# Table of Contents

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glossary of Terms</td>
<td>3</td>
</tr>
<tr>
<td>Introduction</td>
<td>5</td>
</tr>
<tr>
<td>GSF System Description</td>
<td>6</td>
</tr>
<tr>
<td>1.0 Basic System Design</td>
<td>7</td>
</tr>
<tr>
<td>2.0 Systems for Level Sites</td>
<td>11</td>
</tr>
<tr>
<td>3.0 Systems for Sloped Sites</td>
<td>11</td>
</tr>
<tr>
<td>4.0 Pumped Systems</td>
<td>11</td>
</tr>
<tr>
<td>5.0 Ventilated Systems</td>
<td>10</td>
</tr>
<tr>
<td>6.0 Commercial Systems</td>
<td>12</td>
</tr>
<tr>
<td>7.0 Designs Considerations for Replacing Failed Systems</td>
<td>15</td>
</tr>
<tr>
<td>8.0 Required Notes on Design Plans</td>
<td>16</td>
</tr>
<tr>
<td>System Installation Guidelines</td>
<td>17</td>
</tr>
<tr>
<td>Trench and In-Ground Bed System Installation Instructions</td>
<td>18</td>
</tr>
<tr>
<td>Raised or Fill System Installation Instructions</td>
<td>19</td>
</tr>
<tr>
<td>Sequential (drop box) Distribution on Sloped Sites System Installation Instructions</td>
<td>20</td>
</tr>
</tbody>
</table>

## GSF DRAWINGS AND TABLES

### Drawings

<table>
<thead>
<tr>
<th>Fig. 1</th>
<th>GSF System Operation</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fig. 2</td>
<td>Vent Details for Gravity, Demand, Pressure Distribution Systems</td>
<td>11</td>
</tr>
<tr>
<td>Fig. 3</td>
<td>Air By-Pass Line Detail for Venting of Pumped Systems</td>
<td>11</td>
</tr>
<tr>
<td>Fig. 4</td>
<td>Vertical Separation to Limiting Conditions</td>
<td>23</td>
</tr>
<tr>
<td>Fig. 5</td>
<td>A42 Trench Cross Section</td>
<td>23</td>
</tr>
<tr>
<td>Fig. 6</td>
<td>A42 Butterfly Trench Configuration</td>
<td>24</td>
</tr>
<tr>
<td>Fig. 7</td>
<td>A42 Module End-to-End Separation for Trenches</td>
<td>24</td>
</tr>
<tr>
<td>Fig. 8</td>
<td>A42 Bed Cross Section</td>
<td>25</td>
</tr>
<tr>
<td>Fig. 9</td>
<td>Example Level Bed with Cross Over Pipe Plan View</td>
<td>25</td>
</tr>
<tr>
<td>Fig. 10</td>
<td>A42 Raised Bed (Sand Mound) Cross Section</td>
<td>26</td>
</tr>
<tr>
<td>Fig. 11</td>
<td>Example Raised Bed on Slope</td>
<td>26</td>
</tr>
<tr>
<td>Fig. 12</td>
<td>Example Sequential Loading Outlet Setup in a Drop Box</td>
<td>27</td>
</tr>
<tr>
<td>Fig. 13</td>
<td>Pressure Distribution Lateral Layout</td>
<td>27</td>
</tr>
</tbody>
</table>

### Tables

| Table 1  | Standard GSF Sizing Table – Trench Systems | 22   |
## Glossary of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A42 Module</strong></td>
<td>Dimensions – 122 cm x 61 cm x 17.8 cm (L x W x H)</td>
</tr>
<tr>
<td><strong>Biofabric</strong></td>
<td>Special filter fabric within the Geotextile Sand Filter Modules upon which the primary biomat layer forms.</td>
</tr>
<tr>
<td><strong>Cover Fabric</strong></td>
<td>The geotextile cover fabric (provided by manufacturer) that is placed over the GSF modules.</td>
</tr>
<tr>
<td><strong>Cuspated Core</strong></td>
<td>The rigid plastic core of the GSF module. It separates the geotextile fabric and creates downward infiltration channels and upward aeration channels to provide primary filtration and biological treatment of the septic effluent. The curvilinear shape of the cuspations offers increased treatment surface area and greater effluent storage.</td>
</tr>
<tr>
<td><strong>Daily Design Flow</strong></td>
<td>(DDF) is the flow rate used for sizing a wastewater system taking into account mass loading and peak flows. The estimated design flow per A-42 module used to size a GSF system using residential strength waste is 72 liters per day for trenches, beds and mounds. See also Expected Volume of Sewage per Day, Saskatchewan Onsite Wastewater Disposal Guide, and Appendices 1 &amp; 2.</td>
</tr>
<tr>
<td><strong>Distribution Box</strong></td>
<td>(Or D-Box) a plastic or concrete box that receives effluent from a septic tank and splits the flow to pipes placed above the GSF modules.</td>
</tr>
<tr>
<td><strong>Drop Box</strong></td>
<td>(Spill-Over) A plastic or concrete box that receives effluent and delivers flow to pipes placed above the GSF modules before spilling over to down-slope lines.</td>
</tr>
<tr>
<td><strong>Flow Equalizer</strong></td>
<td>Special insert placed in the end of distribution pipes at the distribution box to minimize effects of settling and out of level installation of the D-Box (Also known as speed-levelers).</td>
</tr>
<tr>
<td><strong>GSF</strong></td>
<td>Includes the Eljen Geotextile Filter modules and the 15 cm sand layer along the base and sides of the modules.</td>
</tr>
<tr>
<td><strong>GSF Module</strong></td>
<td>The individual module of a GSF system. The module is comprised of a cusped plastic core and corrugated geotextile fabric.</td>
</tr>
<tr>
<td><strong>LTAR</strong></td>
<td>Long Term Acceptance Rate (LTAR) is the average long term equilibrium absorption rate for effluent in a system. This is usually expressed in liters per day per square meter.</td>
</tr>
<tr>
<td><strong>Point of Application</strong></td>
<td>The Point of Application is the interface surface(s) where the secondary treated effluent passes from the Eljen GSF System to the native (or tertiary engineered media) receiving soils.</td>
</tr>
<tr>
<td><strong>Sequential Distribution</strong></td>
<td>A design common to sloping sites where GSF lines that are laid on contour receive effluent from a series of &quot;spill-overs&quot; at different elevations. Effluent floods up-slope lines and then spills excess effluent to down-slope lines. See also Drop Box.</td>
</tr>
<tr>
<td><strong>SHWT</strong></td>
<td>Seasonal High Water Table.</td>
</tr>
<tr>
<td><strong>STE</strong></td>
<td>Septic Tank Effluent (STE) is anaerobically digested effluent that is discharged to a Geotextile Sand Filter module for further treatment.</td>
</tr>
</tbody>
</table>
Glossary of Terms

Specified Sand  
To ensure proper system operation, the system must be installed using ASTM C33 sand with less than 10% passing #100 sieve and less than 5% passing #200 sieve. Listed below is a chart outlining the sieve requirements for the Specified Sand.

<table>
<thead>
<tr>
<th>Eljen GSF Specified Sand Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve Size</td>
</tr>
<tr>
<td>------------</td>
</tr>
<tr>
<td>0.375”</td>
</tr>
<tr>
<td>#4</td>
</tr>
<tr>
<td>#8</td>
</tr>
<tr>
<td>#16</td>
</tr>
<tr>
<td>#30</td>
</tr>
<tr>
<td>#50</td>
</tr>
<tr>
<td>#100</td>
</tr>
<tr>
<td>#200</td>
</tr>
</tbody>
</table>

Note: Request a sieve analysis from your material supplier to ensure that the system sand meets the specification requirements listed above.

Width & Length  
The system width is the Specified Sand dimension perpendicular to the GSF module rows. The system length is measured parallel to the rows of GSF modules.

Wire Clamps  
Wire Clamps are used to secure perforated pipe above the GSF modules.
Introduction

This manual provides design and installation information for the Eljen GSF Geotextile Sand Filter system using the A42 GSF module. Design layouts and installation instructions for sequential, equal, dosed or pressurized distribution systems are included. Details on unique design and construction procedures for Saskatchewan are also provided. GSF systems must be designed and constructed according to the most current edition of this manual, The Saskatchewan Private Sewage Works Regulation and consideration given to the Saskatchewan Onsite Wastewater Disposal Guide.

The Eljen GSF system technology is derived from research conducted by nationally recognized engineering scientists from the University of Connecticut. Eljen Corporation has over 30 years of success in the onsite wastewater industry, with tens of thousands of systems currently in use worldwide. The GSF is recognized and approved by regulatory officials and experts in the industry as one of the most reliable onsite wastewater technologies in the marketplace today. The system specifications in this manual are founded on this research and long term performance history.

The GSF technology is based on scientific principles which state that improved effluent quality provides increased soil absorption rates. GSF’s proprietary two-stage Bio-Matt™ pre-filtration process improves effluent quality while increasing reliability and ease of operation.

Third-party independent testing data modeled after NSF/ANSI Standard 40 Protocol has shown that the Eljen GSF can provide advanced treatment of septic tank effluent to better than NSF 40(Class 1).
GSF System Description

The Eljen GSF Geotextile Sand Filter system is a cost-effective improvement over other septic treatment technologies. Comprised of a proprietary two-stage Bio-Matt™ treatment process, the geotextile modules apply a clarified effluent to the soil, increasing the soil’s long term absorption rate. The result is superior performance in a smaller soil absorption area.

How the GSF System Works

Primary Treatment Zone

- Perforated pipe is centered above the GSF module to distribute septic effluent over and into corrugations created by the cusped core of the geotextile module.
- Septic effluent is filtered through the Bio-Matt fabric. The module’s unique design provides increased surface area for biological treatment that greatly exceeds the module’s footprint.
- Open-air channels within the module support aerobic bacterial growth on the modules geotextile fabric interface, surpassing the surface area required for traditional absorption systems.
- An anti-siltation geotextile fabric covers the top and sides of the GSF module and protects the Specified Sand and soil from clogging, while maintaining effluent storage within the module.

Secondary Treatment Zone

- Effluent drips into the Specified Sand layer and supports unsaturated flow into the native soil. This Specified Sand/soil interface maintains soil structure, thereby maximizing the available absorption interface in the native soil. The Specified Sand supports nitrification of the effluent, which reduces oxygen demand in the soil, thus minimizing soil clogging from anaerobic bacteria.
- The Specified Sand layer also protects the soil from compaction and helps maintain cracks and crevices in the soil. This preserves the soil’s natural infiltration capacity, which is especially important in finer textured soils, where these large channels are critical for long-term performance.
- The native soil then provides final treatment and filtration prior to groundwater recharge.

Figure 1: GSF System Operation
1.0 Basic System Design

1.1 DISPOSAL FIELD SIZE: The total basil area required is site specific and determined by the Daily Design Flow (DDF) and soils analysis as specified in the Saskatchewan Onsite Wastewater Disposal Guide or by a professional.

The GSF system is an in-ground secondary treatment system thus requiring about ½ the field size of a standard STE stone and pipe system or chamber system.

- The number of GSF modules required (See 1.10) typically fits the required basil area and can be configured to properly cover any shape required and is the same for trench, bed or mound systems.
- In beds and mounds, a minimum of 30 cm separation is required between parallel rows of a GSF to utilize sidewall infiltration area.
- Maximum edge-to-edge and end-to-end separation for Modules in all applications is 91 cm.

1.2 Vertical Separation: As required by the Saskatchewan Onsite Wastewater Disposal Guide or as specified by a professional.

1.3 SPECIFIED SAND SPECIFICATION FOR ALL SYSTEMS: The first 15 cm of Specified Sand immediately under, between rows and around the perimeter of the GSF system must be ASTM C33 WASHED CONCRETE SAND WITH LESS THAN 10% PASSING A #100 SIEVE AND LESS THAN 5% PASSING A #200 SIEVE. Please place a prominent note to this effect on each design drawing. See page 4 of this manual for more information on the ASTM C33 sand specification.

1.4 FILL FOR RAISED SYSTEMS: Fill material below the Specified Sand in Section 1.3 for raised bed systems must be ASTM C-33 or fill per the latest Saskatchewan Regulations. Fill must be consolidated in lifts to prevent differential settling.

1.5 PLACING GSF MODULES: Each row of modules are laid level and end to end on a 15 cm layer of the above Specified Sand bed with a minimum spacing of 30 cm between parallel rows. No mechanical connection is required between units. Alternatively, in all applications modules may be spaced up to 91 cm end-to-end and edge-to-edge to increase effective basal area. See Figure 7 for an example.

1.6 DISTRIBUTION PIPE: Place approved perforated pipe on top of GSF modules with holes a 5 and 7 o'clock. Complete system piping with solid pipe and fittings. Refer to Sections 2 and 3 for level and serial piping information respectively. Secure pipe to GSF modules with provided wire clamps, one clamp per Eljen module. In all applications, any pipe distribution holes not discharging onto the GSF module must be sealed. See Figure 7 for suggested method of sealing holes.

1.7 DISTRIBUTION BOX: Set gravity system D-box outlet invert a minimum of 0.32 cm per 30 cm (0.32 cm per foot) above invert of distribution pipe over modules (5 cm minimum for pumped D-Box systems). The fill below the D-Box and piping must be compacted to avoid settling. Flow Equalizers (speed levelers) are recommended for gravity systems.

1.8 COVER FABRIC: Geotextile fabric, provided with the system, is placed over the top and sides of the module rows to prevent long-term siltation and failure. Cover fabric substitution is not allowed. Fabric should drape vertically over the pipe and must neither block holes nor be stretched from the top of the pipe to the outside edge of the modules. “Tenting” will cause undue stress on fabric and pipe. Note: If modules are spaced end-to-end in trench applications, fabric must be cut and allowed to drape over and protect the ends of each spaced module. A continuous run of geotextile fabric is not allowed for these applications.

1.9 BACKFILL & FINISH GRADING: Carefully place backfill over the modules, followed by top soil to complete a total minimum depth of 30 cm as measured from the top of the module. Systems with total cover that exceeds 46 cm as measured from the top of the module shall be vented at the far end of the system. Backfill material should be a well-graded sandy loam fill; clean, porous, and devoid of sand rocks larger than 5 cm. Divert surface runoff from the effluent disposal area. Finish grade to prevent surface ponding. Seed loam to protect from erosion.
1.0 Basic System Design

1.10 NUMBER OF GSF MODULES REQUIRED: Each Eljen A42 GSF is designed to a standard loading for residential strength effluent of 72 liters per day per module for trenches, beds and mound systems.

Table 1 on page 22 indicates the minimum number of A42 GSF modules required for standard homes as listed in the Saskatchewan Onsite Wastewater Disposal Guide where trench, bed and mound systems are applicable. For all systems with unlisted Daily Design Flows (DDF) of residential effluent the number of A42 GSF modules is calculated by dividing the DDF in Liters/day by 72 L/day/module.

- For trench, bed and mound configuration drawings see pages 23-26 of this manual.
- For information on commercial systems see Section 6.

1.11 ADDITIONAL FACTORS EFFECTING RESIDENTIAL SYSTEM SIZE: Homes with an expected higher than normal water use should increase septic tank capacity and/or utilize multiple compartment tanks. Increasing the minimum effluent disposal area should also be considered.

Factors that may affect system size:
- Luxury homes, homes with a Jacuzzi style tubs, and other high use fixtures.
- Homes with known higher than normal occupancy.
- Homes with water conditioner backwash (Diversion from septic tank required).

Designers should use discretion when there are multiple additional factors involved. Increase size in proportion to excess flow.

1.12 SYSTEM GEOMETRY: Design systems as long and narrow as practical along site contours to minimize ground water mounding especially in poorly drained low permeability soils. If possible, design level systems with equal number of modules per row.

1.13 GARBAGE DISPOSALS: Design drawings shall include a note “Garbage disposals are not recommended to be used with this system.” If owner insists on a garbage disposal (garburator), use a septic tanks with 2 compartments and increase tank size by 50%. An appropriate sized septic tank effluent filter should be added and the number of GSF modules should be increased by 50%.

1.14 WATER CONDITIONERS: Water conditioners can adversely affect septic tank treatment and add to hydraulic load of the GSF system. Discharge residential conditioner backwash from these devices shall be into a separate alternative disposal system.

1.15 SYSTEM VENTING: All systems require sufficient oxygen supply to the effluent disposal area to maintain proper long-term effluent treatment. Therefore, the following situations require venting at the far end of the system:
- Any system with more than 46 cm of total cover as measured from the top of the module.
- Areas subject to compaction.

1.16 VEHICULAR TRAFFIC: All vehicular traffic is prohibited over the GSF system. This is due to the compaction of material required to support traffic loading. This compaction greatly diminishes absorption below the GSF system, and diminishes the void spaces that naturally exist in soils which provide oxygen transfer to the GSF system.

1.17 SEPTIC TANKS: Eljen recommends two septic tanks in series or dual compartment tanks for all their systems. Eljen supports this practice as it helps to assure long system life by reducing suspended solids and BOD to the effluent disposal area.
1.0 Basic System Design

1.18 SEPTIC TANK FILTERS AND RISERS: Wastewater filters are required as a means of preventing solids from leaving the septic tank. Access risers are recommended with septic tanks.

1.19 POINT OF APPLICATION: The Point of Application is the interface surface(s) where the secondary treated effluent passes from the Eljen GSF System to the native (or tertiary engineered media) receiving soils. See Figures 4 & 8.

2.0 Systems for Level Sites

2.1 SYSTEM CONFIGURATIONS: Design level in-ground or raised systems with 30 cm minimum and a 91 cm maximum spacing between module rows. The sand bed, GSF modules, and distribution pipes are installed level at their design elevations.

2.2 DISTRIBUTION PIPE LAYOUT: Approved perforated pipe runs along the center of the modules. Ends are connected with approved solid pipe at the far end of the system and at mid points in systems over 12 m long. Solid pipe is used to connect perforated lines to the distribution box.

3.0 Systems for Sloped Sites

3.1 SYSTEM CONFIGURATIONS: Sequential (drop box) dosed GSF systems may be used on sloped sites where applicable.

3.2 ROW SPACING: Systems with up to 15 cm elevation drop between adjacent module rows use 30 cm minimum spacing. If over 15 cm drop, use 2 times the elevation drop as minimum spacing between module rows.

3.3 DISTRIBUTION BOX: Provide a distribution box at the beginning of the first row of modules for effluent velocity reduction and a system inspection port. Lower rows can utilize drop boxes, or distribution boxes with flow dialer to ensure effluent is loaded to the upslope trench before continuing to lower trenches within the system.

4.0 Pumped Systems

4.1 PUMP TO DISTRIBUTION BOX: Specify an oversized distribution box for pumped systems. Provide velocity reduction in the D-box with a tee or baffle. Set D-box invert 5 cm higher than invert of perforated pipe over GSF modules. Do not use flow equalizers or other restricting devices in the outlet lines of the D-box. Pump chamber shall be vented.

4.2 PRESSURE DISTRIBUTION: Pressure distribution piping is configured as shown in Figures 2 & 13. A smaller pressure pipe is inside the larger perforated pipe. One small diameter pressurized hole is drilled for each Eljen A42. The first, last and every 6th hole in a single run are drilled at 5 o’clock and the remaining holes are drilled at 12 o’clock. Hole size is determined by dividing the selected pump flow rate by the number of holes, then looking up the diameter required for that flow per hole at the squirt height resulting from the residual head of the pump. Minimum recommended residual squirt height for pumping systems is 1.5 meters. For pressure distribution by gravity the minimum recommended residual squirt height is 0.6 meters with 0.6 cm holes.

4.3 DOSSING DESIGN CRITERIA: For all pump systems; use a maximum of 15 liters per dose per A42 module in the system. Adjust pump flow and run time to achieve the above maximum dose or less. Use a minimum pump run time of one minute. Longevity of currently available effluent pumps is not affected by shorter run times. Choose force main diameter to minimize percentage of dose drain back.
4.0 Pumped Systems

Effluent velocity in force main should fall between approximately 0.9 and 1.5 m/sec. Design for 6 to 8 doses per day when pumping to D-box and minimum 6 per day when using pressure distribution. For Commercial systems refer to section 6.0.

*Note: When pumping to D-box do not exceed the D-box manufactures maximum flow rate*

5.0 System Venting

5.1 VENTED SYSTEM: Air vents are only required on absorption systems when located under impervious surfaces or systems with more than 46 cm of cover material as measured from the top of the GSF module to finished grade. This will ensure proper aeration of the modules and sand filter. The GSF has aeration channels between the rows of GSF modules connecting to cuspations within the GSF modules. Under normal operating conditions, only a fraction of the filter is in use. The unused channels remain open for intermittent peak flows and the transfer of air. The extension of the distribution pipe to the vent provides adequate delivery of air into the GSF system, as shown in Figure 2.

Home plumbing operates under negative pressure due to hot water heating the pipes and reducing the density of air in the house vent. As hot air rises and exits the home, it must be replaced by air from the GSF. To maintain this airflow and fully aerate the GSF system, it is important that air vents are located only on the distal end of the GSF pipe network. If a pressure dosed (Pump to D-box) system is specified with greater than 46 cm of cover, an additional 5 cm (2 in.) diameter air line must be extended from the GSF D-box back to the septic tank or the riser on the pump tank as shown in Figure 3. This maintains the continuity of airflow from the field into the house plumbing.

In the gravity fed GSF system, the vent is usually a 10 cm (4 in.) diameter pipe extended to a convenient location behind shrubs, as shown in Figure 2. 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. If the vent is extended, the pipe must not drain effluent and must have an invert higher than the system. Elevated systems requiring venting must elevate the first meter of vent line above the top of the GSF with fittings to prevent effluent from migrating down the vent. The vent can then be pitched away from the system to a discrete area. A drain hole must be installed at the lowest point to drain any condensation.
5.0 System Venting

Figure 2: Vent Details for Gravity / Demand Dosed and Pressure Distribution Systems (when required)

Figure 3: Air By-Pass Line Detail for Venting of Pumped Systems with Greater than 46 cm of Cover
6.0 Commercial Systems

6.1 DESIGN CONSIDERATIONS: Commercial systems differ from residential systems relative to wastewater characteristics, effluent distribution strategies, peak flows, system size and geometry. As these systems are normally larger, the designer must also consider the collection systems and their integrity, groundwater hydrology, drainage above and below the GSF system and design accordingly.

Designers should carefully review and document with their client effluent BOD\textsubscript{5} and TSS concentrations and water use numbers. The designer should document that the system installation meets the technology supplier’s specifications to ensure long-term performance. In addition, designers must be attentive to special details of the system, conduct follow-through startup and document technical capabilities for personnel required for Operation and Maintenance of the system.

Owners can expect operational issues when occupants are not educated in the operation of the system, the discharge of excessive wastewater flows due to leaks, use of excessive water, installation of illegal items such as garbage grinders, and not performing routine maintenance on grease traps and septic tanks. Since the system owners and users may not know the costs associated with these types of problems they will not be motivated to limit effluent problems and should be educated in these types of systems. Regulators must provide permitting for site-specific items and require inspection and evaluation of the overall operating plan. In some cases local management programs are needed. Designers must provide oversight of system installation and associated system equipment.

6.2 MAXIMUM UNIT LOADING: For commercial applications calculate the equivalent residential DDF per Section 6.10.

6.3 DESIGN FLOW: To determine design flow for commercial systems, please refer to Appendices 2 of the Saskatchewan Onsite Wastewater Disposal Guide. Eljen recommends a 1.5 safety factor be added to any metered water reading used for design flow calculations.

6.4 EFFLUENT APPLICATION: Dispersion of effluent across a bed system or down a row of modules in a serially loaded system must be specifically addressed in the design plans. A variety of wastewater delivery options exists and includes pressure distribution, pressure dosing, and gravity dispersed type systems. Wastewater volume and strength, systems size, and site conditions often dictate which type of system is designed. Designers should confer with the local permitting authority as many jurisdictions mandate pressure distribution or pressure dosing when daily wastewater flow exceeds certain levels.

Designers must also consider how the distribution of the effluent onto the GSF modules may affect the linear loading rates and allow for the means to adjust the linear loading should the soils fail to move the effluent as predicted. Longer systems are naturally preferred as this geometry reduces the linear loading and the risk of hydraulic overload with surfacing of treated effluent down slope in serial type systems.

Extremely large systems should be designed as several smaller systems allowing for independent management of the wastewater treatment system. Designs typically include valves to rotate zones into service with access to flow diversion boxes. Management plans are frequently implemented for monitoring the fluid levels and adjusting the effluent application onto the geotextile filter modules.
6.0 Commercial Systems

6.5 SITE DRAINAGE AND STORMWATER: Larger flow onsite absorption systems can be impacted by site drainage from above the systems area. The additional effluent can also increase the groundwater mound down slope. Recharge systems such as the GSF must be designed and located so that they can accept precipitation and the specified wastewater volume. Control and diversion of up-slope storm water is normally included in the design. Understanding the storm water flows onto and out of the system is essential to successful management of these systems.

Landscape position and slope impact the drainage because the gradient frequently changes with the slope of the land, especially if placed above a restrictive layer. The depth and permeability of each soil layer above the restrictive horizon impacts the groundwater mound. For example, upper horizons may be fairly permeable and accept precipitation easily. If these layers are above a more restrictive horizon, a perched water table will develop whenever it rains. Movement of this perched groundwater can influence the disposal system and if not recognized will result in surfacing effluent. Interception and diversion of the groundwater is therefore necessary with larger systems especially over restrictive soils to insure acceptance of the treated effluent under wet conditions.

Down slope hydraulic capacity is also an important consideration with larger systems. For example, a system may be located on a free draining slope but down slope conditions show a perched water table due to a reduced hydraulic gradient. Design limits and linear loading must be considered and these limits should be based on the limitations of these down slope soils and gradient. Ideally systems are located with diverging topography that reduces the linear loading and results in the effluent moving down slope.

6.6 MULTI-FAMILY DWELLINGS: Condominiums, apartments, trailer parks, RV campgrounds and other systems with domestic type wastewater may use the design formula in Section 6.10 with the maximum loading specified in Section 1.10. Make sure that garbage disposals are not being installed or specified. Appropriate sized septic tank effluent filters are required for all commercial systems. If the design formula in Section 6.10 is not used, a 1.5 safety factor should be added to the DDF.

6.7 RESTAURANTS: Restaurant systems shall use the design formula in Section 6.10. Designs shall use 1 more appropriately sized grease filters at the outlet of the grease trap or as required by Saskatchewan Regulation. Specify grease traps whose outlets are compatible with the filter designed or allow for external filter between grease trap and septic tank. Combine kitchen flow with black water flow in 1 or more septic tanks. Multiple tanks are preferred. Install 1 or more appropriately sized septic tank effluent filter(s) at the outlet of the final septic tank.

6.8 LAUNDROMATS: Laundromat systems shall use the design formula in Section 6.10. Designs shall use 1 or more appropriately sized filter(s) to help remove suspended lint.

6.9 OTHER COMMERCIAL SYSTEMS: Other non-residential systems, e.g. schools, butcher shops, milk or ice cream facilities etc. may require more conservative sizing. The designer is advised to contact BWD Engineering Inc. for recommendations on sizing prior to design and submission of plans to the local authority.
6.0 Commercial Systems

6.10 FORMULA FOR DESIGN FLOW ADJUSTMENT: Commercial design flow when the septic effluent has a higher BOD$_5$ + suspended solid concentration (>240 mg/L) than normal domestic wastewater can be adjusted by multiplying by the following factor:

$$\frac{\sqrt[3]{(BOD_5 \text{ mg/l} + SS \text{ mg/l})}}{240}$$

This factor shall not be used if its value is less than one.

As a range of values is normally measured, a sufficient number of samples should be collected and if possible the design should be based on the 75$^{\text{th}}$ percentile. Listed below is an example of this analysis. Based on the wastewater strength, the cubed root equation determined that that system size should be increased by 63%.

<table>
<thead>
<tr>
<th>Percentile</th>
<th>BOD$_5$</th>
<th>TSS</th>
<th>Sum of BOD$_5$ + TSS</th>
<th>BOD$_5$ + TSS / 240</th>
<th>Cubed Root</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low 25$^{\text{th}}$</td>
<td>200</td>
<td>120</td>
<td>320</td>
<td>1.33</td>
<td>1.10</td>
</tr>
<tr>
<td>Median</td>
<td>500</td>
<td>220</td>
<td>720</td>
<td>3.00</td>
<td>1.44</td>
</tr>
<tr>
<td>High 75$^{\text{th}}$</td>
<td>740</td>
<td>300</td>
<td>1040</td>
<td>4.33</td>
<td>1.63</td>
</tr>
</tbody>
</table>

6.11 SYSTEM VENTING: It is recommended that all commercial systems be designed with vents. Systems with high waste strength and systems with more than 46 cm of cover material as measured from the top of the GSF modules to finished grade require venting. Designers that include vents in their designs often specify the use of Granular Activated Carbon or Charcoal (GAC) filters to ensure that septic odors do not become a nuisance. Designers should verify with the GAC filter manufacturer or supplier to ensure that the filter will allow airflow from both directions of the filter. Otherwise the filter will block airflow and the vent will not be effective in supplying enough oxygen that the system demands for long term performance.

6.12 COMMERCIAL SYSTEM PLANS REVIEW: BWD Engineering Inc., Eljen Corporation’s Canadian Technical Representative, is available for a no cost review of any commercial GSF plan prior to submission for approval from the local approving authority. Overall responsibility for system design remains with the licensed designer and/or professional.
7.0 GSF Design Considerations for Replacing Failed Systems

Before designing a GSF system to replace a failed system, **IDENTIFY THE CAUSE OF FAILURE** and adjust new system size accordingly. Listed below are some of the most common reasons why septic systems fail:

- Leaky plumbing fixtures.
- Pump settings incorrect or not working properly.
- More occupants or bedrooms than system were designed for.
- Unusually high water usage.
- Garbage disposal.
- Water softener backwash.
- Detrimental chemicals being used.
- Excessive grease in system.
- Failed or missing septic tank outlet baffle.
- Infiltration of ground water into a leaky septic tank or pump chamber.
- Infiltration of surface water into the system.
- Specified Sand that does not meet the requirements as outlined in this manual.
- Poor quality fills material used below the system.
- Poor quality backfill over system (no oxygen flow to system).
- System too close to water table.
- Mounding due to poor drainage or soil permeability.
- Part or system not used because of blockage or excessive settling.
- System is undersized.
- Excessive backfill over system (more than 46 cm requires venting).
- Crushed distribution pipe(s).
- Distribution pipes not level.
- Loam not removed prior to construction.
- No vent installed or improper venting.
- Clogged septic tank effluent filter.
- No outlet baffle or tee in septic tank.
- Septic Tank needs to be pumped.
- Wiring or electrical problems with bump systems.
- Supply line to septic tank or d-box needs repair.
8.0 Required Notes on Design Plans

1. This system (is/is not) designed for the use of a garbage disposal.

2. This system is not designed for backwash from a water softener.

3. Organic Loam Layer must be removed from bed and slope extension areas prior to fill placement. Scarpify subsoil prior to fill placement.

4. All fill material shall meet requirements as stipulated in the Saskatchewan Onsite Wastewater Disposal Guide. The 15 cm of Specified Sand underneath and surrounding the GSF modules shall be washed concrete sand meeting the requirements of ASTM C33 with less than 10% passing a #100 sieve and less than 5% passing a #200 sieve.

5. Backfill material shall be bank run sand with no stones larger than 5 cm in any dimension to a maximum depth of 30 cm over the GSF modules and covered with 10 cm to 15 cm of clean loam.

6. Any system that is more than 46 cm below finish grade as measured from the top of the module shall be vented.

7. This design complies with and must be installed in accordance with the March 2012 Eljen GSF Design and Installation Manual for Saskatchewan.
System Installation Guidelines

Important Guidelines

- Place the 18 cm tall Geotextile Filter Modules on top of a 15 cm minimum level surface of ASTM C33 Specified Sand with less than 10% passing #100 sieve and less than 5% passing #200 sieve. You must use the Specified Sand as listed on page 4 of this manual to ensure proper system operation.

- Specified Sand placed along both sides and across the top of the GSF module ensures aeration of the modules. Additional sand placed above the module is recommended.

- Use the provided clamps to secure the approved perforated 10 cm diameter distribution pipe to the top of each GSF module.

- In applications where modules are spaced out end-to-end to increase effective basal area all perforated holes not discharging at least 15 cm onto a GSF module must be sealed. See Figure 7 for an example.

- Cover the tops and sides of the modules along the entire length of each row with Eljen geotextile cover fabric.

- If modules are spaced end-to-end, fabric must be cut and allowed to drape over and protect the ends of each spaced module. A continuous run of geotextile fabric is not allowed for these applications.

- Where the percolation rate exceeds 30 minutes-per-inch or the soil texture is finer, the system should be built from one end to the other to avoid any compaction of the soil by the excavator.

- When backfilling the installation with native soil, stones 5 cm or larger must be removed.

- Finish by grading the area to divert storm water runoff away from the system.

- Do not drive backhoe wheels over GSF modules. Light-weight track rigs may cross system area sparingly with a minimum of 30 cm of cover over the distribution pipe. System area should only be crossed perpendicularly.

- Do not drive over mound or elevated systems.

- It is also permissible to back-blade the soil to set final minimum cover. Perimeter landscape timbers are also recommended to locate the shallow beds, thereby keeping vehicles off the system.

- Seeding and stabilizing the soil cover is required to protect the system from soil erosion.

- Where the elevation of the surface exceeds the natural grade, a block or landscape timber frame or sloping soil toe at a 3:1 grade (4:1 for Type II mounds) can be used to help eliminate soil erosion and support maintenance of the stabilizing grass cover adjacent to the GSF.

- For pumped systems, provide a well-anchored D-box with a velocity reduction tee or baffle. Vent system at far end of the trench or bed when more than 46 cm of cover material as measured from the top of the GSF modules to finished grade is used.
Trench and In-Ground Bed System Installation Instructions

1. Carefully lay out the system components and boundaries. Define the location and elevation of the trench or bed and distribution box based on the septic tank outlet elevation and pipe grades required to maintain flow to each component.

2. Prepare the site according to Saskatchewan regulations. Do not install a system on saturated ground or wet soils that are smeared during excavation. Keep heavy machinery off clay soils used for the GSF system as well as down-slope from the system where soil structure is critical for absorption and drainage of the treated effluent.

3. Plan all drainage requirements above (up-slope) of the system as to not adversely affect systems area. Set soil grades to ensure that storm water drainage and ground water is diverted away from the absorption area once the system is complete.

4. Excavate the trench or bed. Scarify the receiving layer to maximize the interface between the native soil and Specified Sand.

5. Minimize walking in the trench or bed prior to placement of the Specified Sand to avoid soil compaction.

6. Place 15 cm layer of Specified Sand to 2.5 cm above the sand fill grade. Compact, level and rake the Specified Sand on grade. A hand tamper is sufficient to stabilize the Specified Sand below the GSF module. The compacted height below the GSF module must be 15 cm minimum. Check the zero grades with a laser level before placing the GSF modules.

7. Place GSF modules with PAINTED STRIPE FACING UP, end to end on top of the Specified Sand.

8. Provide D-box(s) installed in accordance with current regulation.

9. Use approved 10 cm non-perforated pipe from the distribution box to the GFS modules.

10. Center approved 10 cm perforated distribution pipe lengthwise over modules with orifices at 5:00 and 7:00. Connect mid points on level bed systems on rows over 12 m long.

11. In applications where modules are spaced end-to-end to increase effective basal area all perforated holes not discharging at least 15 cm onto a GSF module must be sealed. See Figure 7 for an example.

12. Secure pipe to GSF modules using one Eljen hoop per module. Push hoop ends straight down into up-facing core, through the fabric and into the underlying sand.

13. Spread Eljen cover fabric lengthwise over the pipe and drape over the sides of the GFS module rows. Secure in place with Specified Sand between and along the sides of the modules. Avoid blocking holes in perforated pipe by placing the cover fabric over the pipe prior to placing fill over the modules. Note: If modules are spaced end-to-end, fabric must be cut and allowed to drape over and protect the ends of each spaced module. A continuous run of geotextile fabric is not allowed for these applications.

14. Place 15 cm minimum of Specified Sand along the sides of the modules and at the ends of each module row.

15. Complete backfill with loam to 20 cm minimum of the GSF modules. Backfill exceeding 46 cm requires venting at the far end of the trench. Fill should be clean, porous and devoid of large rocks. Use well graded sandy loam fill. Do not use wheeled equipment over the system. A light track machine may be used with caution, avoiding crushing or shifting of pipe assembly. Backfill in direction of perforated pipe.

Raised or Fill System Installation Instructions

Note: Refer to Figure 10 for Design Illustration.

1. Carefully lay out the system components and boundaries. Define the location and elevation of the raised bed or fill system and distribution box based on the septic tank outlet elevation and pipe grades required to maintain flow to each component.

2. Prepare the site according to Saskatchewan regulations. Do not install a system on saturated ground or wet soils that are smeared during excavation. Keep heavy machinery off clay soils used for the GSF system as well as down-slope from the system where soil structure is critical for absorption and drainage of the treated effluent.

3. Plan all drainage requirements above (up-slope) of the system as to not adversely affect systems area. Set soil grades to ensure that storm water drainage and ground water is diverted away from the absorption area once the system is complete.

4. Excavate the bed. Scarify the receiving layer to maximize the interface between the native soil and Specified Sand.

5. Minimize walking in the excavated area prior to placement of the specified fill material to avoid soil compaction.

6. Place fill material meeting Saskatchewan Onsite Wastewater Disposal Guide requirements onto the soil interface as you move down the excavated area. If this is done in two steps, bring in the fill material from the up-slope side of the excavation. Place 15 cm layer of Specified Sand to 2.5 cm above the sand fill grade. Compact, level and rake the sand on grade.

7. A hand tamper is sufficient to stabilize the Specified Sand below the GSF modules. Check the zero grade of the top of the Specified Sand using a 2 x 4 and carpenter’s level or a laser before placing the modules.

8. Place GSF modules with PAINTED STRIPE FACING UP, end to end on top of the Specified Sand.

9. Provide D-box(s) installed in accordance with current regulation.

10. Use approved 10 cm non-perforated pipe from the distribution box to the GFS modules.

11. Center approved 10 cm perforated distribution pipe lengthwise over modules with orifices at 5:00 and 7:00. Connect mid points on level bed systems on rows over 12 m long.

12. Secure pipe to GSF modules using one Eljen hoop per module. Push hoop ends straight down into up-facing core, through the fabric and into the underlying sand layer.

13. Spread Eljen cover fabric lengthwise over the pipe and drape over the sides of the GFS module rows. Secure in place with Specified Sand between and along the sides of the modules. Avoid blocking holes in perforated pipe by placing the cover fabric over the pipe prior to placing fill over the modules. Note: If modules are spaced end-to-end, fabric must be cut and allowed to drape over and protect the ends of each spaced module. A continuous run of geotextile fabric is not allowed for these applications.

14. Place 15 cm minimum of Specified Sand along the sides of the modules and at the ends of each module row.

15. Complete backfill with loam to 20 cm minimum of the GSF modules. Backfill exceeding 46 cm requires venting at the far end of the trench. Fill should be clean, porous and devoid of large rocks. Use well graded sandy loam fill. Do not use wheeled equipment over the system. A light track machine may be used with caution, avoiding crushing or shifting of pipe assembly. Backfill in direction of perforated pipe. Divert surface runoff. Finish grade to prevent surface ponding. Seed loam, and protect from erosion.
Sequential Distribution on Slopes System Installation Instructions

1. Carefully lay out the system components and boundaries. Define the location and elevation of the serial distribution system and distribution box based on the septic tank outlet elevation and pipe grades required to maintain flow to each component.

2. Prepare the site according to Saskatchewan regulations. Do not install a system on saturated ground or wet soils that are smeared during excavation. Keep heavy machinery off clay soils used for the GSF system as well as down-slope from the system where soil structure is critical for absorption and drainage of the treated effluent.

3. Plan all drainage requirements above (up-slope) of the system so as not to adversely affect systems area. Set soil grades to ensure that storm water drainage and ground water is diverted away from the absorption area once the system is complete.

4. Excavate the bed. Groove receiving layer by raking or contour plowing at a right angle to slope before placing the specified fill material or Specified Sand. Scarify the receiving layer to maximize the interface between the native soil and Specified Sand.

5. Minimize walking in the excavated area prior to placement of the specified fill material to avoid soil compaction.

6. Place fill material meeting Saskatchewan Onsite Wastewater Disposal Guide requirements onto the soil interface as you move down the excavated area. If this is done in two steps, bring in the fill material from the up-slope side of the excavation. Place 15 cm layer of Specified Sand to 2.5 cm above the sand fill grade. Compact, level and rake the sand on grade.

7. A hand tamper is sufficient to stabilize the Specified Sand below the GSF modules. Check the zero grade of the top of the Specified Sand using a 2 x 4 and carpenter’s level or a laser before placing the modules.

8. Place GSF modules with PAINTED STRIPE FACING UP, end to end on top of the Specified Sand.

9. Drop Boxes are placed at the beginning of each row along the slope. Non-perforated pipe is plumbed to the next lower trench. Dial a Flow fittings may be used to further manage wastewater flow if specified by the system designer.

10. Use approved 10 cm non-perforated pipe from the drop box to the GFS modules.

11. Install a line of approved 10 cm perforated distribution pipe lengthwise on the first row over the GSF modules with orifices at 5:00 and 7:00. Cap at the far end.

12. In applications where modules are spaced end-to-end to increase effective basal area all perforated holes not discharging at least 15 cm onto a GSF module must be sealed. See Figure 7 for an example.

13. Secure pipe to GSF modules using one Eljen hoop per module. Push hoop ends straight down into up-facing core, through the fabric and into the underlying sand layer.

14. Spread Eljen cover fabric lengthwise over the pipe and drape over the sides of the GFS module rows. Secure in place with Specified Sand between and along the sides of the modules. Avoid blocking holes in perforated pipe by placing the cover fabric over the pipe prior to placing fill over the modules. Note: If modules are spaced end-to-end, fabric must be cut and allowed to drape over and protect the ends of each spaced module. A continuous run of geotextile fabric is not allowed for these applications.
Sequential Distribution on Slopes System Installation Instructions

15. Place 15 cm minimum of Specified Sand along the sides of the modules and at the ends of each module row.

16. Complete backfill with loam to 20 cm minimum of the GSF modules. Backfill exceeding 46 cm requires venting at the far end of the trench. Fill should be clean, porous and devoid of large rocks. Use well graded sandy loam fill. Do not use wheeled equipment over the system. A light track machine may be used with caution, avoiding crushing or shifting of pipe assembly. Backfill in direction of perforated pipe.

17. Divert surface runoff. Finish grade to prevent surface ponding. Seed loam, and protect from erosion.
Sizing Table

**TABLE 1: Standard GSF Sizing Table for all Applications**

<table>
<thead>
<tr>
<th>Bedrooms</th>
<th>1 or 2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Flow liters/day</td>
<td>1360</td>
<td>1530</td>
<td>2040</td>
<td>2550</td>
<td>3060</td>
</tr>
<tr>
<td>Recommended Number of Modules</td>
<td>20</td>
<td>24</td>
<td>30</td>
<td>36</td>
<td>42</td>
</tr>
</tbody>
</table>

Table 1 reflects the minimum number of Eljen GSF A42 units required for the standard flows for all applications based on bedrooms as listed in the Saskatchewan Onsite Wastewater Disposal Guide. For other Daily Design Flows, Divide the DDF by 72 L/unit/day and round up to the next full number of modules.

To cover the larger basil areas required by slower soils, in beds and mounds increase the edge to edge separation between runs to a maximum of 91 cm. For all systems, the Eljen GSF modules can be separated by up to 91 cm end-to-end to increased effective basal area without additional modules. All perforated holes not discharging at least 15 cm onto a GSF module must be sealed. See Figure 7 for a suggested method of sealing holes. For assistance with very large basil area requirements please contact the Eljen Technical Representative.
Figure 4: Vertical Separation to Limiting Conditions

Figure 5: Example A42 GSF Trench Cross Section
Figure 6: Example A42 Butterfly Trench Configuration

Figure 7: A42 Module End-to-End Separation for Trenches & Beds

NOTE: Half-pipe must cover any hole above the A42 module that is within 15 cm of the edge. If modules are spaced end-to-end, fabric must be cut and allowed to drape over and protect the ends of each spaced module. A continuous run of geotextile fabric is not allowed for these applications.
**System Drawings**

Figure 8: Example A42 Bed Cross Section

![Diagram of A42 Bed Cross Section]

- **GEOTEXTILE FABRIC**
- **SPECIFIED SAND**
- **POINT OF APPLICATION**

30 - 45.7 cm
17.8 cm
15.3 cm
30 cm MIN
91 cm MAX
61 cm
15.3 cm

Figure 9: Example Level Bed with Cross Over Pipe Plan View

![Diagram of Example Level Bed with Cross Over Pipe]

- **NON-PERFORATED CROSS OVER**
- **SPECIFIED SAND**
- **DISTRIBUTION BOX**
- **VENT LOCATIONS AS DETAILED AT RIGHT**

30 cm MIN
91.5 cm MIN
30 cm MAX
30 cm MAX

Per Design
Per Design
Per Design
Per Design

- **NON-PERFORATED LOOP TO OTHER ROWS IN A BED DESIGN**
- **SPECIFIED SAND AT END OF BED OR TRENCH**
- **EDGE OF LAST MODULE**

- **PERFORATED DISTRIBUTION PIPE**
- **NON-PERFORATED (LOOP PIPE)**
- **DISTRIBUTION BOX**

30 cm
91.5 cm
Per Design
Per Design
Per Design
Per Design
System Drawings

Figure 10: A42 Raised Bed Cross Section

- **TOP SOIL AND SEED**
- **STABALIZE SLOPES MINIMUM 7.6 cm OF LOAM**
- **SEED TO PREVENT EROSION**
- **ORIGINAL GRADE**
- **REMOVE TOP SOIL FROM UNDER SYSTEM, FROM TOE TO TOE**
- **TOP SOIL AND SEED TO PROTECT FROM EROSION**
- **SPECIFIED SAND**
- **FILL MATERIAL PER REGULATIONS**
- **FILL MATERIAL**
- **SPECIFIED SAND**
- **PER CODE**
- **30 cm Min. 91 cm Max.**
- **30 - 45.7 cm**
- **15.3 cm**
- **30 cm**
- **1.5 cm**
- **1.5 cm**

Figure 11: Example Raised Bed on Slope

- **TOP SOIL AND SEED TO PROTECT FROM EROSION**
- **STABALIZE 3:1 SLOPE WITH A MINIMUM OF 7.6 cm OF LOAM AND SEED**
- **ORIGINAL GRADE**
- **REMOVE TOP SOIL**
- **FILL MATERIAL**
System Drawings

Figure 12: Drop Box Detail – Sequential Distribution System

Figure 13: Pressure Distribution Lateral Layout
COMPANY HISTORY
Established in 1970, Eljen Corporation created the world’s first prefabricated drainage system for foundation drainage and erosion control applications. In the mid-1980s, we introduced our Geotextile Sand Filter products for the passive advanced treatment of onsite wastewater in both residential and commercial applications. Today, Eljen is a global leader in providing innovative products and solutions for protecting our environment and public health.

COMPANY PHILOSOPHY
Eljen Corporation is committed to advancing the onsite industry through continuous development of innovative new products, delivering high quality products and services to our customers at the best price, and building lasting partnerships with our employees, suppliers, and customers.

www.eljen.com