filter includes both filter module and specified sand layer
GFM:	Geotextile Filter Module
LTAR:	Long Term Acceptance Rate the average equilibrium absorption rate for septic effluent, usually in gallons per day per square foot.

Definitions (continued)

Serial or Sequential Distribution:	Designs common to sloping sites where GFM lines laid on contour receive effluent from a series of drop boxes at different elevations. Effluent floods upslope lines and then spills excess effluent to down slope drop boxes. Each drop box allows inspection and control of effluent into each line of media and can be used to rest upslope lines if the GSF system is managed. This method is not limited to sloping sites.
Specified Sand:	ASTM C33 Sand with <10% Passing #100 sieve and less than 3% passing #200 with Coefficient of Permeability >5 feet.
STE:	Septic Tank Effluent is anaerobically digested effluent discharged to a Geotextile Sand Filter
Wire Clamps:	Hoops used to secure perforated pipe above the geotextile filter modules.
Width & Length	Sand dimension perpendicular to the module row is the system width, as apposed to system length, which is parallel to the rows of filter modules.

Basic System Design

Sizing Table applies to all residential systems (see sizing table on page 17). The 7 inch tall Geotextile Filter Modules are placed on top of a 6-inch (minimum) level surface of specified sand. The perforated 4-inch diameter approved distribution pipe "SDR35 or equivalent is secured to the top of each GFM with provided wire clamps. Geotextile fabric covers the top and sides along the entire length of each row. Specified sand placed along both sides and across the top of the GFM insures aeration of the media. Additional sand placed above the unit is acceptable. When backfilling the installation with native soil, stones 2 inches or larger must be removed. Finished grade for the leaching area diverts storm water runoff. Driving or paving over Geotextile Sand Filter area is prohibited. Seeding and stabilizing the soil cover is required to protect the system from soil erosion.

Trench Layout

The trench configuration is the most cost effective application of the GSF. While end loading is common, central loading using a D-box is also an option where the trench(s) are at the same elevation. The minimum trench width is 4 feet for the sand layer. More sand width can be added down slope in less permeable soils to increase the soil contact area for absorption of the pretreated effluent.

Simple Split Trench with D-Box

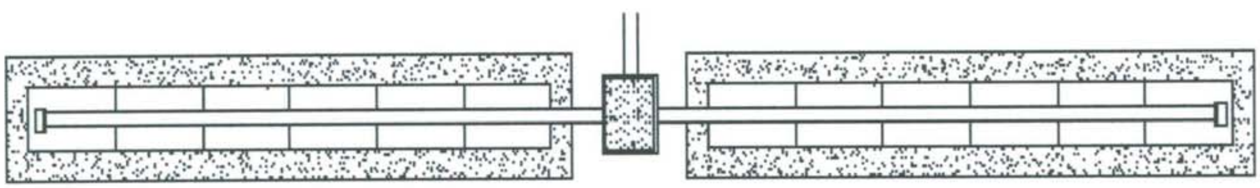

Figure 4

Trenches on Sloping Sites

On sloping sites, individual drop boxes ensure complete utilization of each trench. As the capacity of each trench is utilized prior to flow to the next, trench length can vary. This allows for placement of the trenches around trees or rock outcrops. D-boxes are not allowed for distribution of effluent to trenches at different elevations unless the system is dosed from a pump. Pumps can be used to dose a GSF from above or below. However, given the increased cost and complexity of pumps, they are rarely used if gravity loading is possible.

Trench layouts on slopes follow the topography and work with the existing landscape. Trenches can be as little as 3 inches lower to allow for flow from upper trenches to lower trenches though successive drop boxes. If less elevation exists, loading from a central d-box is possible with outlet flow control preferred to insure sequential distribution of the effluent.

Trench Configuration for a Sloping Site / Avoiding Rock Outcrops and Tress

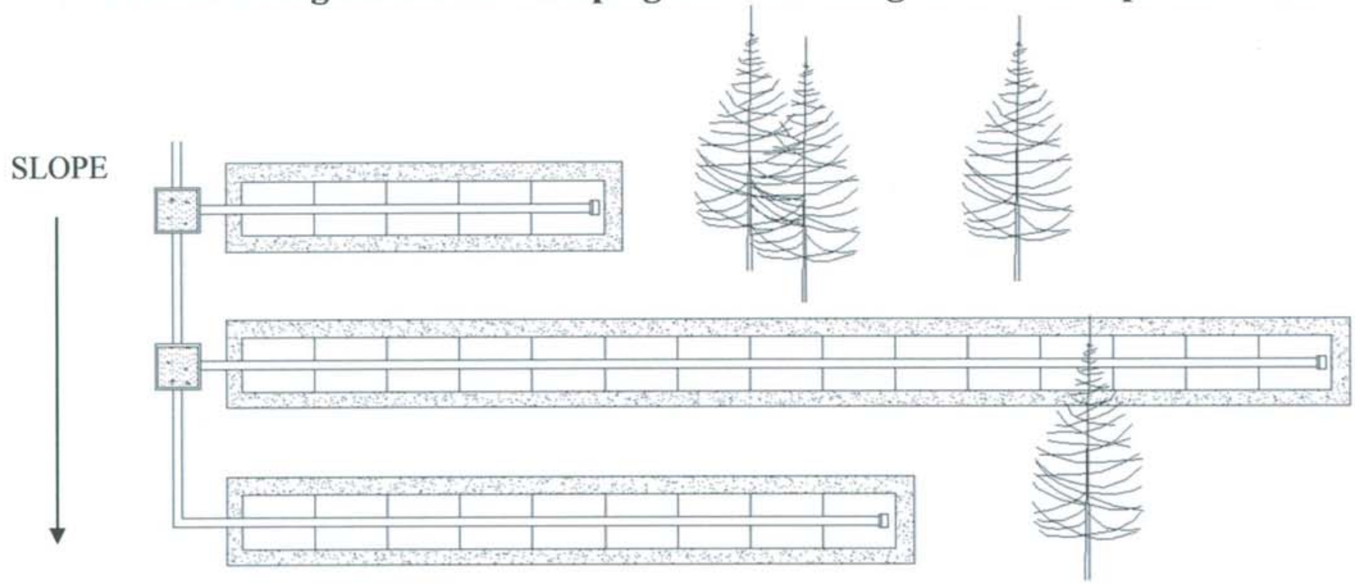

Figure 5

Sequential Loading Outlet Setup in Drop or D-Box

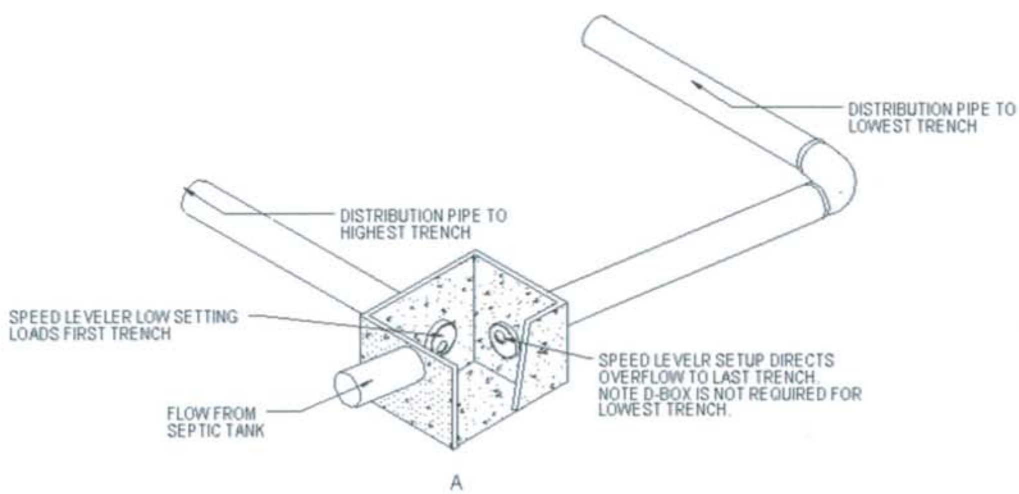

Figure 5.1

Bed Layout

GSF beds minimize the footprint of the Geotextile Sand Filter. Note that in a bed configuration, 2-foot wide spacing is required between each row of geotextile filter modules. As with trenches, a flow splitting or inlet control is required. Center or end designs are possible. If given a choice, longer systems are preferred as they disperse the effluent across the landscape and avoid potential groundwater mounding, which is a concern in very large square systems. In beds, maintain a minimum of 24 inches of spacing between modules ensure aeration of the media.

Minimum B43 Bed Design for a Three Bedroom Home
Three Rows of Five B43 Modules
15 feet wide x 21 feet long

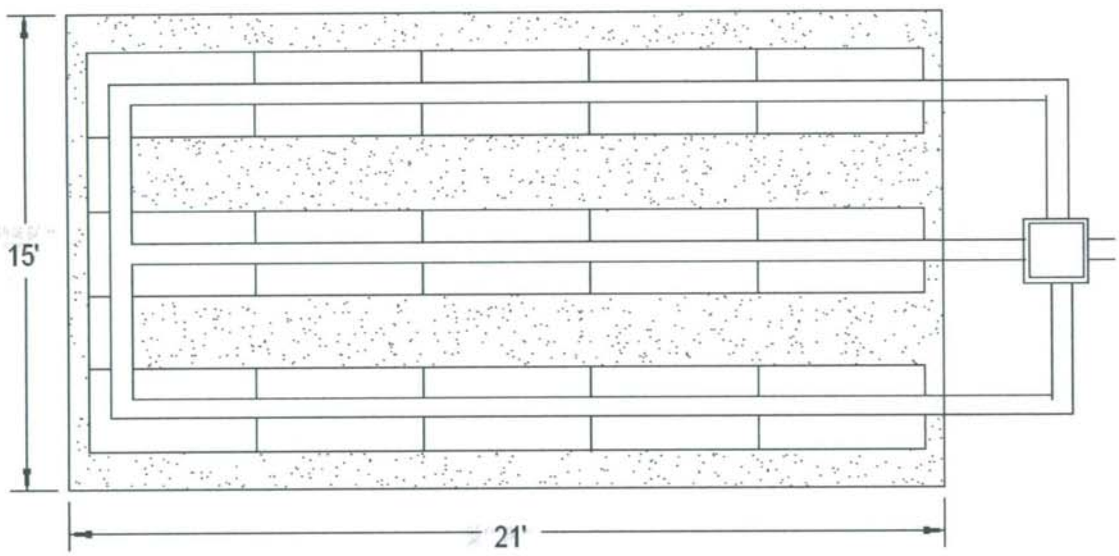

Figure 6

Longer thinner beds in clay soils with the downslope "sand toe" extends the soil contact area for greater infiltration by the native soil. Where the percolation rate exceeds 30 minutes per inch, the contractor builds the system from one end to the other to avoid any compaction of the soil by the excavator. A maximum of 17 A42 geotextile modules per bedroom is needed with the additional infiltrative area provided by the sand as shown below. Note: sequential loading of the d-box is also an advantage here to increase linear loading and therefore equalize dispersion of the across the entire bed before the second line receives effluent. Dosing the d-box is useful when loading larger systems.

GSF Optional Ventilation

The GSF has internal aeration channels between the rows of media connecting to corrugations within the geotextile filter modules. Under normal operating conditions, only a fraction of the filter is in use. The unused corrugations remain open for intermittent peak flows and the transfer of air.

The GSF operates under negative pressure. House vents work like a chimney, heating the air and creating an updraft through the house plumbing vent. Replacement air is pulled through the septic tank with fresh air pulled into the GSF. To maintain this airflow, it's important that any air vents are located on the distal end of the GSF pipe network.

For dosed systems, an additional air line must be extended from the GSF back to the pump tank or septic tank. The air line should connect to the near end of the GSF system and can follow above other distribution lines terminating in the riser above the tank. The distal air vent is also required.

In the gravity fed GSF, the vent is usually 4 inches and can be extended to a convenient location behind shrubs as shown below. Corrugated pipe can be used with the placement and grade such that any condensation that may accumulate in the pipe does not fill and thus close off this line.

GSF with 4 Inch Vent extended to convenient location behind a tree or shrub

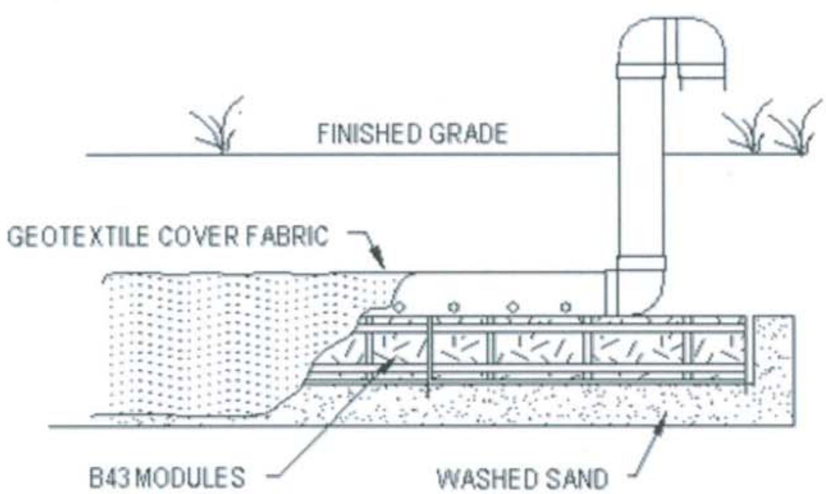

Figure 7

Trench Installation

Usable Percolation Rates 1-60 Minutes per Inch

1. Carefully lay out the system components and boundaries defining the location and elevation for all trenches, distribution or drop boxes based on the outlet elevation of the septic tank and pipe grades required to maintain flow to each component.
2. Prepare the site according to Appendix 75-A and or County regulations. Do not install a system on frozen or saturated ground. Keep heavy machinery off clay soils used for the GSF and down slope from the system where even soils structure is critical to absorption and drainage of the treated effluent.
3. Plan all drainage requirements above the system and set soil grades to insure stormwater drainage away from the absorption area once the system is complete.
4. Scarify receiving layer to eliminate smearing, working from one end to the other excavating and placing fill as you move down the trench. If done in two steps only work from the upslope side of the trench.
5. Do not rake and minimize walking in the trench (if in clay soil) prior to placement of the specified sand. A rough plowed-like surface with backhoe teeth showing is best to maximize the interface between the native soil and specified sand.
6. Add a 6-inch layer of specified sand and bring the media to 1 inch above grade. Compact and rake the media to grade. A hand taper is sufficient to stabilize the sand below the media.

Three Row Trench Installation

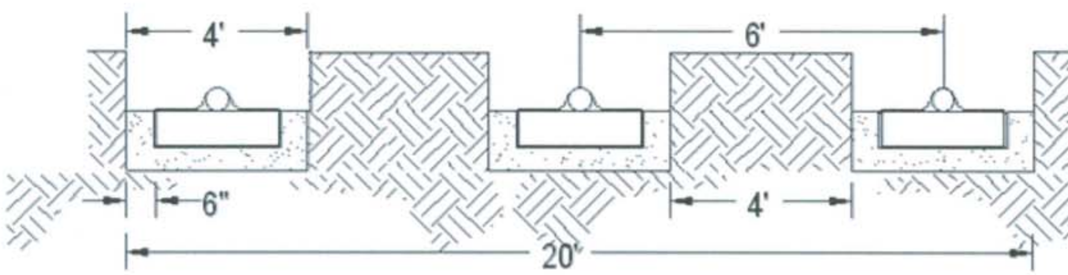

Figure 7.1

7. Place Geotextile Filter Modules with painted STRIPE facing UP, end-to-end on sand in trench or bed. Note: The media does not have to be end-to-end and may angle to follow a curvilinear path. The distribution pipe can also vary from the center to accommodate changes in direction of the media.
8. Provide D-box(s), Velocity reduction tees or baffles may be installed if needed on sloping sites
9. Use non-perforated pipe from distribution box to GFM. Center 4 inch perforated distribution pipe lengthwise over GFM with orifices at 5:00 and 7:00.

10. Secure pipe to GFM using one Eljen wire clamp per GFM. Push clamp ends straight down through core, through the fabric and into the underlying sand.
11. Spread Eljen cover fabric lengthwise over pipe and drape over sides of GFM. Secure in place with hand-shoveled specified sand using caution to avoid blocking holes in perforated pipe. (See graphic page2 for cross section of media with pipe and fabric cover.
12. Place specified sand 6 inches (minimum) at the sides in media.
13. Place specified sand over the fabric cover and rake out.
14. Complete back-fill with loam to 12 inch (minimum) over pipe.. Fill should be clean, porous and devoid of large rocks.
15. Divert surface runoff. Finish grade to prevent surface ponding. Seed loam, and protect from erosion.

Bed System Installation

Usable Percolation Rates 1-30 Minutes per Inch

1. Prepare site as described for the trench system, planning the construction across the slope, down the entire length of the system. Excavation should from one end to the other parallel to the rows of media to keep backhoe teeth parallel and on contour. If bed width requires multiple passes return to head end and remove compacted soils as you pull back.
2. Ladle or push the sand to the lower trench area from upslope keeping off the excavated surface. Using an excavator allow for excavation and placement of sand from one location.
3. After placing and stabilizing the sand, install the B43 modules on 5-foot centers.

    a. Sand bed width / (rows) ➔ center spacing of each row with 1/2 center on each side
    b. For example if three rows of modules are required in a 15 foot wide sand bed
    c. 15 feet / (3) = 5 feet on center with 2 feet of sand fill between modules and 1 foot of sand fill to the outside (see Bed cross section below).

4. Bed width may require multiple passes or excavation of successive down slope sections, working across the slope. Use a lightweight track machine, to push sand from the upslope side. Additional sand over the system may be required to back fill the system in order to maintain minimum cover over the system when placing the final backfill. Final grading with a track machine should go down the slope, perpendicular to the media with sufficient cover to protect the pipe. The final elevation of the GSF should be 3 to 6 inches above grade to allow for natural settlement of the sand and backfill. Final grading is critical to ensure storm water drainage away from the upslope side and off the GSF.

Bed Installation Cross Section

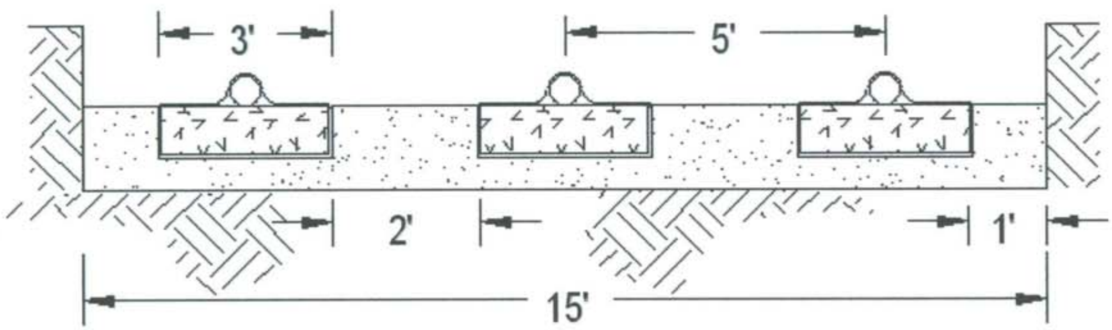

Figure 8

1. Prepare site as described for the trench system or bed.
2. Provide a well-anchored D-box with a velocity reduction tee or baffle. Set outlet orifice (Dial-A-Flow) at the same elevation to equalize flow to each line or use drop boxes.
3. Assemble system as described for gravity designs.
4. Set floats in the pump basin to deliver Dose 4 Gal per B43 Unit Smaller doses are better as it provides time for the media to filter the effluent and maintain unsaturated flow through the sand filter below.

Pressure Distribution Options

Two options for pressure distribution can be used to enhance dispersion of effluent down the filter module rows. The first uses a pressure-dosed d-box with gravity dispersion down the module row and the second pressure distribution pipe using small orifice to apply the effluent to the filter modules.

Pressure Dosed Design

This method can be employed whenever a pump is used with the media, moving the effluent above or downslope from the septic tank. Pumping helps equalize and disperse the effluent over a greater area. It can also be used to encourage loading and resting of the media, a method that can enhance denitrification. Dispersion down a media row is accomplished by placing the gravity 4-inch pipe of the modules so that the holes are located at the 5:00 and 7:00 O'clock positions.

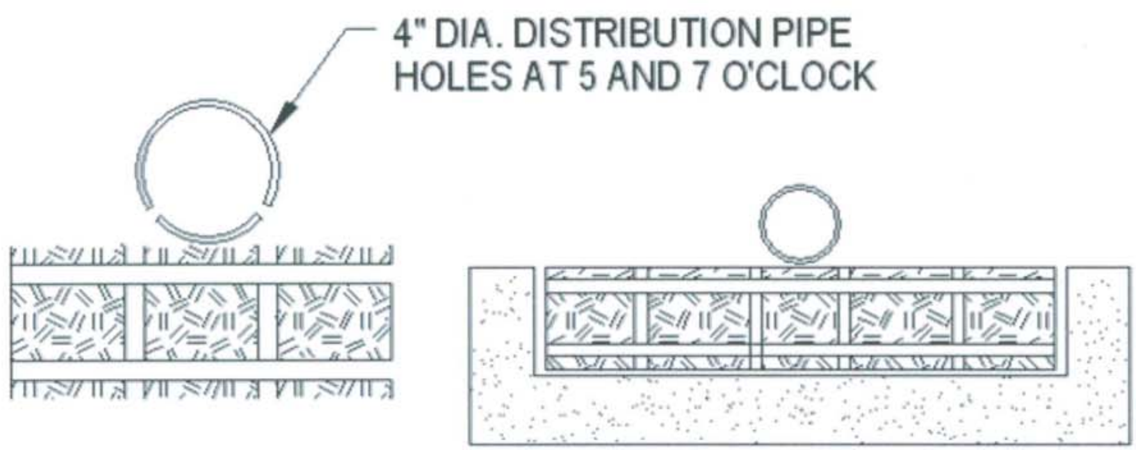

Figure 9

Pressure Design

Pressure Distribution Design upward and downward facing holes are possible with pressure distribution designs. With upward facing holes a low pressure pipe (LLP) may be inserted directly into the 4" distribution pipe on top of the modules. Downward facing holes help drain the pipe between doses and a few of these holes are always required if freezing conditions are anticipated.
For designer seeking more specific contact area the 4' distribution pipe is replaced with a 1½ " or 2.0" LPP directly on top of the modules. Half cut pipes at any location(s) of various lengths are used to protect the upward facing orifices an disperse the effluent.

At least one orifice per module or every 4 feet is the maximum spacing. More than one orifice per module will promote even distribution. The closer spacing (Two feet on Center) may require slightly larger pipe to equalize the flow down each pressure lateral.

Call Eljen if you have any question on design of pressure laterals.

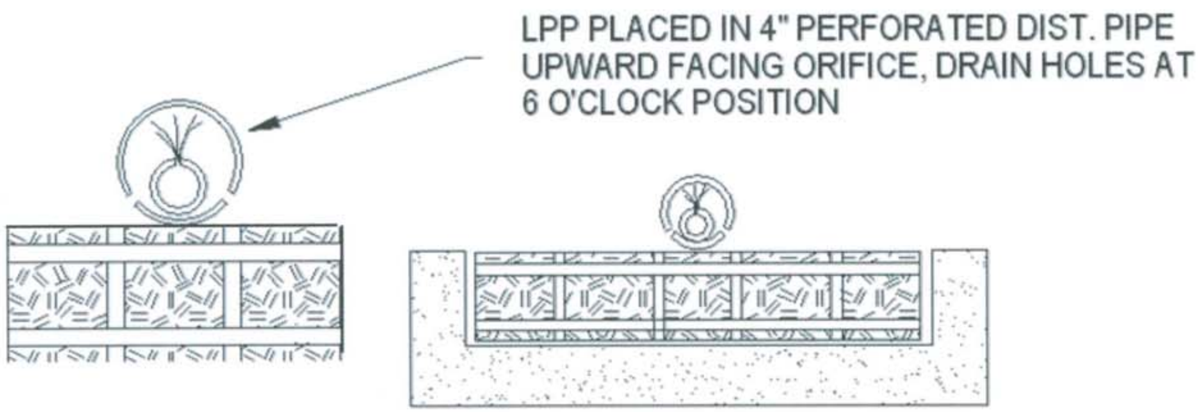

Figure 10

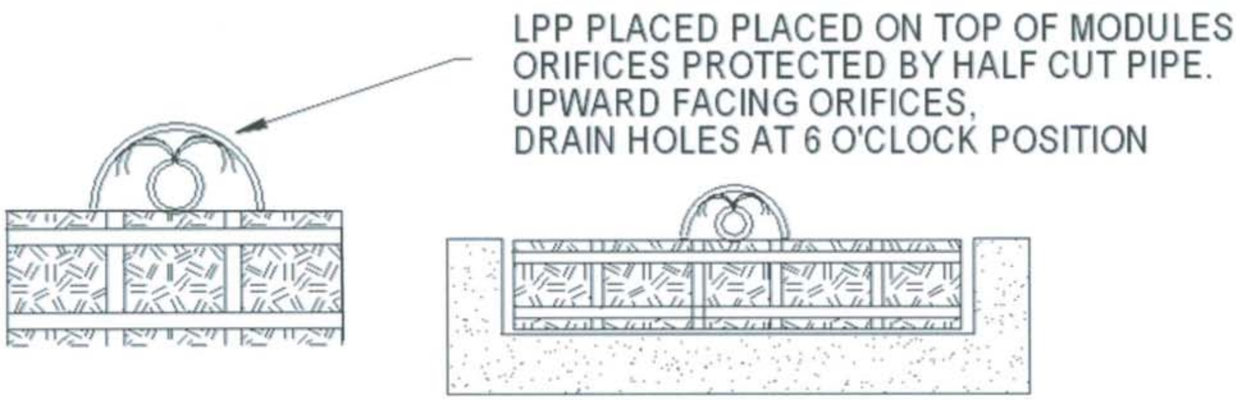

Figure 11

Contoured Pressure of Gravity Design

Plan View of Pressure Lateral on Contour Note: Each Filter Module can change orientation. The pressure lateral may be centered or off center on top of the Geotexitle Filter Module for effluent distribution thought the media. With two orifices per module recommended. Corrugations within the filter modules insure equal flow across each module below each orifice. Dispersion pads are needed below all pressure pipe.

Contoured Pressure of Gravity Design Layout

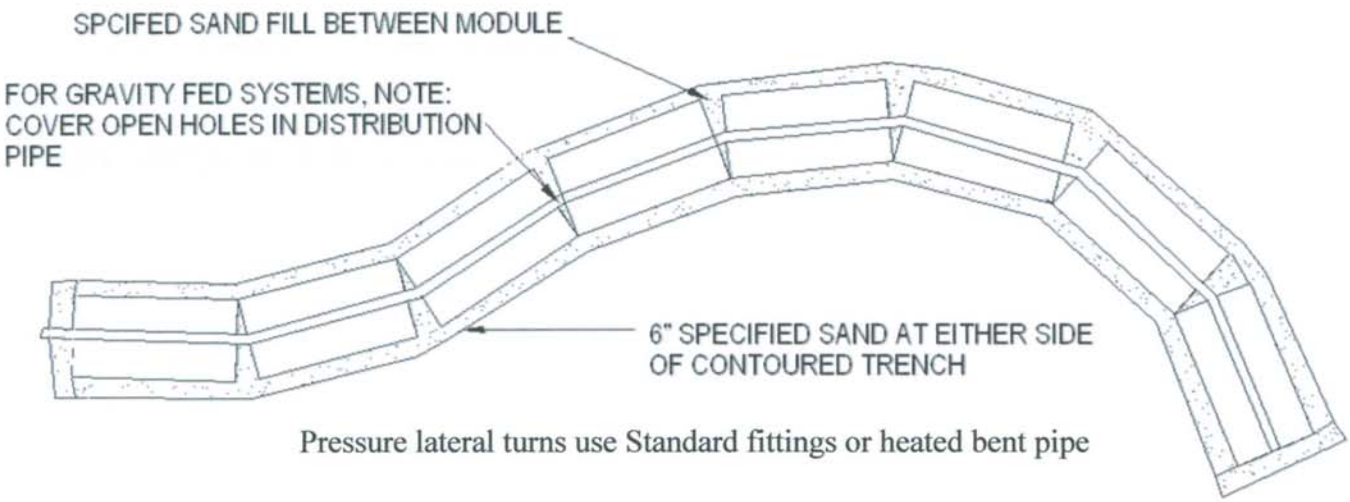

Figure 12

EFFECTIVE LEACHING AREA

Trench	Dimensions (inches) W x L x H	Invert Height Inches	Effective Leaching Area SF/LF
B43	36 x 48 x 7	13	6.0

Table 1

Bed	Dimensions W x L x H	Invert Height Inches	Effective Leaching Area SF/LF
B43	36 x 48 x 7	13	6.0

Table 2

Notes on GSF Installation:
In beds the 24 inch spacing between modules provides aeration of the soil around each GFM.
Trenches may vary in length and must be spaced 4 feet apart, sidewall to sidewall.
Even or Uneven rows may be installed in beds.
Rounding up to equal numbers is recommended.
Perforated pipe openings are set at 5:00 and 7:00 position on top of the GFM.

GSF Application Rates Per Square Foot	
Percolation Rate	Application Rate
1-5	1.72
6-7	1.38
8-10	1.25
11-15	1.15
16-20	0.98
21-30	0.86
31-45	0.69
46-60	0.63

Table 3

Simplified Residential Sizing Procedure

Identify the soil classification and rating and then the number of bedrooms. Use the chart to define the number of modules required per bedroom. The sizing table has been adjusted to provide a minimum of 5 units per bedroom. Adjusted numbers are highlighted with a yellow background.

GSF™

Percolation Rate	Geotextile Sand Filter / Modules per Bedroom														
	2 Bedroom			3 Bedroom			4 Bedroom			5 Bedroom			6 Bedroom		
	220	260	300	330	390	450	440	520	600	550	650	750	660	780	900
1-5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
6-7	5	5	6	5	5	6	5	5	6	5	5	6	5	5	6
8-10	5	6	7	5	6	7	5	6	7	5	6	7	5	6	7
11-15	6	7	8	6	7	8	6	7	8	6	7	8	6	7	8
16-20	7	8	9	7	8	9	7	8	9	7	8	9	7	8	9
21-30	8	9	10	8	9	10	8	9	10	8	9	10	8	9	10
31-45	9	11	12	9	11	12	9	11	12	9	11	12	9	11	12
46-60	10	12	14	10	12	14	10	12	14	10	12	14	10	12	14

5 = Minimum number of GSF Modules per bedroom

Table 4