eljen CORPORATION

Innovative Onsite Products and Solutions Since 1970

May 20, 2024

Anne Mitchell, MPH, REHS
Environmental Quality Analyst
Septic Loan Program Manager
Environmental Health Programs Unit
Drinking Water and Environmental Health Division
Michigan Department of Environment, Great Lakes, and Energy
P.O. Box 30817
Lansing, MI 48909-8311

Dear Anne,

Enclosed is a submission for Approval of the Eljen A42 and B43 Geotextile Sand Filter (GSF) for use as an combined treatment and dispersal system (CTD) in the EGLE program.

Accompanying this request is a packet which contains:

- Manufacturer specification sheets with documentation of NSF 40
- Design and installation manual
- Certification requirements
- Homeowner's manual
- Field inspection and maintenance form
- Technical contact information
- Statement regarding manual changes

The GSF is recognized by industry leaders as one of the most reliable treatment technologies in the marketplace today. Its technology is based on research conducted by nationally recognized engineering scientists from the University of Connecticut and our 40 plus years of success in the onsite wastewater industry. The system specifications proposed in this packet are founded on this research and history of installations of the GSF worldwide.

Third party analysis at the Massachusetts Alternative Septic System Test Center (MASSTC) has confirmed that the GSF's proprietary two-stage Bio-Matt™ pre-filtration process improves effluent quality, resulting in greater reliability and ease of operation. During testing, we stressed the system beyond normal usage and the system maintained NSF 40 standards throughout the entire test. More information on the testing and results are located in this packet.

If you have any questions, please do not hesitate to contact me at 1-800-444-1359.

Respectfully,

Jim King
President
Eljen Corporation

GSF®

Geotextile Sand Filter

Michigan Septic Replacement Loan Program

Approval Packet

April, 2024

eljen CORPORATION

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Windsor, CT 06095
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TAB A: MANUFACTURER SPECIFICATION SHEETS, NSF REPORT

WASTEWATER TECHNOLOGY

NSF/ANSI Standard 40 - *Residential Wastewater Treatment Systems*

Final Report:

Eljen Corporation
GSF-AT-450
14/06/055/0030

NSF International
789 N. Dixboro Road
PO Box 130140
Ann Arbor, Michigan 48113-0140 USA

Evaluation Report:
GSF-AT-450 - Wastewater Treatment System

Under the provisions of NSF/ANSI Standard 40
Residential Wastewater Treatment Systems

August 2015

EXECUTIVE SUMMARY

Testing of the Eljen GSF-AT 450 was conducted under the provisions of NSF/ANSI Standard 40 for Residential Wastewater Treatment Systems (April 2013 revision). NSF/ANSI Standard 40 was developed by the NSF Joint Committee on Wastewater Technology.

The performance evaluation was conducted at the Massachusetts Alternative Septic System Test Center (MASSTC) located at Otis Air National Guard Base in Bourne, Massachusetts, using wastewater diverted from the base residential housing was used for the testing. The evaluation consisted of sixteen weeks of dosing at design flow, seven and one half weeks of stress testing and an additional two and one half weeks of dosing at design flow. Dosing was initiated on November 9, 2014 and the test was officially started on November 9, 2014. Sampling started in the fall and continued through the winter and spring, covering a range of operating temperatures.

Over the course of the evaluation, the average effluent $CBOD_5$ was 13 mg/L, ranging between 2 and 62 mg/L, and the average effluent total suspended solids was 10 mg/L, ranging between 2 mg/L and 40 mg/L.

The Eljen GSF-AT-450 produced an effluent that successfully met the performance requirements established by NSF/ANSI Standard 40 for Class I effluent:

> The maximum 7-day arithmetic mean was 32 mg/L for $CBOD_5$ and 23.8 mg/L for total suspended solids, both below the allowed maximums of 40 and 45 mg/L, respectively. The maximum 30-day arithmetic mean was 24.5 mg/L for $CBOD_5$ and 19.33 mg/L for total suspended solids, both below the allowed maximums of 25 mg/L and 30 mg/L, respectively.

The effluent pH during the evaluation ranged between 6.1 and 7.2, within the required range of 6.0 to 9.0. The Eljen GST-AT met the requirements for noise levels (less than 60 dbA at a distance of 20 feet), color, threshold odor, oily film and foam.

PREFACE

Performance evaluation of residential wastewater treatment systems is achieved within the provisions of NSF/ANSI Standard 40: *Residential Wastewater Treatment Systems* (revised April 2013), prepared by the NSF Joint Committee on Wastewater Technology and adopted by the NSF Board of Trustees.

Conformance with the Standard is recognized by issuance of the NSF Mark. This is not to be construed as an approval of the equipment, but a certification of the data provided by the test and an indication of compliance with the requirements expressed in the Standard.

Plants conforming to Standard 40 are classified as Class I or Class II plants according to the quality of effluent produced by the plant during the performance evaluation. Class I plants must meet the requirements of EPA Secondary Treatment Guidelines[1] for five day carbonaceous biochemical oxygen demand ($CBOD_5$), total suspended solids (TSS) and pH. Class I plants must also demonstrate performance consistent with the effluent color, odor, oily film and foam requirements of the Standard. Class II plant effluent must have no more than 1% of samples exceeding 60 mg/L $CBOD_5$ and 100 mg/L TSS.

Permission to use the NSF Mark is granted only after the equipment has been tested and found to perform satisfactorily, and all other requirements of the Standard have been satisfied. Continued use of the Mark is dependent upon evidence of compliance with the Standard and NSF General and Program Specific Policies, as determined by periodic reinspection of the equipment at the factory, distributors and reports from the field.

NSF Standard 40 requires the testing laboratory to provide the manufacturer of a residential wastewater treatment system a report including significant data and appropriate commentary relative to the performance evaluation of the plant. NSF policy specifies provision of performance evaluation reports to appropriate state regulatory agencies at publication. Subsequent direct distribution of the report by NSF is made only at the specific request of or by permission of the manufacturer.

The following report contains results of the entire testing program, a description of the plant, its operation and key process control equipment, and a narrative summary of the test program, including test location, procedures and significant occurrences. The plant represented herein reflects the equipment authorized to bear the NSF Mark.

CERTIFICATION

NSF International has determined by performance evaluation under the provisions of NSF/ANSI Standard 40 (revised April 2013) that the GSF-AT-450 manufactured by Eljen has fulfilled the requirements of NSF/ANSI Standard 40. The GSF-AT-450 has therefore been authorized to bear the NSF Mark so long as Eljen continues to meet the requirements of Standard 40 and NSF General and Program Specific Policies.

General performance evaluation and stress tests were performed at the Massachusetts Alternative Septic System Test Center (MASSTC) located at Otis Air National Guard Base in Bourne, Massachusetts. The raw wastewater used in the test was residential wastewater. The characteristics of the wastewater during the test are included in the tabulated data of this report.

The observations and analyses included in this report are certified to be correct and true copies of the data secured during the performance tests conducted by NSF on the wastewater treatment system described herein. The manufacturer has agreed to present the data in this certification in its entirety whenever it is used in advertising, prospectuses, bids or similar uses.

Thomas J. Bruursema
General Manager
Wastewater Treatment Unit Certification

Thomas Stevens
Technical Manager
Federal Programs

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1.0 PROCESS DESCRIPTION

The Eljen GSF System is a wastewater treatment and disposal technology that applies treated effluent to the native soil or a collection sump through a proprietary filtering process. In the Single Pass configuration, the GSF protects the native soils long term acceptance rate by keeping the biological growth off the native soils and within the GSF units. The Lined Treatment system provides a means to treat effluent prior to sending it to final disposal. Comprised of a proprietary two-stage Bio-Matt™ pre-treatment process, the geotextile modules apply a better-than-secondary aerobic effluent to the soil, increasing the soil's ability to accept the effluent.

The perforated pipe is centered above the GSF module to distribute septic effluent over and into corrugations created by the cuspated core of the geotextile module. The 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.

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. Native soil provides final filtration and allows for groundwater recharge.

2.0 PERFORMANCE EVALUATION

2.1 Description of Plant Evaluated

The system comprises the Eljen GSF modules and specified soil (ASTM C33 sand) under and on the sides of the units that was leveled above a native receiving soil. In this case, for testing purposes, a cell capable of collecting representative samples from beneath the entire system was constructed. The lined test- cell was fashioned out of 30 mil PVC liner with the approximate dimensions 9 feet x 25 feet. The bottom of the cell and all areas of the liner were sloped and equipped with a four-inch slotted PVC collection pipe positioned longitudinally in the middle of the test-cell and sloped toward a low point in the liner basin. A drain pipe penetrated the liner by means of a bulkhead watertight fitting connecting the drain to the four-inch slotted PVC pipe. This pipe and the bottom of the liner were covered with two inches of double washed 1/8 inch aggregate. During construction, the aggregate was washed again for the purpose of ensuring the removal of all fine material and verifying proper free drainage of the test-cell. Six inches of ASTM C33 sand were then placed above the aggregate and compacted using a vibratory compactor. A laser level ensured that the base for the test units was level.

2.2 Test Protocol

Section 8 of NSF/ANSI Standard 40 protocol, "Performance Testing and Evaluation", is included in Appendix B. Start up of the plant was accomplished by filling the plant with 2/3 water and 1/3 raw sewage. The plant was then dosed at the design loading rate of 500 gpd as follows:

6 a.m. to 9 a.m. - 35 percent of daily rated capacity (175 gallons)
11 a.m. to 2 p.m. - 25 percent of daily rated capacity (125 gallons)
5 p.m. to 8 p.m. - 40 percent of daily rated capacity (200 gallons)

Dosing was accomplished by opening an electrically actuated valve to feed wastewater to the test plant. Five gallon doses were spread uniformly over each dosing period to comprise the total dose volume for the period.

After a start up period (up to three weeks at the manufacturer's discretion), the plant is subjected to the following loading sequence:

Design loading	-	16 weeks
Stress loading	-	7.5 weeks
Design loading	-	2.5 weeks

During the design loading periods, flow proportioned 24-hour composite influent and effluent samples are collected five days per week. The influent samples are analyzed for five-day biochemical oxygen demand (BOD_5) and total suspended solids (TSS) concentrations. The effluent samples are analyzed for five-day carbonaceous biochemical oxygen demand ($CBOD_5$), and total suspended solids (TSS) concentrations. On-site determinations of the effluent temperature and pH are made five days per week.

Stress testing is designed to evaluate how the plant performs under non-ideal conditions, including varied hydraulic loadings and electrical or system failure. The test sequence includes (1) Wash Day stress, (2) Working Parent stress, (3) Power/Equipment Failure stress, and (4) Vacation stress. Detailed descriptions of the stress sequences are shown in Appendix B.

During the stress test sequences, 24-hour composite samples are collected before and after each stress dosing pattern. The analyses and on-site determinations completed on the samples are the same as described for the design load testing. Each stress is followed by seven consecutive days of dosing at design rated capacity before beginning the next stress test. Sample collection is initiated twenty-four hours after completion of Wash Day, Working Parent, and Vacation stresses, and beginning 48 hours after completion of the Power/Equipment Failure stress.

In order for the plant to achieve Class I effluent it is required to produce an effluent, which meets the EPA guidelines for secondary effluent discharge[1]:

(1) $CBOD_5$: The 30-day average of effluent samples shall not exceed 25 mg/L and each 7-day average of effluent samples shall not exceed 40 mg/L.

(2) TSS: Each 30-day average of effluent samples shall not exceed 30 mg/L and each 7-day average of effluent samples shall not exceed 45 mg/L.

(3) pH: Individual effluent values remain between 6.0 and 9.0.

Requirements are also specified for effluent color, odor, oily film and foam, as well as maximum noise levels allowed from the plant.

2.3 Test Chronology

The system was installed under the direction of the manufacturer on November 20, 2013 and reconfigured on October 25, 2014. The infiltration/exfiltration test, during which the entire system was tested for leaks, was completed on November 26, 2013. The unit was filled with 2/3 fresh water and 1/3 raw sewage and dosing was initiated at the rate of 450 gallons per day beginning November 9, 2014. The test was officially started on November 9, 2014. The stress test sequence was started on March 3, 2015 and ended on April 24, 2015. Testing was completed on May 15, 2015.

3.0 ANALYTICAL RESULTS

3.1 Summary

Chemical analyses of samples collected during the evaluation were completed using the procedures in *Standard Methods for the Examination of Water and Wastewater 21st edition*. Copies of the data generated during the evaluation are included in Appendix C. Results of the chemical analyses and on-site observations and measurements made during the evaluation are summarized in Table I.

TABLE I. SUMMARY OF ANALYTICAL RESULTS

	Average	Std. Dev.	Minimum	Maximum	Median	Interquartile Range
Biochemical Oxygen Demand (mg/L)						
Influent (BOD_5)	180	48	70	340	180	140-200
Effluent ($CBOD_5$)	13	9	<2	62	12	7-17
Total Suspended Solids (mg/L)						
Influent	180	45	87	340	170	150-200
Effluent	10	7	2	40	8	6-13
pH						
Influent	-	-	6.4	8.1	7.0	6.9-7.1
Effluent	-	-	6.1	7.2	6.5	6.4-6.7
Temperature (°C)						
Influent	10	3	6	15	10	7-12
Effluent	7	3	2	13	7	4-10
Dissolved Oxygen (mg/L)						
Effluent	3.4	1.3	0.8	7.4	3.2	2.8-4.1

Notes: The median is the point where half of the values are greater and half are less.
The interquartile range is the range of values about the median between the upper and lower 25 percent of all values.

Criteria for evaluating the analytical results from the testing are described in Section 8.5 of NSF/ANSI Standard 40. In completing the pass/fail determination for the data, an allowance is made for effluent TSS and $CBOD_5$ during the first month of testing. The 30- and 7-day averages during this time may not equal or exceed 1.4 times the effluent limits required for the rest of the test. This provision recognizes that an immature culture of microorganisms within the system may require additional time to achieve adequate treatment efficiency. Effluent $CBOD_5$ and TSS concentrations from the GSF-AT-450 during the first calendar month of testing were within the normal limits and did not need to use this provision.

Section 8.5.1.1 of the Standard provides guidance addressing the impact of unusual testing conditions, including sampling, dosing, or influent characteristics, on operation of a system under test. Specific data points may be excluded from 7- and 30-day average calculations where determined to have an adverse impact on performance of the system, with rationale for the exclusion to be documented in the final report.

Sections 3.6 and 8.2.1 of the Standard define influent wastewater characteristics as they apply to testing under the Standard. Typical domestic wastewater is defined as having a 30-day average BOD_5 concentration between 100 and 300 mg/L and a 30-day average TSS concentration between 100 and 350 mg/L. The 30-day average influent remained inside this specified range for the duration of the test.

3.2 Biochemical Oxygen Demand

The five-day biochemical oxygen demand (BOD_5) and five-day carbonaceous biochemical oxygen demand ($CBOD_5$) analyses were completed using *Standard Methods for the Examination of Water and Wastewater* 21st *edition*. The results of both analyses are shown in Figure 1.

Influent BOD_5:

Individual influent BOD_5 concentrations ranged from 70 to 340 mg/L during the evaluation, with average and a median concentrations of 180 mg/L. Thirty day average concentrations ranged from 160 to 190 mg/L.

Effluent $CBOD_5$:

Effluent $CBOD_5$ concentrations ranged from <2 to 62 mg/L over the course of the evaluation, with an average effluent concentration of 13 mg/L and a median effluent concentration of 12 mg/L.

The Standard requires that the effluent $CBOD_5$ not exceed 40 mg/L on a 7-day average or 25 mg/L on a 30-day average. As presented in Table II, over the course of the test the 7-day average effluent $CBOD_5$ ranged from 7 to 32 mg/L and the 30-day average ranged from 8 to 24 mg/L. The GSF-AT-450 met the requirements of Standard 40 for effluent $CBOD_5$.

BOD_5 Loading:

Over the course of the evaluation the influent BOD_5 loading averaged 0.66 lb/day. The GSF-AT-450 achieved an average reduction of 0.61 lbs/day.

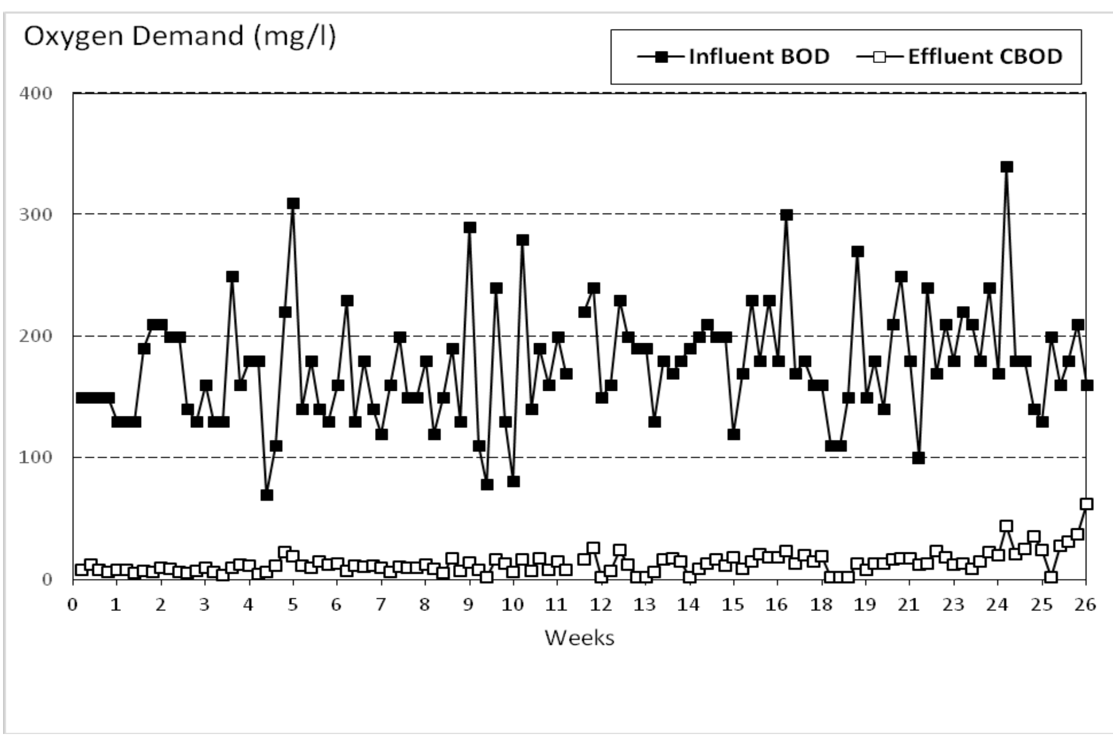

Figure 1. Biochemical Oxygen Demand

3.3 Total Suspended Solids

TSS analyses were completed using *Standard Methods for the Examination of Water and Wastewater* 21st *edition*. The TSS results over the entire evaluation are shown in Figure 2. Data from the TSS analyses are summarized in Table I.

Influent TSS:

The influent TSS ranged from 87 to 340 mg/L during the evaluation, with an average concentration of 180 mg/L and a median concentration of 170 mg/L. The 30-day average concentrations during the test ranged from 160 to 190 mg/L.

Effluent TSS:

The effluent TSS concentration ranged from 2 to 40 mg/L during the evaluation, with an average concentration of 10 mg/L and a median concentration of 8 mg/L.

Over the course of the evaluation, NSF/ANSI Standard 40 requires that the effluent TSS not exceed 45 mg/L on a 7-day average or 30 mg/L on a 30-day average. Table III shows the 7- and 30-day total suspended solids averages. The 7-day average effluent TSS ranged from 5 to 24 mg/L and the 30-day average ranged from 7 to 19 mg/L during the test. The GSF-AT-450 met the requirements of NSF/ANSI Standard 40 for effluent TSS.

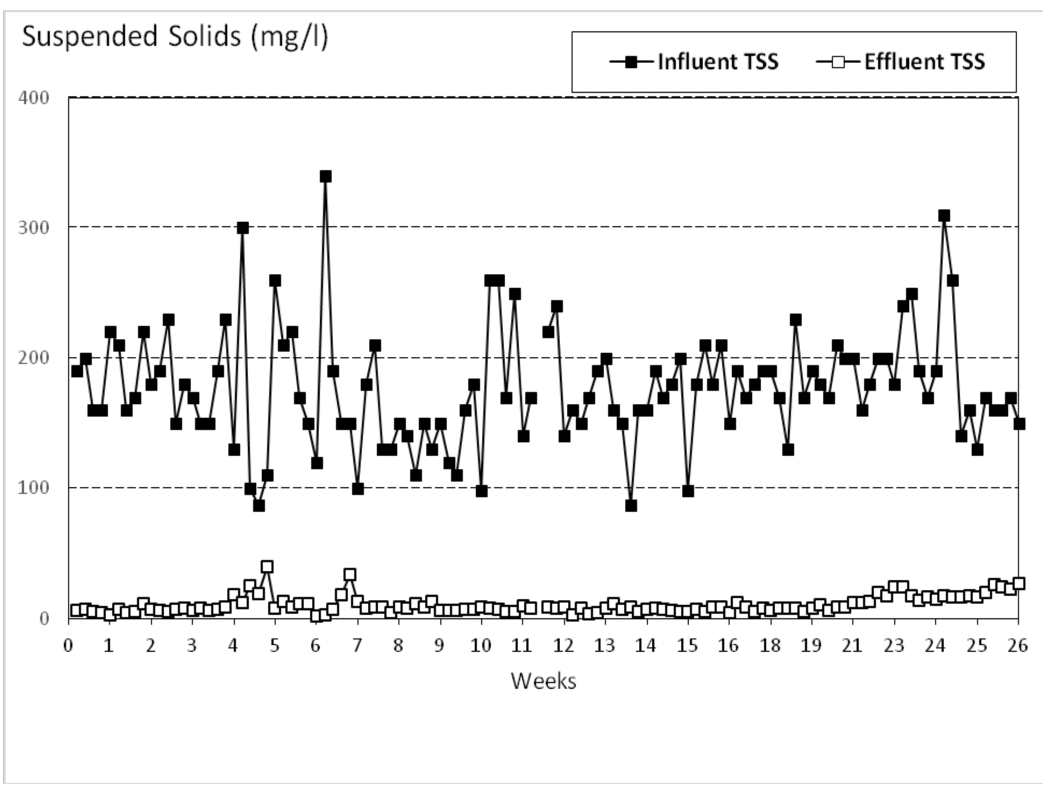

Figure 2. Total Suspended Solids

Table II. 7- and 30-day Average Effluent $CBOD_5$ and 30-day Average Influent BOD_5

Month	Week	7-day Average Effluent $CBOD_5$ (mg/L)	30-day Average Effluent $CBOD_5$ (mg/L)	30-day Average Influent BOD_5 (mg/L)
1	1	8	8	160
	2	7		
	3	7		
	4	8		
2	5	11	11	160
	6	13		
	7	10		
	8	9		
	9	10		
3	10	10	11	180
	11	11		
	12	16		
	13	9		
4	14	11	13	190
	15	10		
	16	14		
	17	19		
5	18	18	12	170
	19	8		
	20	9		
	21	15		
	22	14		
6	23	18	24	190
	24	16		
	25	30		
	26	32		

Table III. 7- and 30-day Total Suspended Solids

Month	Week	7-day Average Effluent TSS (mg/L)	30-day Average Effluent TSS (mg/L)	30-day Average Influent TSS (mg/L)
1	1	6	7	190
	2	6		
	3	7		
	4	7		
2	5	23	13	160
	6	10		
	7	13		
	8	9		
	9	10		
3	10	6	7	170
	11	7		
	12	8		
	13	5		
4	14	8	7	170
	15	7		
	16	6		
	17	7		
5	18	8	8	180
	19	7		
	20	8		
	21	8		
	22	12		
6	23	20	19	190
	24	17		
	25	16		
	26	24		

3.4 pH

Over the entire evaluation period, the influent pH ranged from 6.4 to 8.1 (median of 7.0). The effluent pH ranged from 6.1 to 7.2 during the evaluation (median of 6.5); within the 6 to 9 range required by NSF/ANSI Standard 40. The pH data for the evaluation are shown in Appendix C.

3.5 Temperature

Influent temperatures over the evaluation period ranged from 6 to 15 °C (median of 7 °C). The temperature data are shown in Appendix C.

3.6 Dissolved Oxygen

Dissolved Oxygen (DO) was measured in the effluent during the evaluation. The effluent DO ranged between 0.8 and 7.4 mg/L (median of 3.2 mg/L). All dissolved oxygen data are shown in Appendix C.

3.7 Color, Threshold Odor, Oily Film, Foam

Three samples of the effluent were analyzed for color, odor, oily film and foam as prescribed in NSF Standard 40. The effluent was acceptable according to the requirements in NSF Standard 40, with color less than 15 units, non-offensive threshold odor, no visible evidence of oily film and no foam.

3.8 Noise

A reading of the noise level at a distance of 20 feet from the plant was taken while the plant was in operation, using a hand-held decibel meter. The reading was below the 60 dbA required by ANSI/NSF Standard 40.

3.9 Alkalinity

Over the entire evaluation period, the influent alkalinity ranged from 150 to 500 mg/L (average of 220 mg/L), with the average greater than 175 mg/L as CaCO3 required by NSF/ANSI Standard 40.

4.0 REFERENCES

1. American Public Health Association (APHA), American Water Works Association (AWWA) & Water Environment Federation (WEF): *Standard Methods for the Examination of Water and Wastewater,* 21st Edition, 2005 (hereinafter referred to as *Standard Methods*.

2. ANSI/AWS D.1.1/D1.1M:2010, *Structural Welding Code – Steel* and ANSI/AWS D1.3/D1.3M:2008, *Structural Welding Code – Sheet Steel,* 5th Edition, with Errata

3. NFPA 70®: *National Electrical Code*® (NEC®), 2011*5*

4. US EPA, *Code of Federal Regulations (CFR), Title 40: Protection of Environment, July 1, 2010*.

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APPENDIX A

PLANT SPECIFICATIONS

PLANT SPECIFICATIONS
Eljen GSF 450 GPD

Plant Capacity

Design Flow	450 gpd

Filter Media

Manufacture	Eljen Corporation
Model #	A66 or A42
Sand	ASTM – C33 or equivalent
Size	24” x 48”
Material	Cuspated core wrapped in geotextile fabric

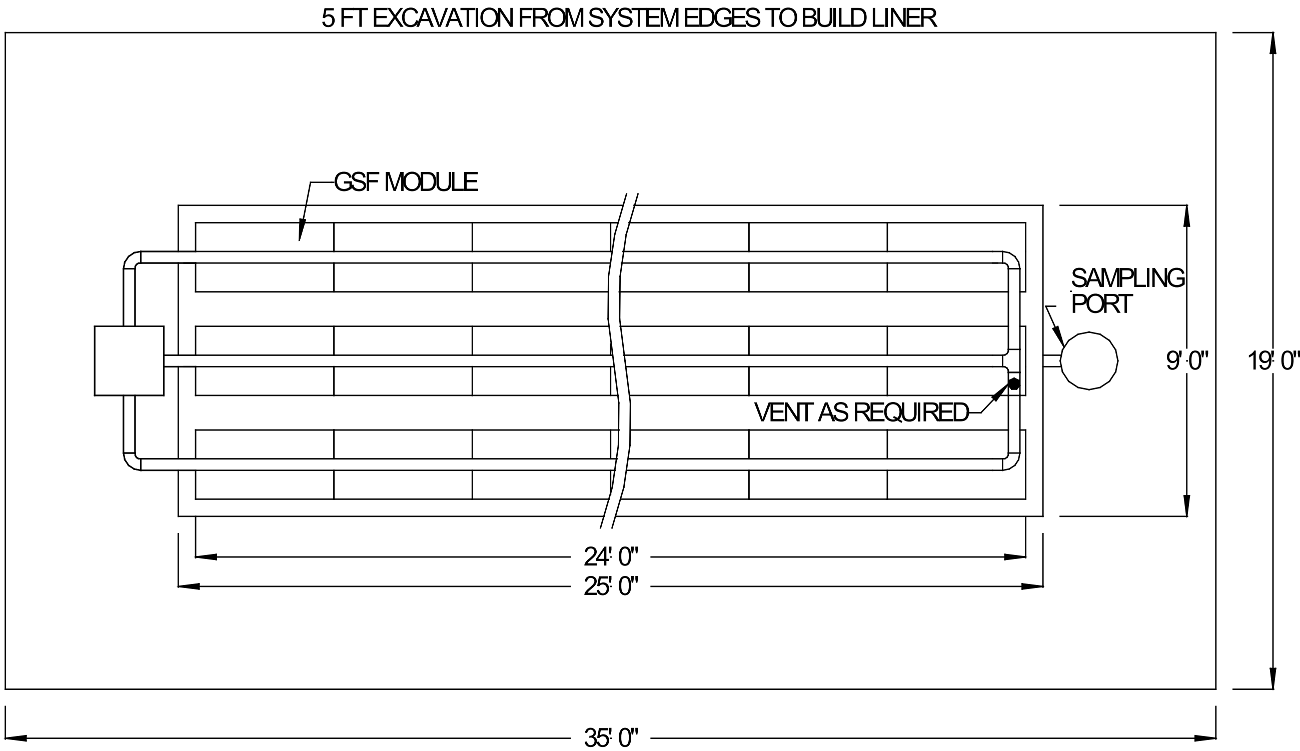
Alarm Panel

SJE Rhombus	Model 1012706

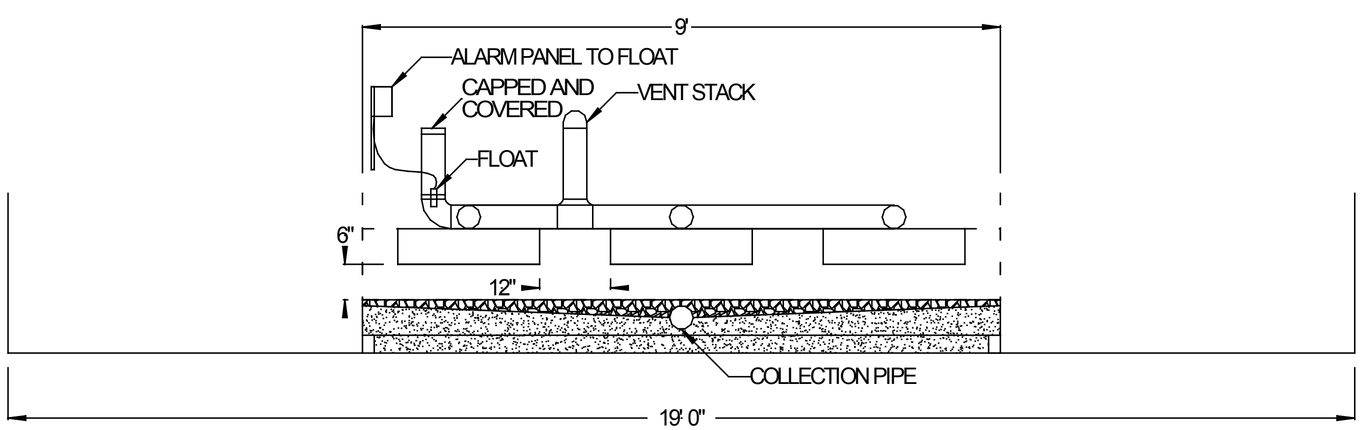
13.0 Model Specifications

LT450

Plan View



Cross Section



APPENDIX B

NSF STANDARD 40 PERFORMANCE EVALUATION METHOD AND REQUIREMENTS

8 Performance testing and evaluation

This section describes the methods used to evaluate the performance of residential wastewater treatment systems. Systems shall be designated as Class I or Class II. The performance classification shall be based upon the evaluation of effluent samples collected from the system over a six-month period.

8.1 Preparations for testing and evaluation

8.1.1 The system shall be assembled, installed, and filled in accordance with the manufacturer's instructions.

8.1.2 The manufacturer shall inspect the system for proper installation. If no defects are detected and the system is judged to be structurally sound, it shall be placed into operation in accordance with the manufacturer's start-up procedures. If the manufacturer does not provide a filling procedure,⅔ of the system's capacity shall be filled with water and the remaining ⅓ shall be filled with residential wastewater.

8.1.3 The system shall undergo design loading (see 8.2.2.1) until testing and evaluations are initiated. Sample collection and analysis shall be initiated within 3 wk of filling the system and, except as specified in 8.5.1.2, shall continue without interruption until the end of the evaluation period.

8.1.4 If conditions at the testing site preclude installation of the system at its normally prescribed depth, the manufacturer shall be permitted to cover the system with soil to achieve normal installation depth.

8.1.5 Performance testing and evaluation of systems shall not be restricted to specific seasons.

8.1.6 When possible, electrical or mechanical defects shall be repaired to prevent evaluation delays. All repairs made during the performance testing and evaluation shall be documented in the final report.

8.1.7 The system shall be operated in accordance with the manufacturer's instructions. However, routine service and maintenance of the system shall not be permitted during the performance testing and evaluation period.

> NOTE – The manufacturer may recommend or offer more frequent service and maintenance of the system but for the purpose of performance testing and evaluation, service and maintenance shall not be performed beyond what is specified in this Standard.

8.2 Testing and evaluation conditions, hydraulic loading, and schedules

8.2.1 Influent wastewater characteristics

The 30-d average BOD5 concentration of the wastewater delivered to the system shall be between 100 mg/L and 300 mg/L.

The 30-d average TSS concentration of the wastewater delivered to the system shall be between 100 mg/L and 350 mg/L.

The average wastewater alkalinity of the wastewater delivered to the system over the course of the testing shall be greater than 175 mg/L as $CaCO_3$ (alkalinity may be adjusted if inadequate). Unless requested by the manufacturer, the raw influent shall be supplemented with sodium bicarbonate if the wastewater is found to be deficient in alkalinity.

8.2.2 Hydraulic loading and schedules

The performance of the system shall be evaluated for 26 consecutive wk. During the testing and evaluation period, the system shall be subjected to 16 wk of design loading, followed by 7.5 wk (52 days) of stress loading, and then an additional 2.5 wk (18 days) of design loading.

8.2.2.1 Design loading

The system shall be dosed 7 days a week with a wastewater volume equivalent to the daily hydraulic capacity of the system. The following schedule shall be adhered to for dosing:

Time Frame	Approximate % rated daily hydraulic capacity
6 a. m. – 9 a. m.	35
11 a. m. – 2 p. m.	25
5 p. m. – 8 p. m.	40

NOTE – The individual dosage shall be no more than 10 gallons per dose, unless the dosage system is based on a continuous flow, and be uniformly applied over the dosing periods.

8.2.2.2 Stress loading

Stress loading is designed to evaluate a system's performance under four non-ideal conditions. Systems shall be subjected to each stress condition once during the 6-month testing and evaluation period, and each of the four stress conditions shall be separated by 7 days of design loading (see 8.2.2.1).

8.2.2.2.1 Wash-day stress

The wash day stress shall consist of 3 wash days in a 5-day period. Each wash day shall be separated by a 24-h period. During a wash-day, the system shall be loaded at times and capacities similar to those delivered during design loading (see 8.2.2.1), however during the first two dosing periods per day, the design loading shall include 3 wash loads (3 wash cycles and 6 rinse cycles).

8.2.2.2.2 Working-parent stress

For 5 consecutive days, the system shall be subjected to a working-parent stress. During this stress, the system shall be dosed with 40% of its daily hydraulic capacity between 6:00 a.m. and 9:00 a.m. Between 5:00 p.m. and 8:00 p.m., the system shall be dosed with the remaining 60% of its daily hydraulic capacity, which shall include 1 wash load (1 wash cycle and 2 rinse cycles).

8.2.2.2.3 Power/equipment failure stress

The system shall be dosed with 40% of its daily hydraulic capacity between 5:00 p.m. and 8:00 p.m. on the day the power/equipment failure stress is initiated. Power to the system shall then be turned off at 9:00 p.m. and dosing shall be discontinued for 48 h. After 48 h, power shall be restored and the system shall be dosed over a 3- h period with 60% of its daily hydraulic capacity, which shall include 1 wash load (1 wash cycle and 2 rinse cycles).

8.2.2.2.4 Vacation stress

On the day that the vacation stress is initiated, the system shall be dosed at 35% of its daily hydraulic capacity between 6:00 a.m. and 9:00 a.m. and at 25% between 11:00 a.m. and 2:00 p.m. Dosing shall then be discontinued for 8 consecutive days (power shall continue to be supplied to the system). Between 5:00 p.m. and 8:00 p.m. of the ninth day, the system shall be dosed with 60% of its daily hydraulic capacity, which shall include 3 wash loads (3 wash cycles and 6 rinse cycles).

8.2.3 Dosing volumes

The 30-d average volume of the wastewater delivered to the system shall be within 100% ± 10% of the system's rated hydraulic capacity.

> NOTE – All dosing days, except those with dosing requirements less than the daily hydraulic capacity, shall be included in the 30-d average calculation.

8.2.4 Color, odor, foam, and oily film assessments

During the 6-month testing and evaluation, a total of three effluent samples shall be assessed for color, odor, foam, and oily film. The assessments shall be conducted on effluent composite samples selected randomly during the first phase of design loading (weeks 1 – 16), the period of stress loading (weeks 17 – 23.5), and the second phase of design loading (weeks 23.5 – 26).

8.3 Sample collection

8.3.1 General

8.3.1.1 A minimum of 96 data days shall be required during system performance testing and evaluation. The maximum length of the test to obtain the 96 data days shall be no more than 34 wk. No routine service or maintenance shall be performed on the system whether the time period to achieve the 96 data days falls within or exceeds 26 wk.

> NOTE – In the event that a catastrophic site problem occurs, as described in 8.5.1.2, the maximum length of the test shall be no more than 37 wk.

8.3.1.2 All sample collection methods shall be in accordance with *Standard Methods* unless otherwise specified.

8.3.1.3 Influent wastewater samples shall be flow-proportional, 24-h composites obtained during periods of system dosing. Effluent samples shall be flow-proportional, 24-h composites obtained during periods of system discharge. Effluent samples shall be representative of all treated effluent discharged from the system, as sampled from a central point of collection of all treated effluent.

8.3.2 Design loading

During periods of design loading, daily composite effluent samples shall be collected and analyzed 5 days a week.

8.3.3 Stress loading

During stress loading, influent and effluent 24-h composite samples shall be collected on the day each stress condition is initiated. Twenty-four h after the completion of washday, working-parent, and vacation stresses, influent and effluent 24-h composite samples shall be collected for 6 consecutive days. Forty-eight h after the completion of the power/equipment failure stress, influent and effluent 24-h composite samples shall be collected for 5 consecutive days.

8.4 Analytical descriptions

8.4.1 pH, TSS, BOD5, and CBOD5

The pH, TSS, and BOD5 of the collected influent and the pH, TSS and CBOD5 of the collected effluent 24-h composite samples shall be determined with the appropriate methods in *Standard Methods* for each listed parameter. Grab samples shall be collected during the morning dosing period for gravity flow systems and during a time of discharge for systems that are pump discharged.

> NOTE – Standards Methods requires pH and temperature to be sampled as grab samples.

8.4.2 Color, odor, oily film, and foam

8.4.2.1 General

The effluent composite samples shall be diluted 1:1000 with distilled water. Three composite effluent samples shall be tested during the 6-month evaluation period.

8.4.2.2 Color

The apparent color of the diluted effluent samples shall be determined with the visual comparison method described in *Standard Methods.*

8.4.2.3 Odor

A panel consisting of at least 5 evaluators shall qualitatively rate 200 mL aliquots of the diluted effluent samples as offensive or non-offensive when compared to odor-free water prepared in accordance with *Standard Methods*.

8.4.2.4 Oily film and foam

Diluted effluent sample aliquots shall be visually evaluated for the presence of an oily film or foaming.

8.5 Criteria

8.5.1 General

8.5.1.1 If conditions during the testing and evaluation period result in system upset, improper sampling, improper dosing, or influent characteristics outside of the ranges specified in 8.2.1, an assessment shall be conducted to determine the extent to which these conditions adversely affected the performance of the system. Based on this assessment, specific data points may be excluded from the 7-d and 30-d averages of effluent measurements. Rationale for all data exclusions shall be documented in the final report.

8.5.1.2 In the event that a catastrophic site problem not described in this Standard including, but not limited to, influent characteristics, malfunctions of test apparatus, and acts of God, jeopardizes the validity of the performance testing and evaluation, manufacturers shall be given the choice to:

> 1) Perform maintenance on the system, reinitiate system start-up procedures, and restart the performance testing and evaluation; or
>
> 2) With no routine maintenance performed, have the system brought back to pre-existing conditions and resume testing within 3 wk after the site problem has been identified and corrected. Data collected during the system recovery period shall be excluded from 7-d and 30-d averages of effluent measurements.
>
> NOTE – Pre-existing conditions shall be defined as the point when the results of 3 consecutive data days are within 15% of the previous 30-d average(s)

8.5.1.3 A 7-d average discharge value shall consist of a minimum of 3 data days. If a calendar week contains less than 3 data days, sufficient data days may be transferred from the preceding calendar week to constitute a 7-d average discharge value. If there are not sufficient data days available in the preceding calendar week, the transfer of data days may take place from the following calendar week to constitute a 7-d average discharge value. No data day shall be included in more than one 7-d average discharge value.

8.5.1.4 A 30-d average discharge value shall consist of a minimum of 50% of the regularly scheduled sampling days per month. If a calendar month contains less than the required number of data days, sufficient data days may be transferred from the preceding calendar month to constitute a 30-d average discharge value. If there are not sufficient data days available in the preceding calendar month, the transfer of data days may take place from the following calendar month to constitute a 30-d average discharge value. No data day shall be included in more than one 30-d average discharge value.

8.5.1.5 During the stress loading sequence, consisting of wash-day, working-parent, power/equipment failure, and vacation stress loading periods, data shall be collected from a minimum of ⅔ of the total scheduled sampling days and from at least 2 of the scheduled sampling days during any single stress recovery.

8.5.2 Class I systems

The following criteria shall be met in order for a system to be classified as a Class I residential wastewater treatment system.

All requirements for each parameter shall be achieved except as provided for in 8.5.2.2.

> NOTE – 8.5.1.3, 8.5.1.4, and 8.5.1.5 are testing minimums. These minimums shall be attained to be considered a valid test.

8.5.2.1 EPA secondary treatment guideline parameters

8.5.2.1.1 CBOD5

The 30-d average of CBOD5 concentrations of effluent samples shall not exceed 25 mg/L.

The 7-d average of CBOD5 concentrations of effluent samples shall not exceed 40 mg/L.

8.5.2.1.2 TSS

The 30-d average of TSS concentrations of effluent samples shall not exceed 30 mg/L.

The 7-d average of TSS concentrations of effluent samples shall not exceed 45 mg/L.

8.5.2.1.3 pH

The pH of individual effluent samples shall be between 6.0 and 9.0.

8.5.2.2 Effluent concentration excursions

System performance shall not be considered outside the limits established for Class I systems if, during the first calendar month of performance testing and evaluation, 7-d average and 30-d average effluent CBOD5 and TSS concentrations do not equal or exceed 1.4 times the effluent limits specified in 8.5.2.1.

> NOTE – The technology utilized in many residential wastewater treatment systems is biologically based. The allowance of excursions from the effluent limits established in this Standard during the first calendar month of performance testing and evaluation reflects the fact that an immature culture of microorganisms within the system may require additional time to achieve adequate treatment efficiency

The value of 1.4 is based on the USEPA Technical Review Criteria for Group I Pollutants[6], including CBOD5 and TSS.

8.5.2.3 Color, odor, oily film, and foam

8.5.2.3.1 Color

The color rating of each of the three diluted composite effluent samples shall be reported. There are no criteria that these values shall meet.

8.5.2.3.2 Odor

The overall rating of each of the three diluted composite effluent samples shall be nonoffensive.

8.5.2.3.3 Oily film and foam

Oily films and foaming shall not be visually detected in any of the diluted composite effluent samples.

8.5.3 Class II systems

The following criteria shall be met in order for a system to be classified as a Class II residential wastewater treatment system.

8.5.3.1 CBOD5

Not more than 10% of the effluent CBOD5 values shall exceed 60 mg/L.

8.5.3.2 TSS

Not more than 10% of the effluent TSS values shall exceed 100 mg/L.

APPENDIX C

ANALYTICAL RESULTS

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 9-Nov-14 Plant Code: GSF-AT

Weeks Into Test: 1

Weekend Dosing: Sunday 450 gallons Saturday 450 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber					
	effluent		a	7.2	7.4	7.1
Temperature (C)	influent		a	15	15	15
	aeration chamber					
	effluent		a	13	13	13
pH	influent		a	7.1	7.2	7.0
	aeration chamber					
	effluent		a	6.9	7.2	7.1
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)		150	150	150	150
	effluent ($CBOD_5$)		7	12	8	6
Suspended Solids (mg/L)	influent		190	200	160	160
	aeration chamber					
	effluent		6	7	5	4

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: The test site did not take field readings on 11/11.
Alkalinty was 270 mg/l on 11/12.

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 16-Nov-14 Plant Code: GSF-AT

Weeks Into Test: 2

Weekend Dosing: Sunday 450 gallons Saturday 450 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber					
	effluent	6.0	6.2	7.0	6.9	5.8
Temperature (C)	influent	14	14	14	14	14
	aeration chamber					
	effluent	11	11	11	11	10
pH	influent	7.0	6.9	6.9	7.2	7.1
	aeration chamber					
	effluent	6.9	6.7	6.7	6.8	6.7
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	200	130	130	190	210
	effluent ($CBOD_5$)	8	8	5	7	6
Suspended Solids (mg/L)	influent	220	210	160	170	220
	aeration chamber					
	effluent	3	7	4	5	11

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Alkalinity was 160 mg/l on 11/19.

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 23-Nov-14 Plant Code: GSF-AT

Weeks Into Test: 3

Weekend Dosing: Sunday 450 gallons Saturday 450 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber					
	effluent	5.2	4.9	4.7	5.2	5.0
Temperature (C)	influent	14	14	14	14	14
	aeration chamber					
	effluent	10	11	11	11	11
pH	influent	6.9	7.0	7.1	7.0	7.0
	aeration chamber					
	effluent	6.6	6.7	6.6	6.8	6.7
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	210	200	200	140	130
	effluent ($CBOD_5$)	9	8	6	5	7
Suspended Solids (mg/L)	influent	180	190	230	150	180
	aeration chamber					
	effluent	7	6	5	7	8

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Alkalinity was 210 mg/l on 11/24.

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 30-Nov-14 Plant Code: GSF-AT

Weeks Into Test: 4

Weekend Dosing: Sunday 450 gallons Saturday 450 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber					
	effluent	4.7	4.5	5.5	4.4	3.7
Temperature (C)	influent	13	13	13	13	13
	aeration chamber					
	effluent	10	10	10	10	10
pH	influent	6.9	7.0	7.0	6.9	6.9
	aeration chamber					
	effluent	6.5	6.7	6.7	6.3	6.5
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	160	130	130	250	160
	effluent ($CBOD_5$)	10	6	4	10	12
Suspended Solids (mg/L)	influent	170	150	150	190	230
	aeration chamber					
	effluent	6	8	6	7	9

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Alkalinity was 170 mg/l on 12/5.

NSF International

Standard 40 - Residential Wastewater Treatment Systems

Plant Effluent

Week Beginning: 7-Dec-14 Plant Code: GSF-AT

Weeks Into Test: 5

Weekend Dosing: Sunday 450 gallons Saturday 450 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber					
	effluent	4.3	3.8	3.5	3.5	3.1
Temperature (C)	influent	12	12	12	12	12
	aeration chamber					
	effluent	10	9	9	9	9
pH	influent	7.1	7.2	6.9	7.1	7.0
	aeration chamber					
	effluent	6.4	6.5	6.4	6.5	6.5
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	180	180	70	110	220
	effluent ($CBOD_5$)	11	4	6	11	22
Suspended Solids (mg/L)	influent	130	300	100	87	110
	aeration chamber					
	effluent	18	12	25	19	40

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Alkalinity was 170 mg/l on 12/12.

NSF International

Standard 40 - Residential Wastewater Treatment Systems

Plant Effluent

Week Beginning: 14-Dec-14 Plant Code: GSF-AT

Weeks Into Test: 6

Weekend Dosing: Sunday 450 gallons Saturday 450 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber					
	effluent	3.6	2.9	3.0	2.7	2.9
Temperature (C)	influent	12	12	12	11	11
	aeration chamber					
	effluent	8	8	8	9	9
pH	influent	6.9	6.9	7.0	8.0	7.0
	aeration chamber					
	effluent	6.6	6.3	6.7	6.6	6.4
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	310	140	180	140	130
	effluent ($CBOD_5$)	19	11	9	15	12
Suspended Solids (mg/L)	influent	260	210	220	170	150
	aeration chamber					
	effluent	8	13	9	11	11

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Alkalinity was 280 mg/l on 12/15.

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 21-Dec-14 Plant Code: GSF-AT

Weeks Into Test: 7

Weekend Dosing: Sunday 450 gallons Saturday 450 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber					
	effluent	3.2	2.8	3.1	3.6	4.2
Temperature (C)	influent	13	11	12	12	12
	aeration chamber					
	effluent	8	8	8	9	10
pH	influent	6.6	7.3	6.9	6.8	6.9
	aeration chamber					
	effluent	6.2	6.4	6.5	6.4	6.2
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	160	230	130	180	140
	effluent ($CBOD_5$)	13	7	11	10	11
Suspended Solids (mg/L)	influent	120	340	190	150	150
	aeration chamber					
	effluent	2	3	7	18	34

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Alkalinity was 160 mg/L on 12/22.

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 28-Dec-14 Plant Code: GSF-AT

Weeks Into Test: 8

Weekend Dosing: Sunday 450 gallons Saturday 450 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber					
	effluent	3.2	3.3	3.5	3.4	3.6
Temperature (C)	influent	11	11	11	11	11
	aeration chamber					
	effluent	9	8	8	7	7
pH	influent	6.6	7.1	7.0	7.0	6.9
	aeration chamber					
	effluent	6.3	6.6	6.5	6.5	6.3
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	120	160	200	150	150
	effluent ($CBOD_5$)	9	6	10	10	10
Suspended Solids (mg/L)	influent	100	180	210	130	130
	aeration chamber					
	effluent	13	8	9	9	5

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Alkalinity was 180 mg/l on 12/31.

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 4-Jan-15 Plant Code: GSF-AT

Weeks Into Test: 9

Weekend Dosing: Sunday 450 gallons Saturday 450 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber					
	effluent	3.5	3.3	3.4	3.2	3.1
Temperature (C)	influent	10	10	10	10	10
	aeration chamber					
	effluent	7	7	6	6	5
pH	influent	6.9	7.1	7.0	7.2	7.1
	aeration chamber					
	effluent	6.3	6.4	6.4	6.5	6.5
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	180	120	150	190	130
	effluent ($CBOD_5$)	12	8	6	17	7
Suspended Solids (mg/L)	influent	150	140	110	150	130
	aeration chamber					
	effluent	9	8	11	9	13

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Alkalinity was 180 mg/l on 1/9.

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 11-Jan-15 Plant Code: GSF-AT

Weeks Into Test: 10

Weekend Dosing: Sunday 450 gallons Saturday 450 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber					
	effluent	3.4	3.0	3.2	3.6	4.1
Temperature (C)	influent	10	10	10	9	9
	aeration chamber					
	effluent	5	5	4	4	4
pH	influent	6.9	7.0	7.1	7.1	6.9
	aeration chamber					
	effluent	6.4	6.5	6.5	6.5	6.5
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	290	110	78	240	130
	effluent ($CBOD_5$)	14	7	2	16	13
Suspended Solids (mg/L)	influent	150	120	110	160	180
	aeration chamber					
	effluent	6	6	6	7	7

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Alkalinity was 240 mg/L on 1/12.
1/7/15 Odor, Foam, Oily Film all ND and color was 70

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 18-Jan-15 Plant Code: GSF-AT

Weeks Into Test: 11

Weekend Dosing: Sunday 450 gallons Saturday 450 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber					
	effluent	4.2	4.2	4.6	3.6	3.2
Temperature (C)	influent	8	8	8	8	8
	aeration chamber					
	effluent	4	4	4	4	4
pH	influent	6.9	6.9	6.9	6.9	7.0
	aeration chamber					
	effluent	6.8	6.7	6.6	6.5	6.6
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	81	280	140	190	160
	effluent ($CBOD_5$)	6	16	7	17	8
Suspended Solids (mg/L)	influent	98	260	260	170	250
	aeration chamber					
	effluent	9	8	7	5	6

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Alkalinity was 200 mg/L on 1/20.

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 25-Jan-15 Plant Code: GSF-AT

Weeks Into Test: 12

Weekend Dosing: Sunday 450 gallons Saturday 450 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber					
	effluent	3.3	d	d	4.6	4.6
Temperature (C)	influent	8	d	d	8	8
	aeration chamber					
	effluent	4	d	d	4	4
pH	influent	6.9	d	d	7.2	6.9
	aeration chamber					
	effluent	6.3	d	d	6.3	6.6
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	200	170	d	220	240
	effluent ($CBOD_5$)	15	8	d	16	26
Suspended Solids (mg/L)	influent	140	170	d	220	240
	aeration chamber					
	effluent	9	8	d	9	8

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Field paramaters were not taken on 1/27 or 1/28 and samples were not collected on 1/28 due to a blizzard.

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 1-Feb-15 Plant Code: GSF-AT

Weeks Into Test: 13

Weekend Dosing: Sunday 450 gallons Saturday 450 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber					
	effluent	3.9	3.5	3.2	3.5	3.6
Temperature (C)	influent	10	8	8	8	7
	aeration chamber					
	effluent	4	4	4	4	4
pH	influent	7.0	6.9	7.1	6.9	7.1
	aeration chamber					
	effluent	6.3	6.3	6.6	6.4	6.7
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	150	160	230	200	190
	effluent ($CBOD_5$)	2	7	24	12	2
Suspended Solids (mg/L)	influent	140	160	150	170	190
	aeration chamber					
	effluent	8	2	8	3	4

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Alkalinity was 150 mg/L on 2/4.

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 8-Feb-15 Plant Code: GSF-AT

Weeks Into Test: 14

Weekend Dosing: Sunday 450 gallons Saturday 450 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber					
	effluent	3.4	3.2	3.1	2.9	3.2
Temperature (C)	influent	7	8	7	8	7
	aeration chamber					
	effluent	4	4	4	4	4
pH	influent	6.9	7.2	7.1	7.6	7.0
	aeration chamber					
	effluent	6.5	6.6	6.7	6.9	6.5
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	190	130	180	170	180
	effluent ($CBOD_5$)	2	6	16	17	15
Suspended Solids (mg/L)	influent	200	160	150	87	160
	aeration chamber					
	effluent	8	11	7	9	5

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Alkalinity was 170 mg/L on 2/11.

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 15-Feb-15 Plant Code: GSF-AT

Weeks Into Test: 15

Weekend Dosing: Sunday 450 gallons Saturday 450 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber					
	effluent	3.1	2.9	2.9	3.0	4.2
Temperature (C)	influent	8	8	7	7	7
	aeration chamber					
	effluent	4	3	4	4	2
pH	influent	7.3	6.9	6.9	7.4	7.1
	aeration chamber					
	effluent	6.7	6.2	6.2	6.3	6.2
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	190	200	210	200	200
	effluent ($CBOD_5$)	2	9	13	16	11
Suspended Solids (mg/L)	influent	160	190	170	180	200
	aeration chamber					
	effluent	7	8	7	6	5

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Alkalinity was 160 mg/L on 2/18.

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 22-Feb-15 Plant Code: GSF-AT

Weeks Into Test: 16

Weekend Dosing: Sunday gallons Saturday gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber					
	effluent	3.2	4.1	3.2	2.7	2.8
Temperature (C)	influent	7	7	7	7	7
	aeration chamber					
	effluent	3	3	3	3	3
pH	influent	6.8	6.7	6.6	7.3	7.2
	aeration chamber					
	effluent	6.2	6.2	6.2	6.3	6.3
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	120	170	230	180	230
	effluent ($CBOD_5$)	18	9	15	21	18
Suspended Solids (mg/L)	influent	98	180	210	180	210
	aeration chamber					
	effluent	5	7	5	9	9

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Alkalinity was 180 mg/L on 2/27.

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 1-Mar-15 Plant Code: GSF-AT

Weeks Into Test: 17

		Sun	Mon	Tue	Wed	Thur	Fri	Sat
Dosed Volume (gallons)		450	450	450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber							
	effluent		3.3					
Temperature (C)	influent		7					
	aeration chamber							
	effluent		3					
pH	influent		7.4					
	aeration chamber							
	effluent		6.5					
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)		180					
	effluent ($CBOD_5$)		18					
Suspended Solids (mg/L)	influent		150					
	aeration chamber							
	effluent		4					

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Wash Day Stress completed 3/2 through 3/6.
Alkalinity on 3/2/15 was 500 mg/L

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 8-Mar-15 Plant Code: GSF-AT

Weeks Into Test: 18

		Sun	Mon	Tue	Wed	Thur	Fri	Sat
Dosed Volume (gallons)		450	450	450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber							
	effluent		2.4	2.5	3.1	2.7	2.7	3.8
Temperature (C)	influent		7	7	7	6	6	7
	aeration chamber							
	effluent		3	3	3	3	3	3
pH	influent		7.1	7.0	6.8	8.1	7.0	6.9
	aeration chamber							
	effluent		6.8	6.4	6.2	6.3	6.2	6.3
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)		300	170	180	160	160	110
	effluent ($CBOD_5$)		23	13	20	15	19	2
Suspended Solids (mg/L)	influent		190	170	180	190	190	170
	aeration chamber							
	effluent		12	9	5	8	6	8

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Working Parent Stress started on 3/14.
Alkalinity was 170 mg/L on 3/11.

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 15-Mar-15 Plant Code: GSF-AT

Weeks Into Test: 19

		Sun	Mon	Tue	Wed	Thur	Fri	Sat
Dosed Volume (gallons)		450	450	450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber							
	effluent							5.3
Temperature (C)	influent							7
	aeration chamber							
	effluent							4
pH	influent							6.8
	aeration chamber							
	effluent							6.4
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)							110
	effluent ($CBOD_5$)							2
Suspended Solids (mg/L)	influent							130
	aeration chamber							
	effluent							8

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Working Parent Stress completed on 3/18.
alkalinity on 3/18/15 was 270 mg/L

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 22-Mar-15 Plant Code: GSF-AT

Weeks Into Test: 20

		Sun	Mon	Tue	Wed	Thur	Fri	Sat
Dosed Volume (gallons)		450	450	450	450	450	0	270
Dissolved Oxygen (mg/L)	aeration chamber							
	effluent	3.6	3.1	3.1	2.9	2.7		
Temperature (C)	influent	7	7	6	6	6		
	aeration chamber							
	effluent	3	3	3	4	4		
pH	influent	6.9	6.9	7.6	7.0	7.3		
	aeration chamber							
	effluent	6.3	6.4	6.5	6.3	6.5		
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	150	270	150	180	140		
	effluent ($CBOD_5$)	2	13	8	13	13		
Suspended Solids (mg/L)	influent	230	170	190	180	170		
	aeration chamber							
	effluent	8	5	8	10	6		

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Power/Equipment Failure Stress 3/26 through 3/28.
Color, Odor, Foam, Oily Film all ND on 3/25.

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 29-Mar-15 Plant Code: GSF-AT

Weeks Into Test: 21

		Sun	Mon	Tue	Wed	Thur	Fri	Sat
Dosed Volume (gallons)		450	450	450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber							
	effluent			2.5	2.6	2.7	2.8	2.9
Temperature (C)	influent			7	7	7	7	8
	aeration chamber							
	effluent			5	5	5	5	6
pH	influent			7.0	6.6	7.0	7.1	7.2
	aeration chamber							
	effluent			6.7	6.4	6.6	6.7	6.7
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)			150	210	250	180	100
	effluent ($CBOD_5$)			11	16	17	17	12
Suspended Solids (mg/L)	influent			160	210	200	200	160
	aeration chamber							
	effluent			11	9	9	12	12

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Alkalinity was 190 mg/L on 4/1.
The sample collected and analyzed on 3/31 was not required and is included for informational purposes only.

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 5-Apr-15 Plant Code: GSF-AT

Weeks Into Test: 22

		Sun	Mon	Tue	Wed	Thur	Fri	Sat
Dosed Volume (gallons)		270	0	0	0	0	0	0
Dissolved Oxygen (mg/L)	aeration chamber							
	effluent	2.6						
Temperature (C)	influent	7						
	aeration chamber							
	effluent	6						
pH	influent	7.0						
	aeration chamber							
	effluent	6.1						
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	240						
	effluent ($CBOD_5$)	13						
Suspended Solids (mg/L)	influent	180						
	aeration chamber							
	effluent	13						

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Vacation Stress started on 4/5.
alkalinity on 4/6/15 was 180 mg/L

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 12-Apr-15 Plant Code: GSF-AT

Weeks Into Test: 23

Parameter	Location	Sun	Mon	Tue	Wed	Thur	Fri	Sat
Dosed Volume (gallons)		0	0	270	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber							
	effluent						2.3	3.0
Temperature (C)	influent						9	9
	aeration chamber							
	effluent						9	9
pH	influent						7.0	7.1
	aeration chamber							
	effluent						6.6	6.6
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)						170	210
	effluent ($CBOD_5$)						23	18
Suspended Solids (mg/L)	influent						200	200
	aeration chamber							
	effluent						20	17

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Vacation Stress completed on 4/14.
alkalinity on 4/15/15 was 180 mg/L

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 19-Apr-15 Plant Code: GSF-AT

Weeks Into Test: 24

Parameter	Location	Sun	Mon	Tue	Wed	Thur	Fri	Sat
Dosed Volume (gallons)		450	450	450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber							
	effluent	2.7	3.0	1.7	1.9	1.5	1.6	
Temperature (C)	influent	10	10	10	10	10	10	
	aeration chamber							
	effluent	9	9	9	10	10	10	
pH	influent	7.0	7.1	7.0	7.3	7.1	7.0	
	aeration chamber							
	effluent	6.7	6.5	6.6	6.6	6.5	6.7	
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	180	220	210	180	240	170	
	effluent ($CBOD_5$)	12	13	9	15	22	20	
Suspended Solids (mg/L)	influent	180	240	250	190	170	190	
	aeration chamber							
	effluent	24	24	17	14	16	15	

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: alkalinity on 4/22/15 was 190 mg/L

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 26-Apr-15 Plant Code: GSF-AT

Weeks Into Test: 25

Weekend Dosing: Sunday 450 gallons Saturday 450 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber					
	effluent	1.7	1.2	2.0	2.1	1.9
Temperature (C)	influent	10	10	10	10	10
	aeration chamber					
	effluent	10	10	10	10	10
pH	influent	6.8	7.0	7.1	7.1	7.1
	aeration chamber					
	effluent	6.6	6.6	6.8	6.7	6.7
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	340	180	180	140	130
	effluent ($CBOD_5$)	44	21	25	35	24
Suspended Solids (mg/L)	influent	310	260	140	160	130
	aeration chamber					
	effluent	17	16	16	17	16

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: Alkalinity on 4/29/15 was 420 mg/L
4/29/15 Color, Odor, Foam, Oily Film all ND

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 3-May-15 Plant Code: GSF-AT

Weeks Into Test: 26

Weekend Dosing: Sunday 450 gallons Saturday 450 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		450	450	450	450	450
Dissolved Oxygen (mg/L)	aeration chamber					
	effluent	1.3	0.9	1.1	1.2	0.8
Temperature (C)	influent	11	11	11	11	11
	aeration chamber					
	effluent	12	12	13	13	13
pH	influent	6.9	6.4	7.0	7.0	6.6
	aeration chamber					
	effluent	6.6	6.5	6.7	6.7	6.6
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	200	160	180	210	160
	effluent ($CBOD_5$)	<2	28	31	37	62
Suspended Solids (mg/L)	influent	170	160	160	170	150
	aeration chamber					
	effluent	20	26	24	22	27

(a) Site problem
(b) Malfunction of system under test
(c) Weather problem
(d) Other

Notes: <2 value checked and correct per masstc.
Alkalinity was 340 mg/L on 5/6.

APPENDIX D

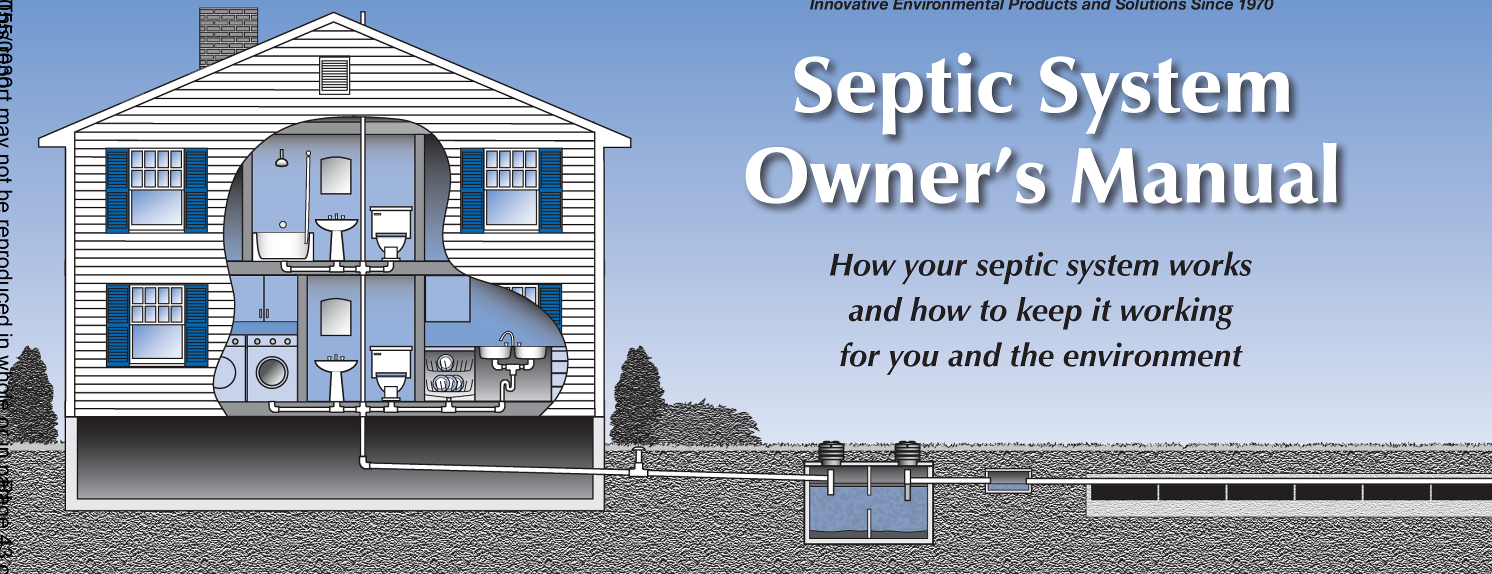
OWNER'S MANUAL

eljen CORPORATION

Innovative Environmental Products and Solutions Since 1970

Septic System Owner's Manual

How your septic system works and how to keep it working for you and the environment



GSF®

eljen Geotextile Sand Filter

NSF®

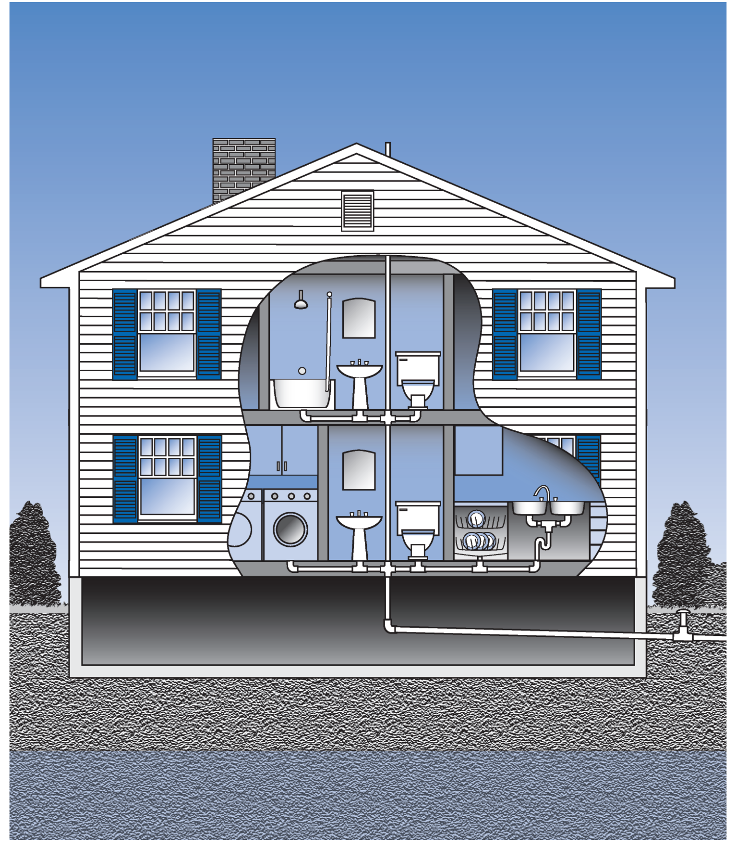
Table of Contents

Introduction

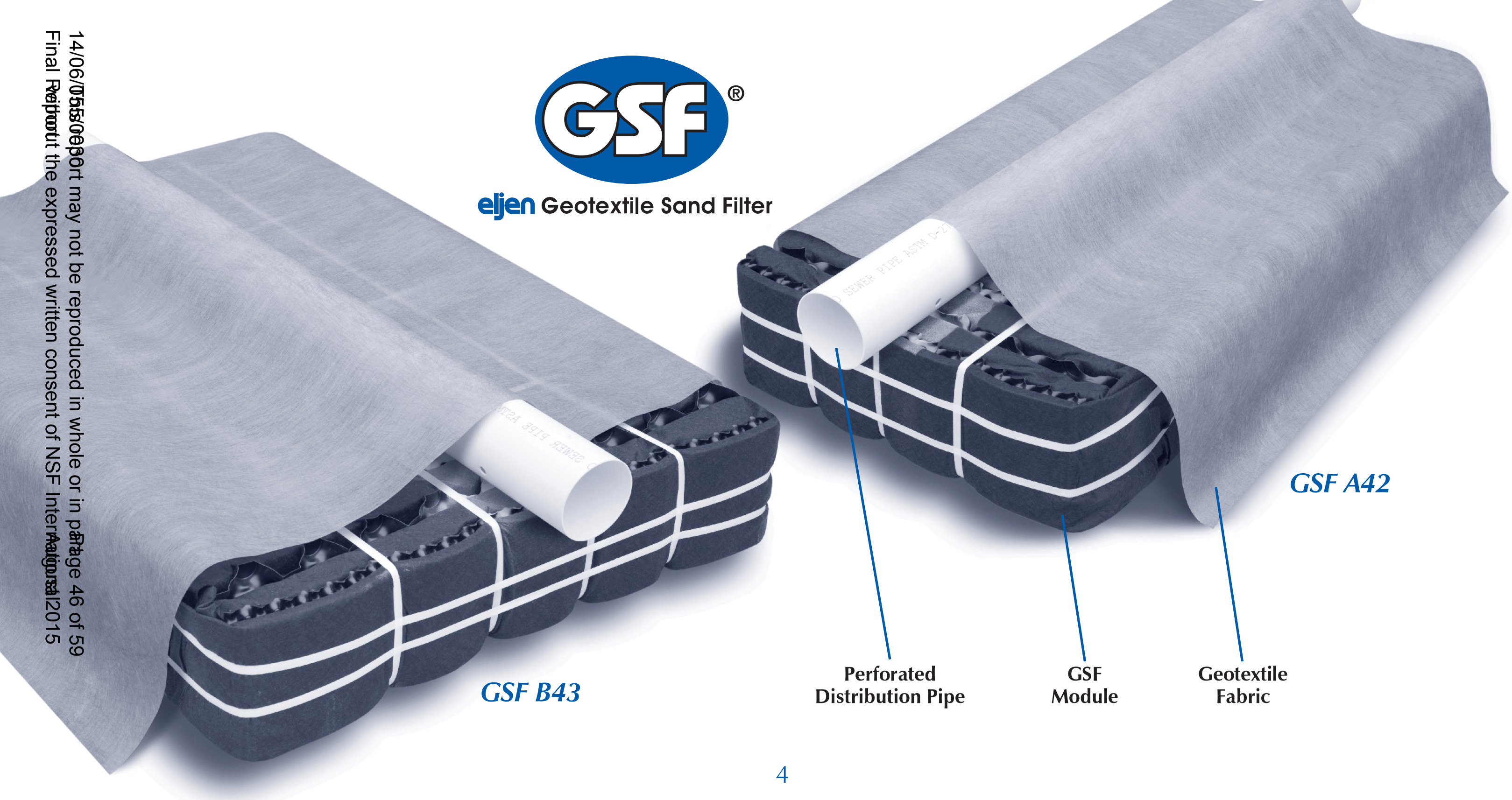
No one budgets for a septic system failure. A new residential septic system can cost anywhere from $4,000 to more than $20,000 to install. If the system is not maintained, the soil around the system could become clogged causing sewage to overflow on to the ground or back up into the house. Bottom line, rebuilding a failed septic system is an expensive burden on the homeowner.

Preventing a septic system failure is easier and more affordable than it is to correct. By keeping harmful materials out of the system and by pumping out the septic tank at least every three years, the homeowner can protect their system against premature failure. The minimum cost of having the septic tank pumped is wise insurance to protect your homes wastewater system.

This manual outlines the principles of septic system operations and explains the basic maintenance procedures that will lengthen the life of your system. If properly operated and maintained, your Eljen wastewater system can provide many years of trouble-free service.



The Eljen GSF System



GSF System Description

The Eljen GSF Geotextile Sand Filter system is a cost-effective upgrade from other septic technologies. Unlike other systems that treat effluent only once, the GSF's patented Bio-Matt™ pre-treatment process treats septic effluent twice. That means that the soil can absorb the effluent more easily, resulting in a better-performing system in a smaller area than other systems.

TESTED FOR PROVEN PERFORMANCE

The Eljen GSF system technology is based on 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. The GSF is recognized by regulatory officials and experts in the industry as one of the most reliable wastewater treatment technologies in the market-place today.

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.

How the GSF System Works

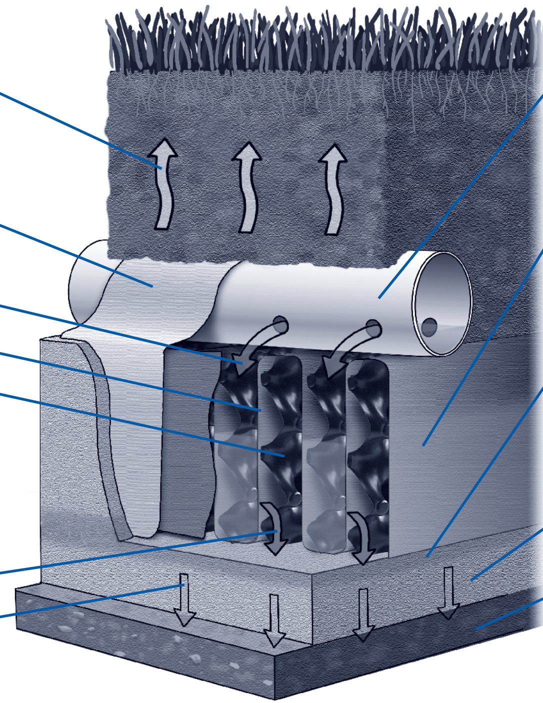
- Incoming effluent and bacteria flow through the perforated pipes which distribute the effluent over the Modules.
- Open air channels in the Modules allow beneficial bacteria to grow on the Bio-Matt fabric and treat effluent.
- A geotextile fabric covers the top and sides of the GSF Modules, protecting the system's sand and soil from fine particles that can clog the system. It also helps maintain effluent storage inside the Modules.
- After effluent passes through the GSF Modules, a lighter, secondary biomat forms on the layer of sand below the system, where the treatment process is continued.
- Treated effluent is then absorbed by the native soil where final filtration takes place.

GSF®

eljen Geotextile Sand Filter

GSF System Operation

This schematic shows the inner workings of the GSF Module and the overall operation of a GSF System.



- **Porous Top of the GSF System** allows evapotranspiration and oxygen exchange for better effluent treatment.
- **Anti-Siltation Fabric** keeps fines out of the GSF system
- **Untreated Effluent**
- **Bio-Matt™ Fabric**
- **Cuspated Plastic Core** provides separation between layers of Bio-Matt™ fabric. Maintains structural integrity of Modules & aids oxygen transfer. Increases treatment surface area and effluent storage capacity.
- **Filtered Effluent**
- **Treated Effluent**

Perforated Pipes
distribute effluent to the GSF system. Pipes are secured to the GSF Modules with preformed metal clamps.

Primary Treatment Zone
forms on Bio-Matt™ fabric. Significant fabric is provided for every ft² of soil interface.

Secondary Treatment Zone
forms at sand layer. Long term acceptance rate of this biomat layer is significantly increased as compared to conventional systems.

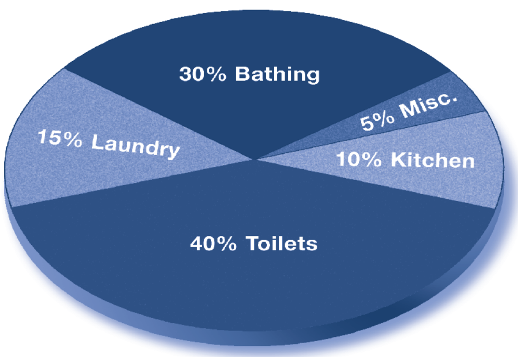
Specified Sand Layer
provides additional filtration

Native Soil or Fill
provides final filtration

The Nature of Household Sewage

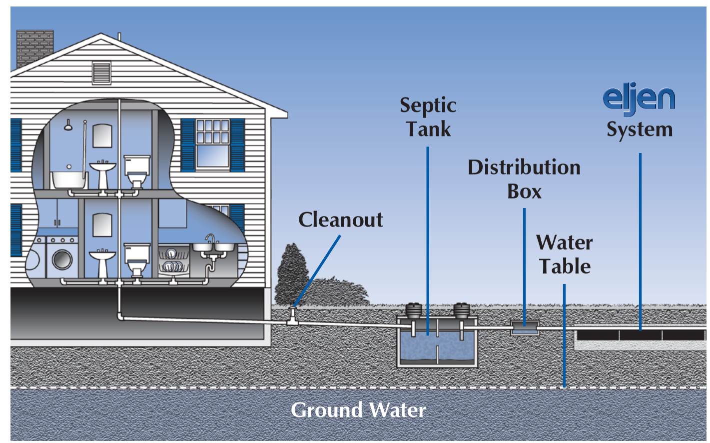
Household sewage is a combination of wastewater from several sources including sinks, toilets, showers, washing machines, dishwashers, and garbage disposals. The largest source of household sewage may vary depending upon the number of residents and water-using appliances within the home. Organic matter comes mostly from toilets and garbage disposals, while sinks, showers, and washing machines contribute large amounts of wastewater containing only small amounts of soap and dirt (including grease, detergents, lint, and vegetable matter).

NOTE: Your State and/or Local Code may require larger septic tanks and septic systems to accommodate garbage disposals.



The Septic System

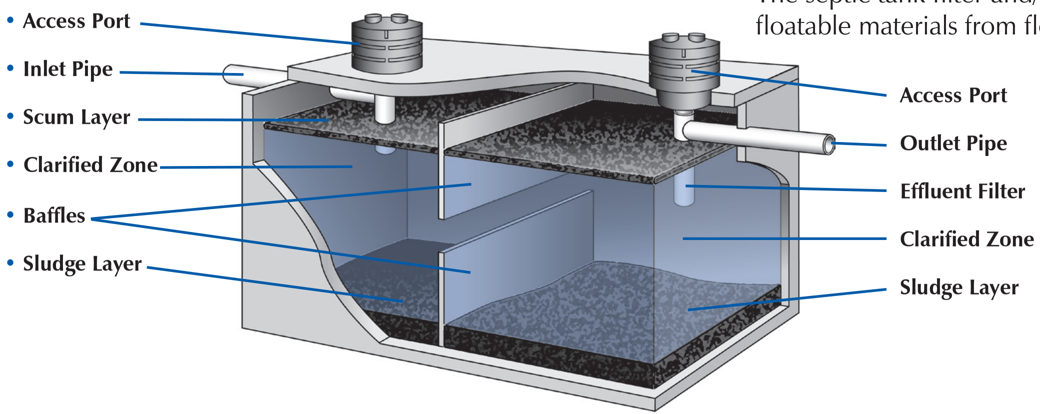
Your septic system is a two-part sewage treatment and disposal system buried in the ground. It is composed of a septic tank and a treatment system, and may have filters, pumps, and other components depending on your location and system demands. The sewage generally flows by gravity: first, into the septic tank where larger particles settle out and some primary decomposition takes place, and then into the wastewater system where it is further decomposed before slowly soaking into the soil.



The Septic Tank

Untreated household sewage would quickly clog any system if applied directly to the soil. The function of the septic tank is primarily a settling tank allowing solids to settle to the bottom of the tank while a somewhat cleaner liquid is discharged to the wastewater system for additional treatment. Septic tanks may contain one or more compartments, or the designer may have specified two or more tanks for your system.

Regardless of the number of compartments or tanks in your system, the basic principle is the same. Within the tank, as shown below, four important processes take place.

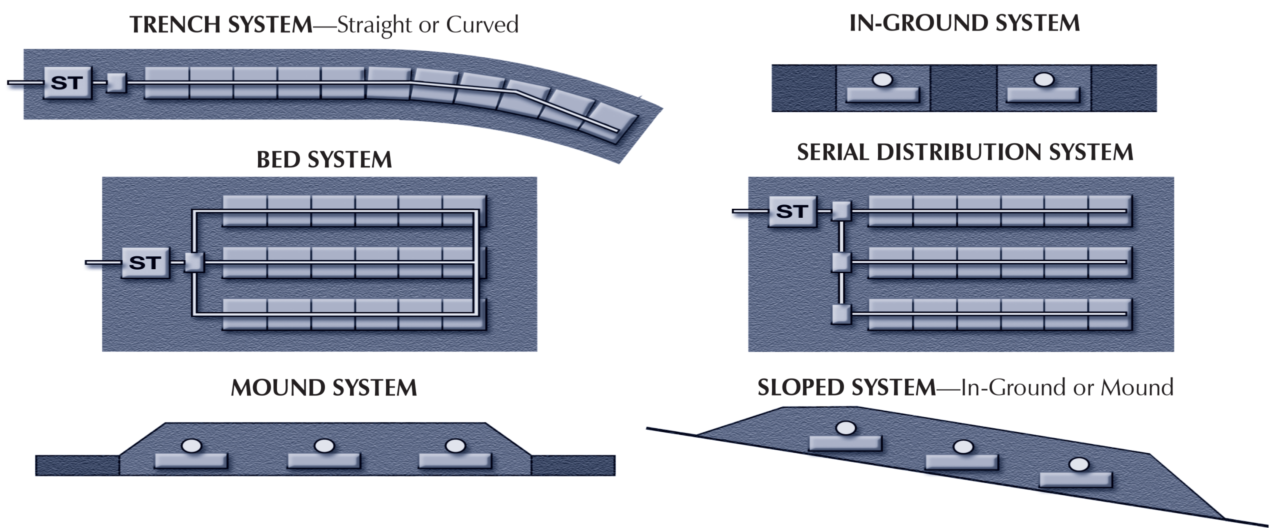


- The heavier, solid particles in the sewage settle to the bottom of the tank forming a layer of sludge. Lighter materials, including fat and grease, float to the surface, forming a scum layer.
- Bacteria living in the septic tank break down some of the organic solids into liquid components, helping to reduce the build up of sludge in the tank.
- Sludge and scum are stored in the septic tank rather than being allowed to flow out of the septic tank, where they would quickly create problems.
- The septic tank filter and/or baffles prevent scum and other floatable materials from flowing out to the wastewater system.

GSF System Designs

In a typical gravity-fed septic system, after primary treatment in the septic tank (ST), the effluent flows to the distribution box located just before the system. In level systems, the distribution box divides the flow equally to the rows of GSF Modules. In sloped systems, called serial distribution, the effluent flows first to the highest row and then, by overflow pipes, it passes to successively lower rows of Modules.

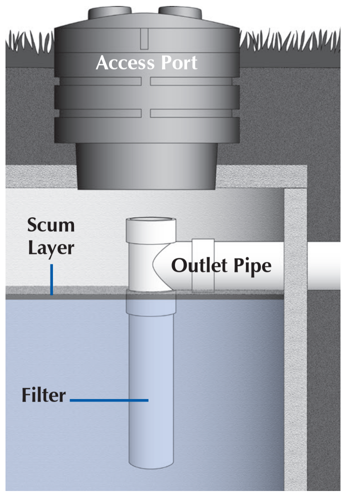
All GSF systems are installed on a layer of clean, medium to coarse specified sand. The effluent flows into the Modules through perforated plastic pipes which are secured to the tops of or within the Modules. A geotextile fabric covers the GSF Modules and distribution pipe assembly. This fabric prevents backfill materials and silt from entering the GSF Modules.



Septic Tank Effluent Filters

Your septic system may include an effluent filter, which may be located at the outlet of the septic tank, or in a separate tank located just after your septic tank. Effluent filters protect your Eljen system from solids that may carry over from the septic tank during peak usage. By limiting the maximum size of particles entering the GSF Modules to about 1/16 inch, they safeguard your system from unnecessary failure.

While effluent filters are partially self-cleaning, they must be thoroughly cleaned when the tank is inspected. When operating properly, they provide a fail-safe reminder that your tank needs pumping. Effluent filters may also be added to an existing system, either in the tank or externally. Filters must be installed before a pump chamber and should be easily accessible when the tank is serviced.



Pumped Systems

Some site conditions require that the system is installed at a higher elevation than the septic tank. When this is the case, an effluent pump and pump chamber are used to raise the sewage to the system's elevation. The pump chamber may be located in a separate tank, or it may be placed in a second compartment within the septic tank.

Effluent levels in the pump chamber are controlled by internal switches that turn the pump on and off, sending effluent to the system by dosing or pressure distribution.

SEPTIC TANK PUMPING

- Do not wait until your system shows signs of failure to have your septic tank pumped out. Waiting can mean complete clogging and an expensive repair bill. A septic tank filter will gradually slow down effluent flow over 2 to 3 years as a reminder that your tank should be serviced. Filters in residential systems usually need cleaning only as often as you pump the tank. Call a professional to inspect your system.
- Clean your filter and pump your tank at a minimum of every 3 years.
- For a list of septic tank service providers in your area, consult your local health department, phone directory, or the Internet.
- If your system's access manholes are at ground level or are clearly marked or mapped, the job of pumping the tank should be fast and easy. While your tank is being inspected, ask the operator to examine the inlet and outlet baffles and/or septic tank filter. If anything is broken, have repairs done immediately. The inlet should also be checked to see if wastewater is continuously flowing into the tank from previously undetected plumbing leaks.
- It is not necessary to leave any of the sludge in the tank as "seed." Incoming sewage contains all the bacteria needed for proper operation. Acids or bleaches should not be used to clean the tank.
- The use of enzymes or other "miracle" septic system additives has not been shown to be of significant value. It has been observed that some of these additives can actually harm your system. Regular pumping remains the best insurance against system failure.
- Keep accurate records of your system's inspections and pumping in the space provided on page 18 of this manual.

INTERMITTENT OR EXTENDED PERIODS OF NON-USE

The system does not require startup time to obtain the required treatment levels. No additional additives or substances are required either. The system does not require any changes for intermittent or extended periods of non-use. Continue to adhere to the maintenance schedule.

Potential System Problems

SIGNS OF A FAILING SYSTEM:

- Slow draining toilets or fixtures
- Sewage backing up into the house
- Sewage odors near the field or tank
- Sewage breakout on to the lawn

Problems with septic systems can be quite difficult to analyze. Whenever your system is not operating properly, it is best to contact a trained professional, such as the installer who constructed your system or a licensed septic system pumper. Your area Eljen distributor will be able to recommend trained personnel to assist you. Keep a copy of your design plan on hand for use in analyzing any malfunctions. Always be sure to document any inspections or maintenance done to your system.

If toilets or fixtures are draining slowly and your system has a septic tank filter, check your service records to see if it has been too long between tank servicing and pumping. The pipe between the tank and the distribution box can also be checked for obstructions. If necessary, have your tank inspected, pumped, and clean the septic tank filter. Remember, the filter is there to protect your system.

If sewage is backing up into the house and you have a pumped system, have the pump and pump controls checked to make sure they are functioning properly. Make sure that the pump dose is not excessive and/or is set according to the original design. The distribution box can be exposed to determine if effluent is properly flowing out of the pump chamber. Also note that in winter, effluent can freeze in the force main or the distribution box and block sewage flow if the system is not used for a period of time.

If you detect sewage odors, sewage over or near the system, your system is overloaded. This may be caused by excessive water use and/or ground water intrusion into the septic tank through a leaking tank seam. Check your water consumption, check for leaky toilets or fixtures, and have your tank pumped so that the system can be checked for ground water intrusion into the tank, especially at seasonal high water time.

Sewage odors coming from vent pipes are common with all types of disposal systems. Call us for information about activated charcoal filters that can be attached to the vent pipes.

NOTE: If a problem occurs with your system or service is required, contact your service provider. Their information is found on the data plate attached to the alarm and in the electrical box of your system.

Preventing System Problems

DO'S

- **DO** have your tank pumped at least every 3 years by a licensed septic tank service provider. Contact your local health department, or look in your phone directory, or on the Internet to find a qualified professional.
- **DO** practice water conservation. Promptly repair leaky faucets and toilets, run washing machines and dishwashers only when full, avoid long showers, and use water-saving features in faucets, showerheads and toilets.
- **DO** divert roof drains and surface water from driveways and hillsides away from the septic system. Keep sump pumps and household footing drains away from the septic system as well.
- **DO** take leftover hazardous household chemicals to your approved hazardous-waste collection center for disposal. Use bleach, drain and toilet bowl cleaners, and disinfectants sparingly and in accordance with product labels.
- **DO** learn the location of your septic tank and system's location and record it in the chart provided on page 18 of this manual. Keep a copy of your plan on file and attach a complete Eljen System Card to a convenient place such as the main electrical panel.
- **DO** use the space provided on page 18 of this manual to keep a record of pumping, inspections and other maintenance.

INITIAL AND EXTENDED SERVICE POLICIES

Included in the cost of your system is the initial two year service contract. Every six months the service provider will inspect the system to ensure it is in proper operation. The system inspection covers the electrical connections, high water alarm function, septic tank and pump tank inspected as well as the point of discharge. Any problems will be noted and the written notes will be given to the homeowner.

After the two year service contract expires, the service provider will offer an extended service contract which will cover the same criteria as the initial service contract.

Preventing System Problems

DON'TS

- **DON'T** drive or park over any part of your septic system. The area over the system should be left undisturbed with only a mowed grass cover. Roots from nearby trees or shrubs may clog or damage your system.
- **DON'T** put large amounts of cooking oil or grease into the system.
- **DON'T** discharge water treatment systems into your septic system.
- **DON'T** put non-degradable materials such as disposable diapers, sanitary products, plastic, and cigarettes into the system.
- **DON'T** put poisons such as gasoline, oil, paint, paint thinner, pesticides, antifreeze, or other chemicals into the system.
- **DON'T** use commercial septic tank additives. These products usually do not help and some may hurt your system in the long run.
- **DON'T** wait for signs of system failure. Follow the maintenance advice in this manual.
- **DON'T** use garbage disposals unless your system has been designed according to the requirements of Eljen's Garbage Disposal, Design and Installation Guidelines.

Service and Maintenance Record

Date	Type of Service	Contractor

Map of Your Septic System

System Details

Owner's Name, Address, Phone:	**System Address, if Different than Owner's Address:**
Contractor's Name, Address, Phone:	**Engineer's Name, Address, Phone:**
Contractor's License Number:	**Engineer's License Number:**
Installation Date:	**Code Gallons / Day / Bedroom:**
Number of Bedrooms:	**Number of Occupants:**
Design Flow in Gallons / Day:	**Septic Tank Filter:** ❑ No ❑ Yes, Location:
Number of GSF Modules:	**Type of GSF Modules:**
Number of Rows:	**GSF Modules per Row:**
System Design: ❑ Level Bed ❑ Trench ❑ Serial Distribution ❑ Pumped ❑ Other:	
System Type: ❑ Repair / Replacement ❑ New Construction ❑ Upgrade	
Structure Type: ❑ Residential ❑ Commercial	
System Use: ❑ Year-Round ❑ Seasonal	

Eljen Corporation Standard Limited Warranty for Septic Products

Each GSF Module manufactured by Eljen Corporation and installed and operated as an on-site treatment system in accordance with Eljen Corporation's installation instructions, is warranted to the original system owner against defective materials and workmanship for two years from the date the system is inspected and activated for operation. In order to exercise its warranty rights, the original system owner must notify Eljen Corporation in writing at 125 McKee Street, East Hartford, Connecticut 06108 within 15 days of the alleged defect. Eljen Corporation will supply replacement Modules determined by Eljen Corporation to be defective and covered by this Limited Warranty. Eljen Corporation's liability specifically excludes the cost of removal and/or installation of the Modules; damage to the Modules due to ordinary wear and tear, alteration, accident, misuse, abuse or neglect of the Modules; the placement and or use of improper materials into the system containing the Modules; failure of the Modules or the septic system due to improper design, improper installation, excessive water usage, improper grease disposal, or improper operation; not using specified materials during system construction specifically sand meeting the ASTM C33 specification; or any other event not caused by Eljen Corporation. System owners shall consider the Modules as single use, and re-use of Modules that were previously installed in an activated on-site system shall void this Limited Warranty. For this Limited Warranty to apply, the Modules must be installed in accordance with all site conditions required by state and local codes, all other applicable laws, and Eljen Corporation's installation instructions. This Limited Warranty and its remedies are exclusive and shall apply to no other party other than the original system owner.

THERE IS NO IMPLIED WARRANTY OF MERCHANTABILITY AND THERE IS NO IMPLIED WARRANTY OF FITNESS FOR BUYER'S PARTICULAR PURPOSE; THE IMPLIED WARRANTY OF MERCHANTABILITY AND THE IMPLIED WARRANTY OF FITNESS FOR BUYER'S PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF.

UNDER NO CIRCUMSTANCES SHALL ELJEN CORPORATION BE LIABLE TO THE SYSTEM OWNER OR ANY THIRD PARTY UNDER THIS AGREEMENT OR OTHERWISE FOR (a) ANY LOSS OR DAMAGE CAUSED BY OR ARISING OUT OF ANY DELAY IN FURNISHING ANY MATERIALS UNDER THIS AGREEMENT OR ANY ACT THAT IS NOT INTENTIONAL OR RECKLESS IN NATURE; OR (b) ANY INDIRECT, SPECIAL, EXEMPLARY OR CONSEQUENTIAL DAMAGES, REGARDLESS OF WHETHER ELJEN CORPORATION HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. WITHOUT LIMITING THE FOREGOING, SYSTEM OWNER OR ANY THIRD PARTY'S SOLE AND EXCLUSIVE REMEDY IN RESPECT OF THIS AGREEMENT AND THE MATERIALS FURNISHED HEREUNDER SHALL BE LIMITED TO THE REFUND TO SYSTEM OWNER OR ANY THIRD PARTY OF THE APPLICABLE FEES ACTUALLY PAID TO ELJEN CORPORATION UNDER THIS AGREEMENT WITH RESPECT TO THE PARTICULAR MATERIALS AT ISSUE. IN NO EVENT SHALL ELJEN CORPORATION'S LIABILITY HEREUNDER EXCEED THE APPLICABLE FEES ACTUALLY PAID TO ELJEN CORPORATION UNDER THIS AGREEMENT WITH RESPECT TO THE MATERIALS AT ISSUE.

This is the Standard Limited Warranty offered by Eljen Corporation. Any purchaser or potential system owner of Modules should carefully read and understand this warranty prior to the purchase of the Modules.

Represented By:

eljen CORPORATION

Innovative Environmental Products and Solutions Since 1970

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TAB B: DESIGN AND INSTALLATION MANUAL

GSF®

Geotextile Sand Filter

Michigan - Septic Replacement Loan Program Design & Installation Manual

eljen CORPORATION

Innovative Onsite Products & Solutions Since 1970

May 2024

www.eljen.com

Table of Contents

A42 Module 48” x 24” x 7” (L x W x H)

B43 Module 48” x 36” x 7” (L x W x H)

Cover Fabric The geotextile cover fabric (provided by manufacturer) that is placed over the GSF modules.

Design Flow The estimated peak flow that is used to size a GSF system is 150 gallons per day per Bedroom.

Flow Dial/Equalizer Special insert placed in the end of distribution pipes within the distribution box to compensate for possible unlevel installation and promote favorable flow to the distribution pipes.

GSF The Eljen Geotextile Sand Filter Modules and the 6-inch sand layer at the base and the 6–12-inch layer along the sides of the modules.

GSF Module The individual module of a GSF system. The module is comprised of a cuspated plastic core and geotextile fabric.

Specified Sand To ensure proper system operation, the system MUST be installed using ASTM C33 Sand. Ask your material supplier for a sieve analysis to verify that your material meets the required specifications.

ASTM C33 Sand will have less than 10% passing the #100 Sieve and less than 3% passing the # 200 sieve.

TABLE 1: SPECIFIED SAND SIEVE REQUIREMENTS

ASTM C33 & MDOT 2NS SAND SPECIFICATION		
Sieve Size	Sieve Square Opening Size	Specification Percent Passing (Wet Sieve)
3/8 inch	9.52 mm	100
No. 4	4.76 mm	95 - 100
No. 8	2.38 mm	80 - 100
No. 16	1.19 mm	50 - 85
No. 30	590 µm	25 - 60
No. 50	297 µm	5 - 30
No. 100	149 µm	0 - 10
No. 200	75 µm	0 - 3

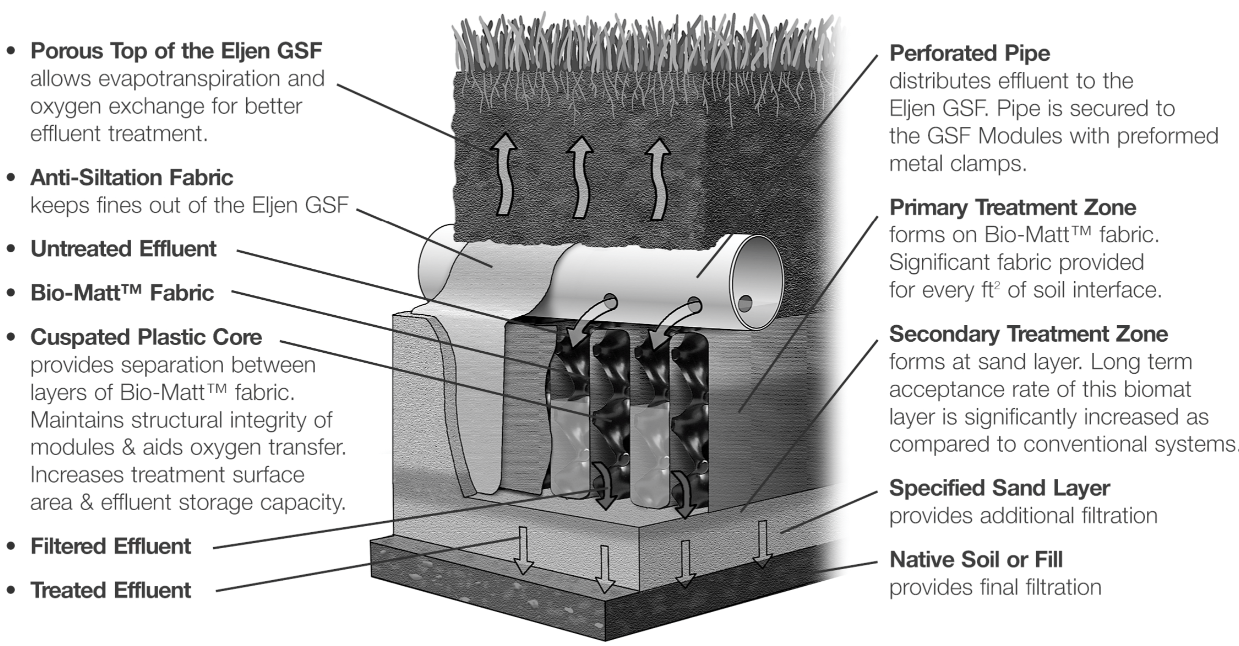
Primary Treatment Zone

- Perforated pipe is centered above the GSF module to distribute septic effluent over and into corrugations created by the cuspated 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 module's 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.
- Native soil provides final filtration and allows for groundwater recharge.

FIGURE 1: GSF SYSTEM OPERATION



1.0 System Preconditions

1.1 REQUIREMENTS: Eljen GSF systems must meet all State and/or local rules and regulations except as outlined in this manual. The Michigan Criteria for Subsurface Sewage Disposal and the local regulations will be referred to as the *Guidelines* in this manual. All design and sizing information within this manual applies to residential strength wastewater.

Please contact Eljen's Technical Resource Department at 1-800-444-1359 for design information on commercial systems or other technical questions.

1.2 WATER SOFTENER BACKWASH: At no time should water softener backwash be disposed of in the septic system. Water softener backwash should be discharged to a separate soil absorption field.

1.3 GARBAGE DISPOSALS: The use of a garbage disposal is not recommended as they can cause septic system problems by generating an increase of suspended solids, grease and nutrients.

However, if such units are proposed to be used, other measures should be taken to mitigate the increased nutrients to the field. Consult your local and state code for garbage disposal requirements. Eljen recommends a dual compartment tank or tanks in series. Consider upsizing the field for the additional biological load.

NOTE: Eljen requires the use of septic tank outlet effluent filters on all systems. Filters with higher filtration are recommended for systems with garbage disposals.

1.4 ADDITIONAL FACTORS AFFECTING RESIDENTIAL SYSTEM SIZE: Homes with expected higher than normal water usage may consider increasing the septic tank volume as well as incorporating a multiple compartment septic tank. Consideration for disposal area may be up-sized for expected higher than normal water use.

For example:

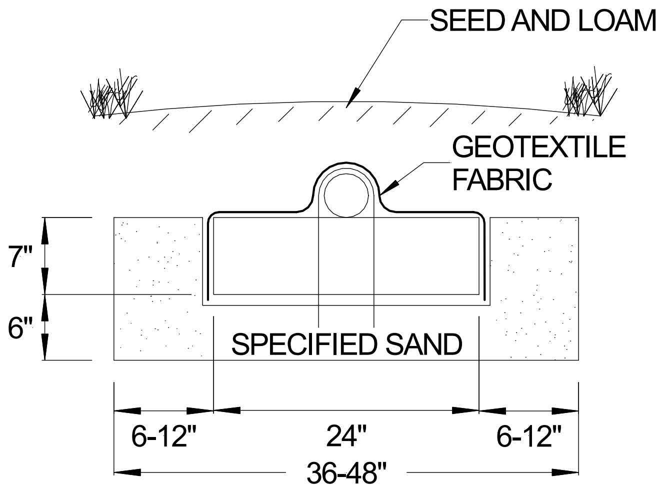
- Luxury homes, homes with a Jacuzzi style tubs, and other high use fixtures.
- Homes with known higher than normal occupancy.
- Short-term Rentals.

1.5 SYSTEM PROHIBITED AREAS: All vehicular traffic is prohibited over the GSF system. GSF systems shall not be installed under paved or concreted areas. If the system is to be installed in livestock areas, the system must be fenced off around the perimeter to prevent compaction of the cover material and damage to the system.

1.6 ELJEN INSTALLER CERTIFICATION: All installers are required to be trained and certified by an authorized Eljen representative. Contact your local distributor for training information.

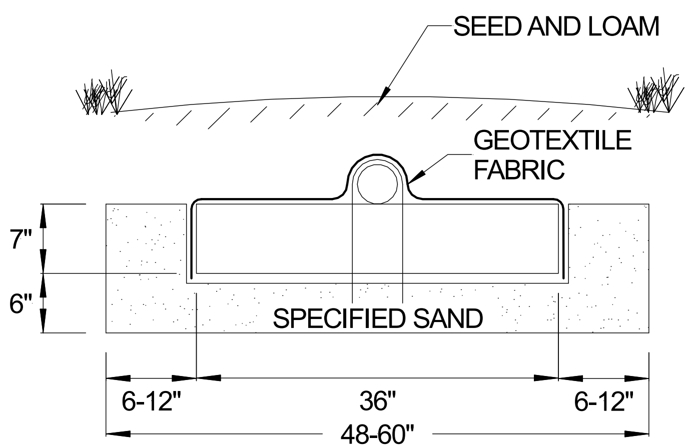
1.7 PURPOSE OF MANUAL: The purpose of this manual is to provide the minimum specifications for design and installation of the Eljen GSF in Michigan, specifically for the Septic Replacement Loan Program (SRLP). All state and local ordinances, requirements, and procedures must be followed. Each revised version of this manual supersedes the previous version. Any revisions will be submitted to EGLE for consideration."

FIGURE 2: TYPICAL A42 CROSS SECTION



A42 MODULE (L x W x H) 48” x 24” x 7”

FIGURE 3: TYPICAL B43 CROSS SECTION



B43 MODULE (L x W x H) 48” x 36” x 7”

<u>All systems are required to have a minimum of:</u>

- 6 – 12 inches of Specified Sand is at the edges of the GSF module.
- Minimum 6 inches of Specified Sand is at the beginning and end of each GSF Row.
- 6 inches of Specified Sand is directly below the GSF module.
- Minimum 12 inches of cover above the module.
- Maximum trench width for Eljen A42 Modules = 4 ft.
- Maximum trench width for Eljen B43 Modules = 5 ft.

2.0 Design and Installation

2.1 SEPTIC TANK: Septic tanks shall meet state sizing standards. Many designers are now specifying dual compartment tanks for all their systems. Eljen supports this practice as it helps to promote long system life by reducing TSS and BOD to the effluent disposal area. Eljen recommends septic tank pump outs to be performed every three years or on an as needed basis.

2.2 SEPTIC TANK FILTERS: An effluent filter is ***REQUIRED*** for use with Eljen GSF products. Effluent filter sizing should be based on effluent filter manufacturers recommendations.

Septic tank effluent filters are used as a means of preventing solids from leaving the tank and entering your system. Effluent filters should be cleaned from time to time. Cleaning requirements should be based on the type or make of the effluent filter installed.

2.3 VERTICAL SEPARATION TO LIMITING LAYER: Separation distance to limiting conditions must meet the minimum requirements of State or Local regulations. Vertical separation is measured from the restrictive feature to six inches below the GSF module.

2.4 SPECIFIED SAND SPECIFICATION FOR GSF SYSTEMS: The sand immediately under, between rows and around the perimeter of the GSF system must meet ASTM C33 Sand Specification, ***WITH LESS THAN 10% PASSING A #100 SIEVE AND LESS THAN 3% PASSING A #200 SIEVE.*** Please place a prominent note to this effect on each design drawing. See Table 1 for more information on the sand and sieve specifications. Michigan department of transportation (MDOT) 2NS sand meets these specifications.

2.5 PLACING GSF MODULES: The “painted stripe” on the GSF modules indicates the top of the module and is not intended to indicate the location of the distribution pipe. With the painted stripe facing up, all rows of GSF modules are set level, end to end on the Specified Sand layer.

2.6 DISTRIBUTION: Gravity, pump to gravity or pressure distribution are acceptable when using the GSF System. Piping shall meet the guidelines; however, Eljen strongly recommends the use of SDR 35 pipe and fittings as to prevent crushing during backfill. All distribution piping must meet a minimum 2,500-pound crush test specification for polyvinyl chloride (PVC) drain, waste and vent pipe.

All systems require a perforated 4” diameter pipe centered on top of the GSF modules unless the system is curving. The distribution pipe continues along the entire length of all modules in a trench or row. Holes are set at the 4 and 8 o’clock position and secured by the Eljen provided wire clamps.

When using pressure distribution, a pressure manifold is placed inside the 4-inch distribution pipe or orifice shields are used with the pressure manifold. Section 7.0 of this manual goes into details of how to construct the distribution network. All piping must meet state and local regulations.

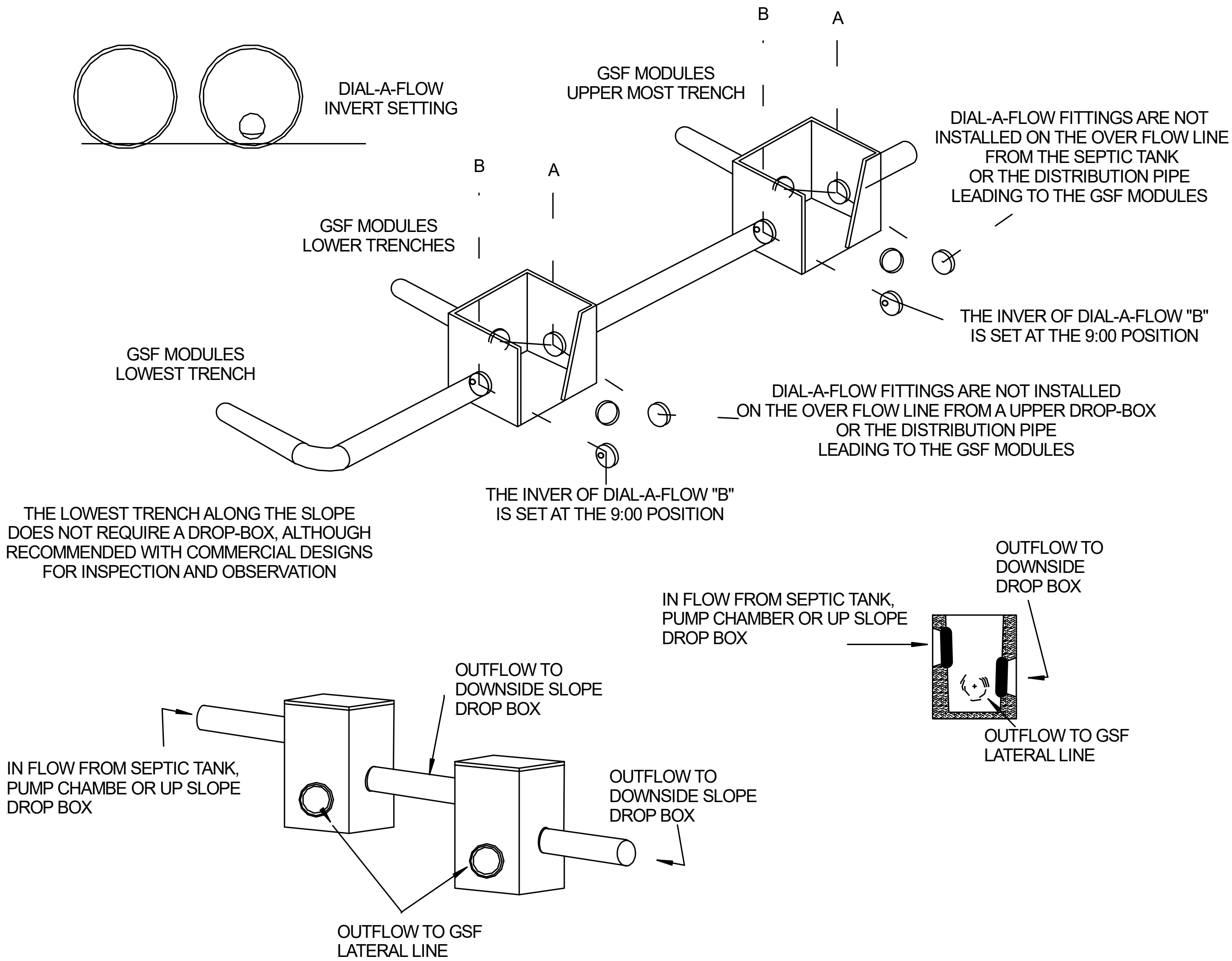
2.7 CONNECTIONS AND FITTINGS: Connections of lines to tanks and distribution boxes must be made using watertight seals. Use of any grouting material is not permitted.

2.8 DISTRIBUTION BOX: Set the gravity system D-box outlet invert a minimum of ⅛ inch drop in elevation per linear foot to the top first module in the row. Set a 2-inch minimum drop for dosed systems from the D-box to the modules. Ensure that the distribution box and pipes feeding the system are placed on compacted soil. Flow Dials may be used in either Gravity or Dosed installations.

2.9 EQUAL DISTRIBUTION: Parallel distribution is the preferred method of dosing to a gravity or pump to gravity system. It encourages equal flows to each of the lines in the system. It is recommended for most trench systems.

2.10 SEQUENTIAL DISTRIBUTION: Sequential Distribution using a distribution box will fully utilize the uppermost section of the system prior to spilling effluent into a lower row of modules. This is for use on any site with greater than 0.5% slope when not using parallel distribution.

FIGURE 4: SEQUENTIAL DISTRIBUTION DROP–BOX DETAIL



2.11 COVER FABRIC: Geotextile cover fabric is provided by Eljen Corporation for all GSF systems. It 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 *not* block holes in the distribution pipe or be stretched from the top of the pipe to the outside edge of the modules. "Tenting" will cause undue stress on fabric and pipe.

2.12 SYSTEM VENTING: It is required to vent all systems that are more than 18" below finished grade and systems beneath any surface condition that would not allow for surface air exchange with the system such as patios. See Section 8.0 for a more detailed explanation of venting GSF products.

2.13 BACKFILL & FINISH GRADING: Complete backfill with a minimum of 6 inches of clean porous fill measured from the top of the distribution pipe. Use well graded sandy fill that is clean, porous and devoid of large rocks. Do not use wheeled equipment over the system. A light track machine may be used with caution, avoiding crushing or shifting of pipe assembly. Divert surface runoff from the system absorption area. Finish grade to prevent surface ponding. Seed and loam system area to protect from erosion.

2.14 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.

2.15 NUMBER OF GSF MODULES REQUIRED: Residential systems use a minimum of six (6) A42 modules per bedroom or five (5) B43 modules per bedroom. In bed systems, we recommend not exceeding 11 B43 or 13 A42 modules per bedroom. See Table 3 for more information on system sizing.

2.16 SYSTEM SIZING: Eljen typically recommends a 50% reduction to standard stone and pipe sizing for similar soils. Below, Table 3 shows soil application and linear loading rates when the local approval authority is silent on application or linear loading rates for treatment and dispersal products.

TABLE 2: GSF SOIL APPLICATION RATES

				Linear Loading Rate (gal/d/ft)									
				Slope									
Soil Characteristics			Infiltration Loading Rate gal/day/ft^2	0-4%			5-9%			>10%			
Texture	Structure			Infiltration Distance (in)			Infiltration Distance (in)			Infiltration Distance (in)			
	Shape	Grade	<30mg/L	6 - 12	12 - 24	> 24	6 - 12	12 - 24	> 24	6 - 12	12 - 24	> 24	Row
COS, S,LCOS,LS	--	0SG	1.6	4	5	6	5	6	7	6	7	8	1
FS, VFS,LFS,LVFS	--	0SG	1	3.5	4.5	5.5	4	5	6	5	6	7	2
CSL,SL	--	0M	0.6	3	3.5	4	3.6	4.1	4.6	5	6	7	3
	PL	1	0.5	3	3.5	4	3.6	4.1	4.6	4	5	6	4
		2,3	0	-	-	-	-	-	-	-	-	-	5
	PR/BK /GR	1	0.7	3.5	4.5	5.5	4	5	6	5	6	7	6
		2,3	1	3.5	4.5	5.5	4	5	6	5	6	7	7
FSL,VFSL	--	0M	0.5	2	2.3	2.6	2.4	2.7	3	2.7	3.2	3.7	8
	PL	1,2,3	0	-	-	-	-	-	-	-	-	-	9
	PR/BK /GR	1	0.6	3	3.5	4	3.3	3.8	4.3	3.6	4.1	4.6	10
		2,3	0.8	3.3	3.8	4.3	3.6	4.1	4.6	3.9	4.4	4.9	11
L	--	0M	0.5	2	2.3	2.6	2.4	2.7	3	2.7	3.2	3.7	12
	PL	1,2,3	0	-	-	-	-	-	-	-	-	-	13
	PR/BK /GR	1	0.6	3	3.5	4	3.3	3.8	4.3	3.6	4.4	4.6	14
		2,3	0.8	3.3	3.8	4.3	3.6	4.1	4.6	3.9	4.4	4.9	15
SIL	--	0M	0.2	2	2.5	3	2.2	2.7	3.2	2.4	2.9	3.4	16
	PL	1,2,3	0	-	-	-	-	-	-	-	-	-	17
	PR/BK /GR	1	0.6	2.4	2.7	3	2.7	3	3.3	3	3.5	4	18
		2,3	0.8	2.7	3	3.3	3	3.5	4	3.3	3.8	4.3	19
SCL,CL,SICL	--	0M	0	-	-	-	-	-	-	-	-	-	20
	PL	1,2,3	0	-	-	-	-	-	-	-	-	-	21
	PR/BK /GR	1	0.3	2	2.5	3	2.2	2.7	3.2	2.4	2.9	3.4	22
		2,3	0.6	2.4	2.9	3.4	2.7	3	3.3	3	3.5	4	23
SC,C,SIC	--	0M	0	-	-	-	-	-	-	-	-	-	24
	PL	1,2,3	0	-	-	-	-	-	-	-	-	-	25
	PR/BK /GR	1	0	-	-	-	-	-	-	-	-	-	26
		2,3	0.3	2	2.5	3	2.2	2.7	3.2	2.4	2.9	3.4	27
A	B	C	D	E	F	G	H	I	J	K	L	M	O

Trench Example:

House size:	3 Bedrooms
Design Flow:	450 gpd
Soil Type:	FSL, 2, BK
Slope:	3%
Absorption Field Type:	Trench

Calculate Minimum Absorption Area

Lookup loading rate and Linear Loading Rate from Table 3:

				Linear Loading Rate (gal/d/ft)								
				Slope								
Soil Characteristics			Infiltration Loading Rate gal/day/ft^2	0-4%			5-9%			>10%		
Texture	Structure			Infiltration Distance (in)			Infiltration Distance (in)			Infiltration Distance (in)		
	Shape	Grade	<30mg/L	6 - 12	12 - 24	> 24	6 - 12	12 - 24	> 24	6 - 12	12 - 24	> 24
FSL,VFSL	PR/BK /GR	1	0.6	3	3.5	4	3.3	3.8	4.3	3.6	4.1	4.6
		2,3	0.8	3.3	3.8	4.3	3.6	4.1	4.6	3.9	4.4	4.9

Loading Rate: 0.8 gpd / ft^2

Linear Loading Rate: 3.8 gpd / lf

Calculate Minimum Absorption Area

Minimum Absorption Area: Design Flow ÷ Infiltration Loading Rate

450 gpd ÷ 0.8 gpd / ft^2 = 562.5 ft^2

Calculate Minimum Linear Length (based on HLLR)

Minimum Linear Length: Design Flow ÷ Linear Loading Rate

450 gpd ÷ 3.8 gpd / lf = 118.4, round up to 119 ft

Width Configuration (choose one)

Unit	Sand on Sides of Unit	Trench Width	Square Footage per Configuration
A42	6"	3 ft	12
	12"	4 ft	16
B43	6"	4 ft	16
	12"	5 ft	20

Calculate Minimum Trench Length

Minimum Trench Length: Minimum Absorption Area ÷ Width Configuration

565.5 ft^2 ÷ 5 ft = 113.1 ft, round to 114 ft

Choose the larger Minimum Trench Length based on HLLR or Minimum Absorption Area. In this case, the HLLR minimum Length is driving the system length.

Calculate Number of Modules Required

Number of Modules Required: 119 ft ÷ 4 Feet per Module

119 ft ÷ 4 ft/ Module = 29.75 Modules, round down to 29 Modules

Final Dimension Layout

(Note: System layout and number of rows will vary based on site constraints)

3.0 Trench Installation Sizing and Guidelines

Min. Product Length	119 ft
Trench Width	5 ft
Minimum Number of Units	29 Modules
Min. System Area	595 ft^2

FIGURE 5: PLAN VIEW –TRENCH SYSTEM

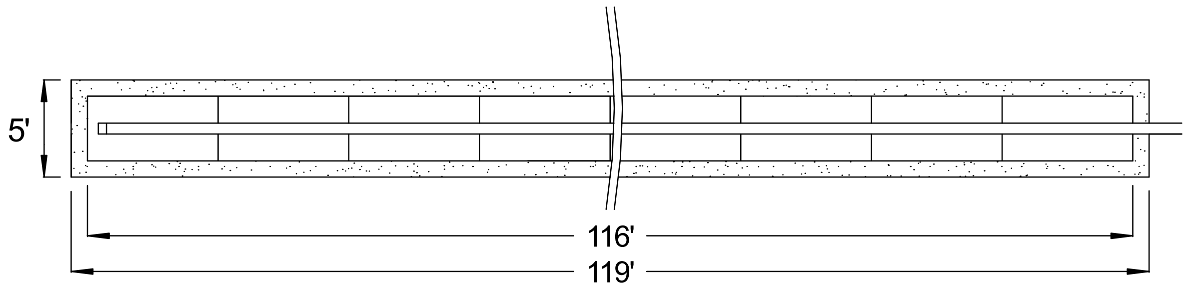
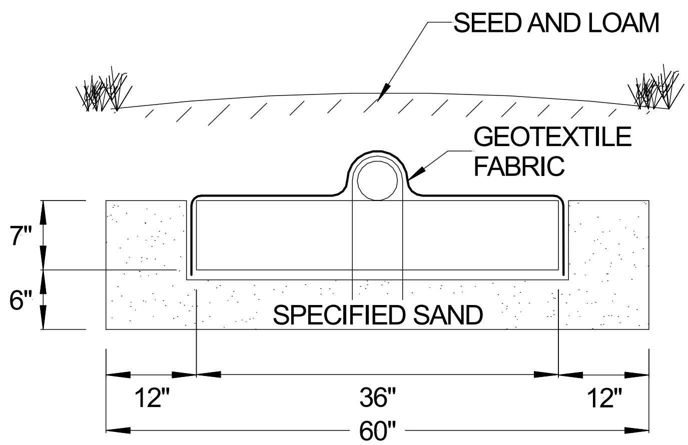


FIGURE 6: CROSS SECTION – TRENCH SYSTEM



3.0 Trench Installation Sizing and Guidelines

1. Ensure all components leading to the GSF system are installed properly. Septic tank effluent filters are required with the GSF system.

2. Determine the number of GSF Modules required using the trench sizing example.

3. Prepare the site. Do not install a system on saturated ground or wet soils that are smeared during excavation. Keep machinery off infiltrative areas.

4. Plan all drainage requirements above (up-slope of) the system. Set soil grades to ensure that storm water drainage and ground water is diverted away from the absorption area once the system is complete.

5. Excavate the trench; scarify and prepare the receiving layer to maximize the interface between the native soil and specified sand.

6. Minimize walking in the trench prior to placement of the specified sand to avoid soil compaction.

7. Place specified sand in 6" lifts and stabilize by foot, a hand-held tamping tool, or a portable vibrating compactor. The minimum stabilized height below the GSF module must be level at 6".

8. Place GSF modules with **PAINTED STRIPE FACING UP**, end to end on top of the specified sand along their 4-foot length, centered laterally in the trench.

9. Place a standard 4-inch perforated pipe, SDR 35 or equivalent, atop the row of modules, centered laterally. Ensure orifices are set at the 4 & 8 o'clock position.

10. Secure all 4-inch pipes with manufacturers supplied wire clamps, one per module.

11. (Pressure Distribution Systems) Insert a pressure pipe (size per design and code) into the standard 4-inch perforated pipe. The pressure pipe orifices are set at the 12 o'clock position as shown in Figure 11. Each pressure lateral will have a drain hole at the 6 o'clock position. Each pressure lateral shall include sweeping cleanouts at the terminal ends and be accessible from grade. The 4" distribution pipe is capped at both ends with a hole cut in the cap to allow the pressure pipe through.

12. ***Cover fabric substitution is not allowed.*** The installer should lay the Eljen provided geotextile cover fabric lengthwise down the trench, with the fabric fitted to the perforated pipe on top of the GSF modules. Fabric should be neither too loose, nor too tight. The correct tension of the cover fabric is set by:
    a. Spreading the cover fabric over the top of the module and down both sides of the module with the cover fabric tented over the top of the perforated distribution pipe.
    b. Place shovelfuls of Specified Sand directly over the pipe area allowing the cover fabric to form a mostly vertical orientation along the sides of the pipe. Repeat this step moving down the pipe.

13. Place the sand extensions along both sides of the modules edge. A minimum of 6 inches of Specified Sand is placed at the beginning and end of each trench.

14. Complete backfill with a minimum of 6 inches of clean porous fill measured from the top of the distribution pipe. Backfill exceeding 18 inches requires venting at the far end of the trench. Use well graded native soil fill that is clean, porous and devoid of large rocks. Do not use wheeled equipment over the system. A light track machine may be used with caution, avoiding crushing or shifting of pipe assembly.

15. Divert surface runoff from the system. Finish grade to prevent surface ponding. Topsoil and seed system area to protect from erosion.

Bed Example 1 (HLLR Applied):

House size:	3 Bedrooms
Design Flow:	450 gpd
Soil Type:	L, 0M,
Slope:	12%
Infiltration Distance (trench bottom to restrictive layer):	18 inches
Absorption Field Type:	Bed

Calculate Minimum Absorption Area
Lookup loading rate and Linear Loading Rate from Table 3:

				Linear Loading Rate (gal/d/ft)								
				Slope								
Soil Characteristics			Infiltration Loading Rate gal/day/ft^2	0-4%			5-9%			>10%		
Texture	Structure			Infiltration Distance (in)			Infiltration Distance (in)			Infiltration Distance (in)		
	Shape	Grade	<30mg/L	6 - 12	12 - 24	> 24	6 - 12	12 - 24	> 24	6 - 12	12 - 24	> 24
L	--	0M	0.5	2	2.3	2.6	2.4	2.7	3	2.7	3.2	3.7

Loading Rate: 0.5 gpd / ft^2

Linear Loading Rate: 3.2 gpd / lf

Calculate Minimum Absorption Area

Absorption Area: Design Flow ÷ Loading Rate

450 gpd ÷ 0.5 gpd / ft^2 = 900 ft^2

Calculate Minimum Linear Length

Minimum Linear Length: Design Flow ÷ Linear Loading Rate

450 gpd ÷ 3.2 gpd / lf = 140.6, round to 141 ft

Calculate Number of Modules Required
Lookup the minimum units required from the table below (for this example we are using B43s):

Min. Units per Bedroom		
	A42	B43
1.6	6	5
1	7	6
0.8	8	7
0.7	9	
0.6	10	8
0.5	11	9
0.3	12	10
0.2	13	11

Number of Bedrooms x Min. Units per Bedroom = Number of Modules Required

3 x 9 B43s per Bedroom = 27 B43

4.0 Bed Installation Sizing and Guidelines

Calculate Bed Length

Units per Row: Number of Modules ÷ Number of Rows
27 modules ÷ 2 Rows = 13.5 units per row, round up to 14

Unit Spacing

Minimum Linear Length – 5 ft (6" sand at each end of trench+ 1 Unit) ÷ (Number of Units per Row – 1)

(141 ft – 5 ft) ÷ (14 modules – 1) = 91ft ÷ 13 = 10.5 ft center to center spacing

Edge to Edge Spacing – Center to Center spacing – 4 = 7 ft – 4 ft 6.5 ft edge to edge spacing

Determine Best Width Configuration

Width of Minimum-Length Bed: Minimum Absorption Area ÷ Minimum Linear Length

900 ft^2 ÷ 141 ft = 6.4 ft, round to 6.5 ft for easy construction

Min. Width per Row	
Model	Row Width
A42	3ft
B43	4 ft

Bed Width: Number or Rows x Row Width
2 Rows x 4 ft = 8 ft

Choose the larger of the two. In this case our use 8 ft.

Final Dimension Layout

(Note: System layout and number of rows will vary based on site constraints)

Bed Length	141 ft.
Bed Width	8 ft.
Minimum Number of Units	28 units
Units per Row	14 units per row
Unit Type	GSF B43
System Area	1,128 ft^2

Bed Example 2:

House size:	3 Bedrooms
Design Flow:	450 gpd
Soil Type:	L, 0M,
Slope:	12%
Infiltration Distance (trench bottom to restrictive layer):	18 inches
Absorption Field Type:	Bed

Calculate Minimum Absorption Area

Lookup loading rate and Linear Loading Rate from Table 3:

Soil Characteristics			Infiltration Loading Rate gal/day/ft^2
Texture	Structure		
	Shape	Grade	<30mg/L
	--	0M	0.5
L	PL	1,2,3	0
	PR/BK/G	1	0.6
	R	2,3	0.8

Loading Rate: 0.5 gpd / ft^2

Calculate Minimum Absorption Area

Absorption Area: Design Flow ÷ Loading Rate

450 gpd ÷ 0.5 gpd / ft^2 = 900 ft^2

Calculate Number of Modules Required

Lookup the minimum units required from the table below (for this example we are using B43s):

Min. Units per Bedroom		
	A42	B43
1.6	6	5
1	7	6
0.8	8	7
0.7	9	
0.6	10	8
0.5	11	9
0.3	12	10
0.2	13	11

Number of Bedrooms x Min. Units per Bedroom = Number of Modules Required

3 x 9 B43s per Bedroom = 27 B43

Calculate Minimum Row Length

Units per Row: Number of Modules ÷ Number of Rows
27 modules ÷ 2 Rows = 13.5 units per row, round up to 14

Row Length: Number of Modules x 4 Feet per Module + 1 Foot of Sand
14 Units x 4 ft/Module + 1 ft = 57 ft

Determine Width Configuration

Bed Width: Minimum Absorption Area ÷ Minimum Row Length

900 ft^2 ÷ 57 ft = 15.8 ft, round to 16 ft for easy construction

Final Dimension Layout

(Note: System layout and number of rows will vary based on site constraints)

Bed Length	57 ft.
Bed Width	16 ft.
Minimum Number of Units	28 units
Units per Row	14 units per row
Unit Type	GSF B43
System Area	912 ft^2

FIGURE 7: PLAN VIEW – BED SYSTEM – LEVEL SITE

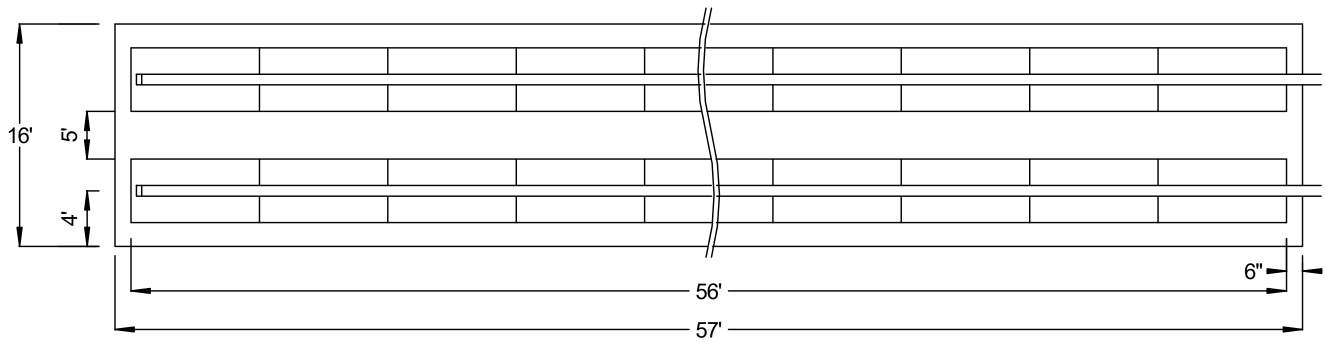


FIGURE 8: SECTION VIEW – BED SYSTEM – LEVEL SITE

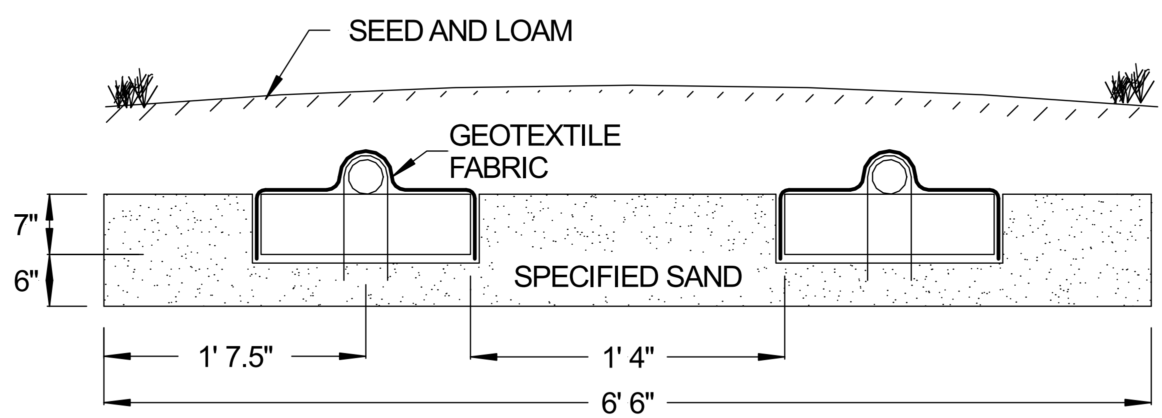


FIGURE 9: PLAN VIEW – BED SYSTEM – SLOPING SITE

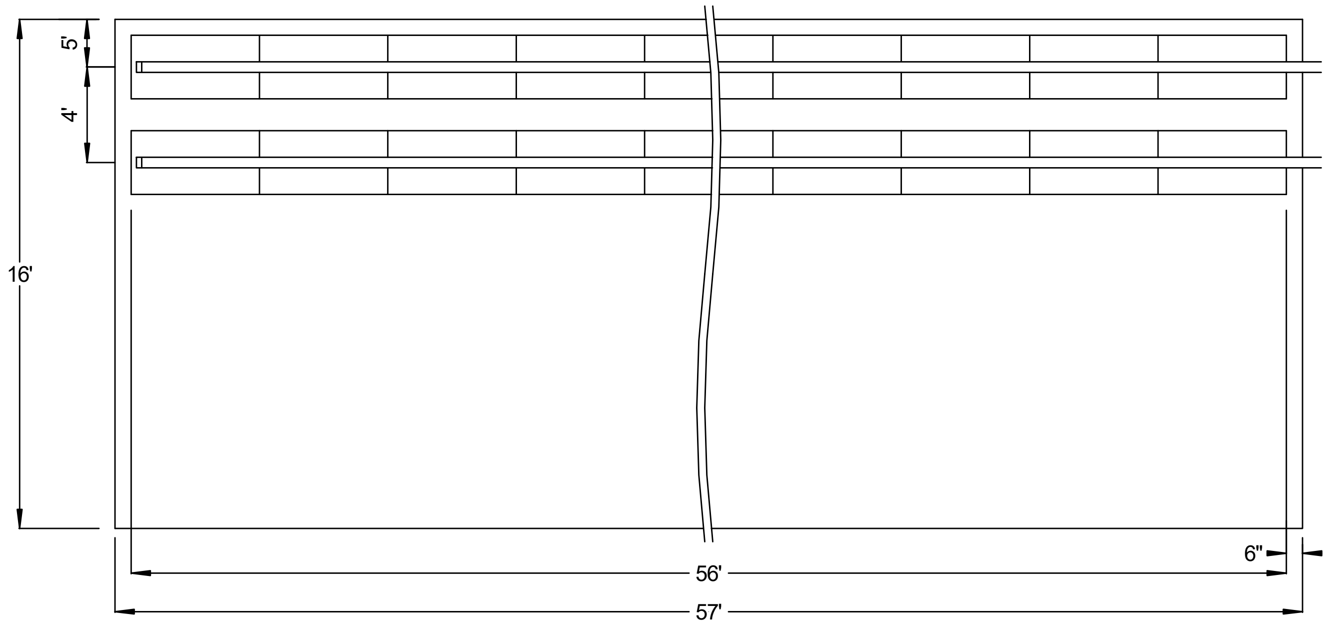
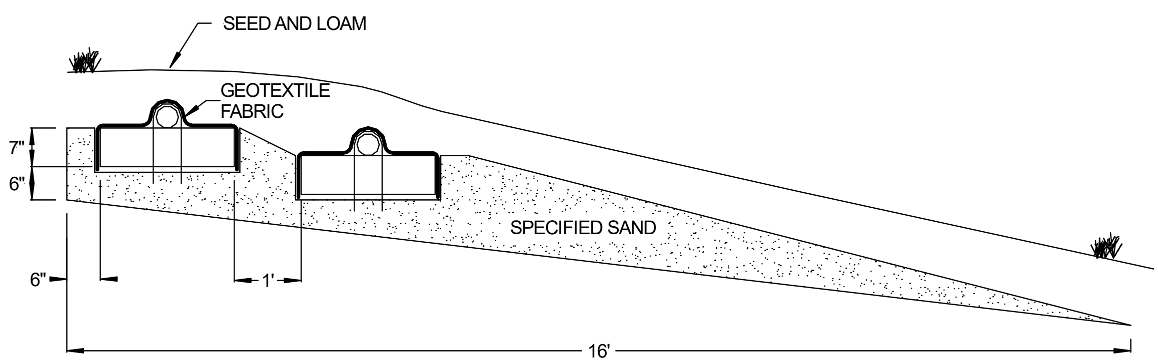


FIGURE 10: SECTION VIEW – BED SYSTEM – SLOPING SITE



4.0 Bed Installation Sizing and Guidelines

1. Ensure all components leading to the GSF system are installed properly. Septic tank effluent filters are required with the GSF system.

2. Determine the number and type of GSF Modules required using the bed sizing example.

3. Prepare the site. Do not install a system on saturated ground or wet soils that are smeared during excavation. Keep machinery off infiltrative areas.

4. Plan all drainage requirements above (up-slope of) the system. Set soil grades to ensure that storm water drainage and ground water is diverted away from the absorption area once the system is complete.

5. Excavate the bed absorption area; scarify the receiving layer to maximize the interface between the native soil and specified sand.

6. Minimize walking in the absorption area prior to placement of the specified sand to avoid soil compaction.

7. Place specified sand in 6" lifts, and stabilize by foot, a hand-held tamping tool, or a portable vibrating compactor. The minimum stabilized height below the GSF module must be level at 6".

8. Place GSF modules with **PAINTED STRIPE FACING UP**, end to end on top of the specified sand along their 4-foot length, spaced laterally as shown in the design.

9. Place a standard 4-inch perforated pipe, SDR 35 or equivalent, atop the row of modules, centered laterally. Ensure orifices are set at the 4 & 8 o'clock position.

10. Secure all 4-inch pipes with manufacturers supplied wire clamps, one per module.

11. (Pressure Distribution Systems) Insert a pressure pipe (size per design and code) into the standard 4-inch perforated pipe. The pressure pipe orifices are set at the 12 o'clock position as shown in Figure 11. Each pressure lateral will have a drain hole at the 6 o'clock position. Each pressure lateral shall include sweeping cleanouts at the terminal ends and be accessible from grade. The 4" distribution pipe is capped at both ends with a hole cut in the cap to allow the pressure pipe through.

12. ***Cover fabric substitution is not allowed.*** The installer should lay the Eljen provided geotextile cover fabric lengthwise down the row, with the fabric fitted to the perforated pipe on top of the GSF modules. Fabric should be neither too loose, nor too tight. The correct tension of the cover fabric is set by:
    a. Spreading the cover fabric over the top of the module and down both sides of the module with the cover fabric tented over the top of the perforated distribution pipe.
    b. Place shovelfuls of Specified Sand directly over the pipe area allowing the cover fabric to form a mostly vertical orientation along the sides of the pipe. Repeat this step moving down the pipe.

13. Place 6 inches of Specified Sand along both sides of the modules edge. A minimum of 6 inches of Specified Sand is placed at the beginning and end of each module row. A minimum of 12 inches of Specified Sand is placed in between module rows.

14. Complete backfill with a minimum of 6 inches of clean porous fill measured from the top of the distribution pipe. Backfill exceeding 18 inches requires venting at the far end of the bed. Use well graded native soil fill that is clean, porous and devoid of large rocks. Do not use wheeled equipment over the system. A light track machine may be used with caution, avoiding crushing or shifting of pipe assembly.

15. Divert surface runoff from the system. Finish grade to prevent surface ponding. Topsoil and seed system area to protect from erosion.

5.0 Mound Installation Sizing and Guidelines

1. Ensure all components leading to the GSF system are installed properly. Septic tank effluent filters are required with the GSF system.

2. Determine the number and type of GSF Modules required using the sizing formula.

3. Prepare the site. Do not install a system on saturated ground or wet soils that are smeared during preparation. Keep machinery off infiltrative areas.

4. Plan all drainage requirements above (up-slope of) the system. Set soil grades to ensure that storm water drainage and ground water is diverted away from the absorption area once the system is complete.

5. Remove the organic soil layer. Scarify the receiving layer to maximize the interface between the native soil and Specified Sand. Minimize walking in the absorption area prior to placement of the Specified Sand to avoid soil compaction.

6. Place fill material meeting local requirements (or Specified Sand requirements) onto the soil interface as you move down the excavated area. Place specified sand in 6" lifts, and stabilize by foot, a hand-held tamping tool, or a portable vibrating compactor. The stabilized height below the GSF module must meet the mound design requirements.

7. Place GSF modules with **PAINTED STRIPE FACING UP**, end to end on top of the specified sand along their 4-foot length.

8. Place a standard perforated 4-inch distribution pipe, SDR 35 or equivalent, atop the row of modules, centered laterally. Ensure orifices are set at the 4 & 8 o'clock position.

9. Secure all distribution pipes with manufacturers supplied wire clamps, one per module.

10. (Pressure Distribution Systems) Insert a PVC Sch. 40 pressure pipe (size per design and code) into the standard perforated distribution pipe. The pressure pipe orifices are set at the 12 o'clock position as shown in Figure 11. Each pressure lateral will have a drain hole at the 6 o'clock position. Each pressure lateral shall include sweeping cleanouts at the terminal ends and be accessible from grade. The 4" distribution pipe is capped at both ends with a hole cut in the cap to allow the pressure pipe through.

11. ***Cover fabric substitution is not allowed.*** The installer should lay the Eljen provided geotextile cover fabric lengthwise down the row, with the fabric fitted to the perforated pipe on top of the GSF modules. Fabric should be neither too loose, nor too tight. The correct tension of the cover fabric is set by:
    a. Spreading the cover fabric over the top of the module and down both sides of the module with the cover fabric tented over the top of the perforated distribution pipe.
    b. Place shovelfuls of Specified Sand directly over the pipe area allowing the cover fabric to form a mostly vertical orientation along the sides of the pipe. Repeat this step moving down the pipe.

12. Ensure there is 6 inches of specified sand surrounding the GSF modules in the mound. Slope the sand away from the mound as described on the plan.

13. Complete backfill with a minimum of 12 inches of cover material measured from the top of the module. Use well graded native soil fill that is clean, porous and devoid of large rocks. Do not use wheeled equipment over the system. A light track machine may be used with caution, avoiding crushing or shifting of pipe assembly.

14. Divert surface runoff from the system. Finish grade to prevent surface ponding. Topsoil and seed system area to protect from erosion.

6.0 Dosing Distribution Guidance

6.1 DEMAND DOSED GUIDANCE: Specify a distribution box for pumped systems. Provide velocity reduction in the D-box with a tee or baffle if necessary. If the absorption area is installed deeper than 18 inches, the system must be vented.

6.2 DOSING DESIGN CRITERIA: Dosing volume must be set to deliver a maximum of **3 gallons per A42 Module or 4 gallons per B43** per dosing cycle. Head loss and drain back volume must be considered in choosing the pump size and force main diameter.

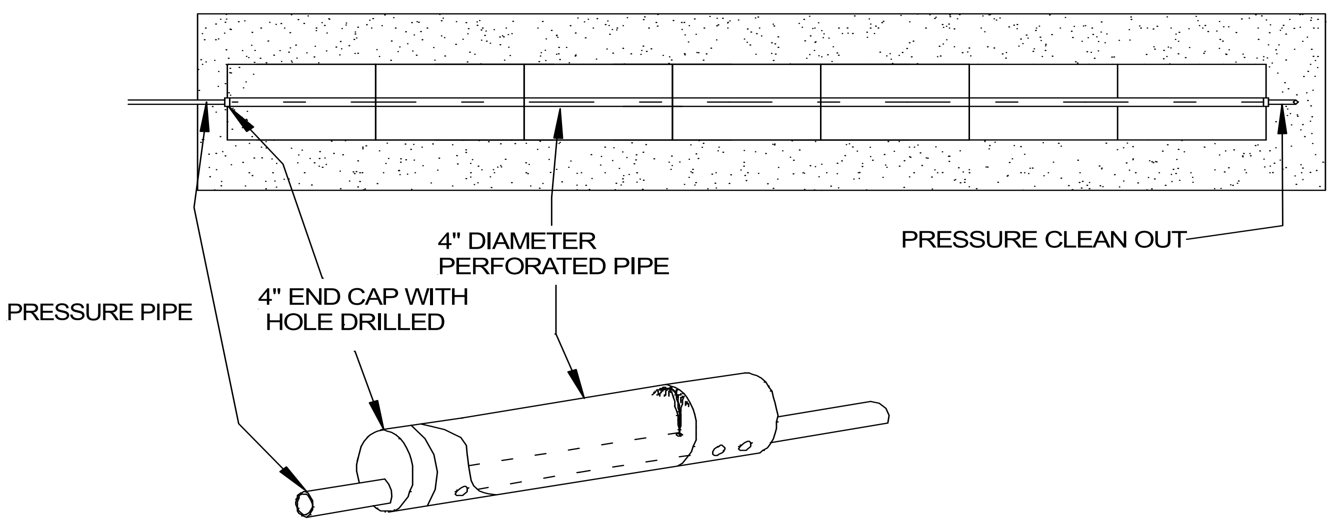
7.0 Pressure Distribution Guidance

PRESSURE DISTRIBUTION: Dosing with small diameter pressurized laterals is acceptable for GSF systems. The pipe networks must be engineered and follow principles established for pressure distribution. Flushing ports are required to maintain the free flow of effluent from orifices at the distal ends of each lateral. Contact Eljen's Technical Resource Department at 1-800-444-1359 for more information on pressure distribution systems.

Standard procedures for design of pressure distribution networks apply to the GSF system. Minimum orifice and lateral pipe size are based on design. A drain hole is required at the end of each row at the 6 o'clock position of each pressure lateral for drainage purposes. The lateral pipe network is placed within a standard 4-inch perforated pipe. The perforation in the 4-inch outer pipe are set at the 4 and 8 o'clock position, the drilled orifices on the pressure pipe are set to spray at the 12 o'clock position directly to the top of the 4-inch perforated pipe as shown below.

Orifice shields are an acceptable replacement for the 4" pipe.

FIGURE 11: PRESSURE PIPE PLACEMENT



PRESSURE PIPE CROSS SECTION FOR ALL APPLICATIONS

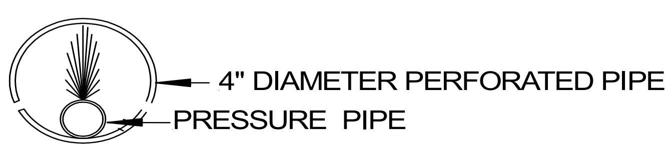


FIGURE 12: PRESSURE CLEAN OUT

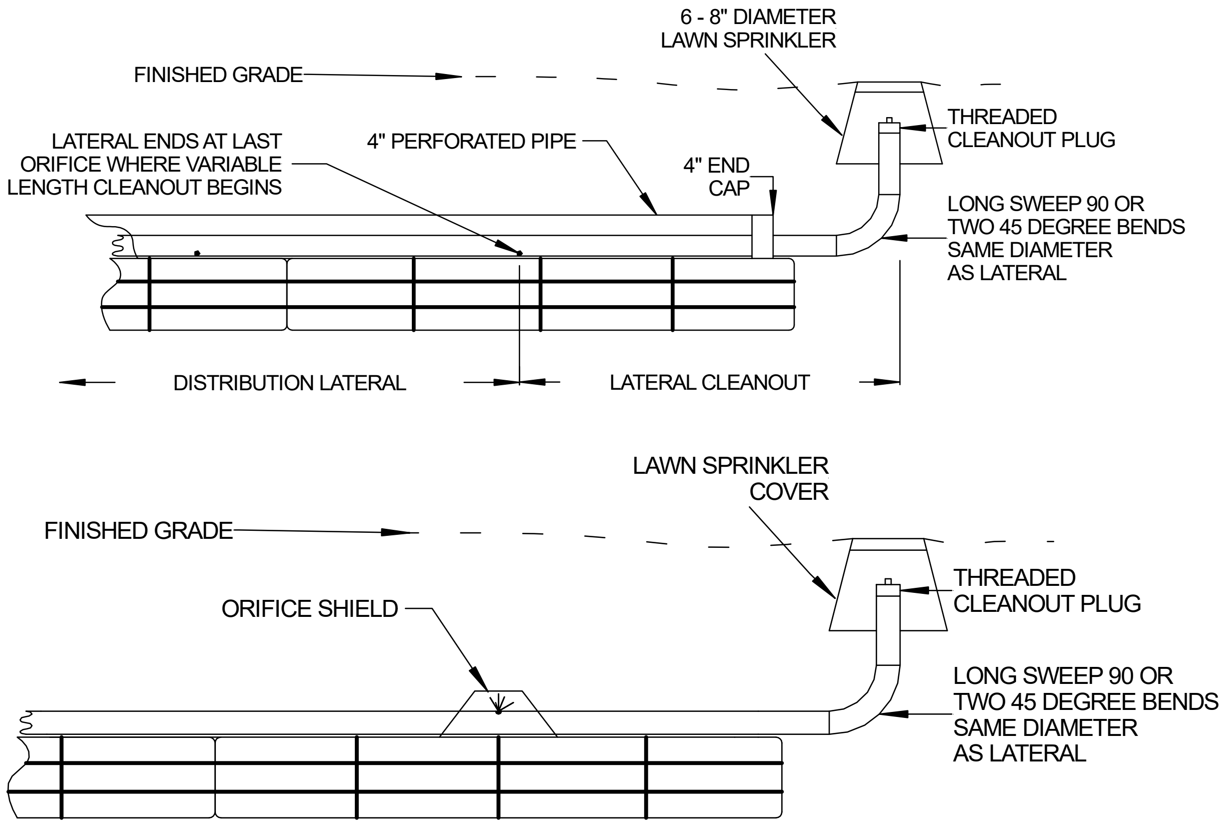
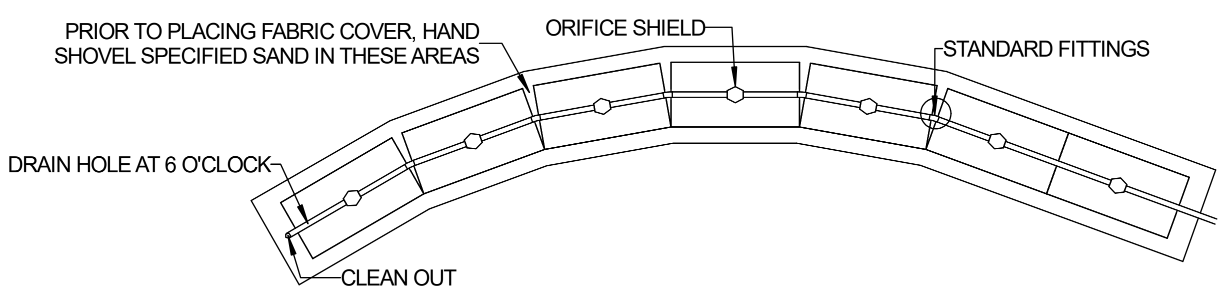


FIGURE 13: CONTOURED TRENCH PRESSURE DISTRIBUTION



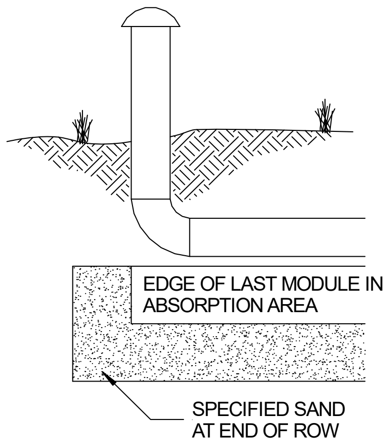
GSF Pressure Distribution trench placed on a contour or winding trenches to maintain horizontal separation distances may also be used in Dosed or Gravity system by removing the pressure pipe and using the 4-inch diameter perforated distribution pipe.

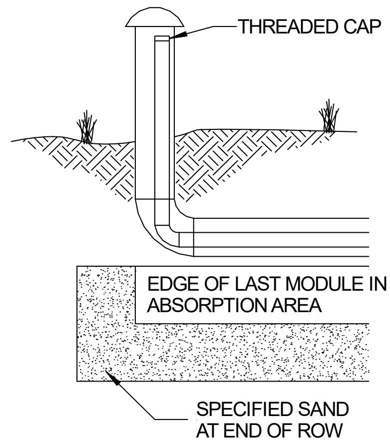
Note: The image above is depicted with orifice shields as an alternative.

8.1 SYSTEM VENTILATION: Air vents are required on all absorption systems located under impervious surfaces or systems **with *more than 18 inches 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.

8.2 VENT PIPE FOR GRAVITY AND LOW-PRESSURE SYSTEMS: Systems with over 18" of cover over the top of the modules require a vent. If the system is a low-pressure distribution system, the LPP clean outs may be located in the vent for easy access.

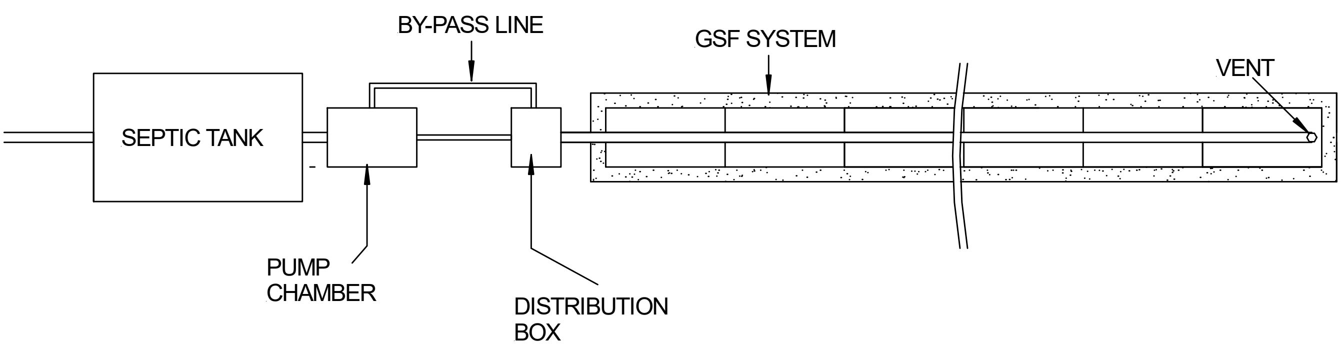
FIGURE 14: VENT LAYOUTS FOR GRAVITY AND LOW-PRESSURE SYSTEMS





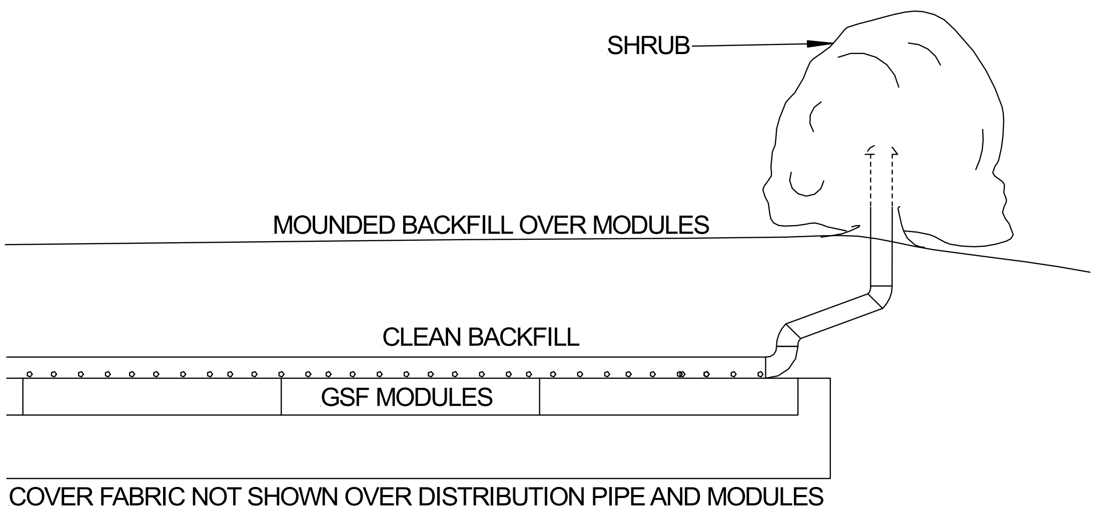
8.3 AIR BY-PASS LINE: Systems with over 18" of cover that are pumped or pressure dosed require an air by-pass line to continue flow from the low vent on the system to the high vent of the house. Simply plumb an airline from the distribution system back to the pump chamber or septic tank to provide unobstructed flow.

FIGURE 15: AIR BY-PASS LINE PLAN VIEW FOR VENTING OF PUMPED SYSTEMS



8.4 VENTILATION PLACEMENT: In a GSF system, the vent is usually a 4-inch diameter pipe extended to a convenient location behind shrubs, as shown in the figure below. Corrugated pipe may be used. If using corrugated pipe, ensure that the pipe does not have any bends that will allow condensation to pond in the pipe. This may close off the vent line. The pipe must have an invert higher than the system so that it does not drain effluent.

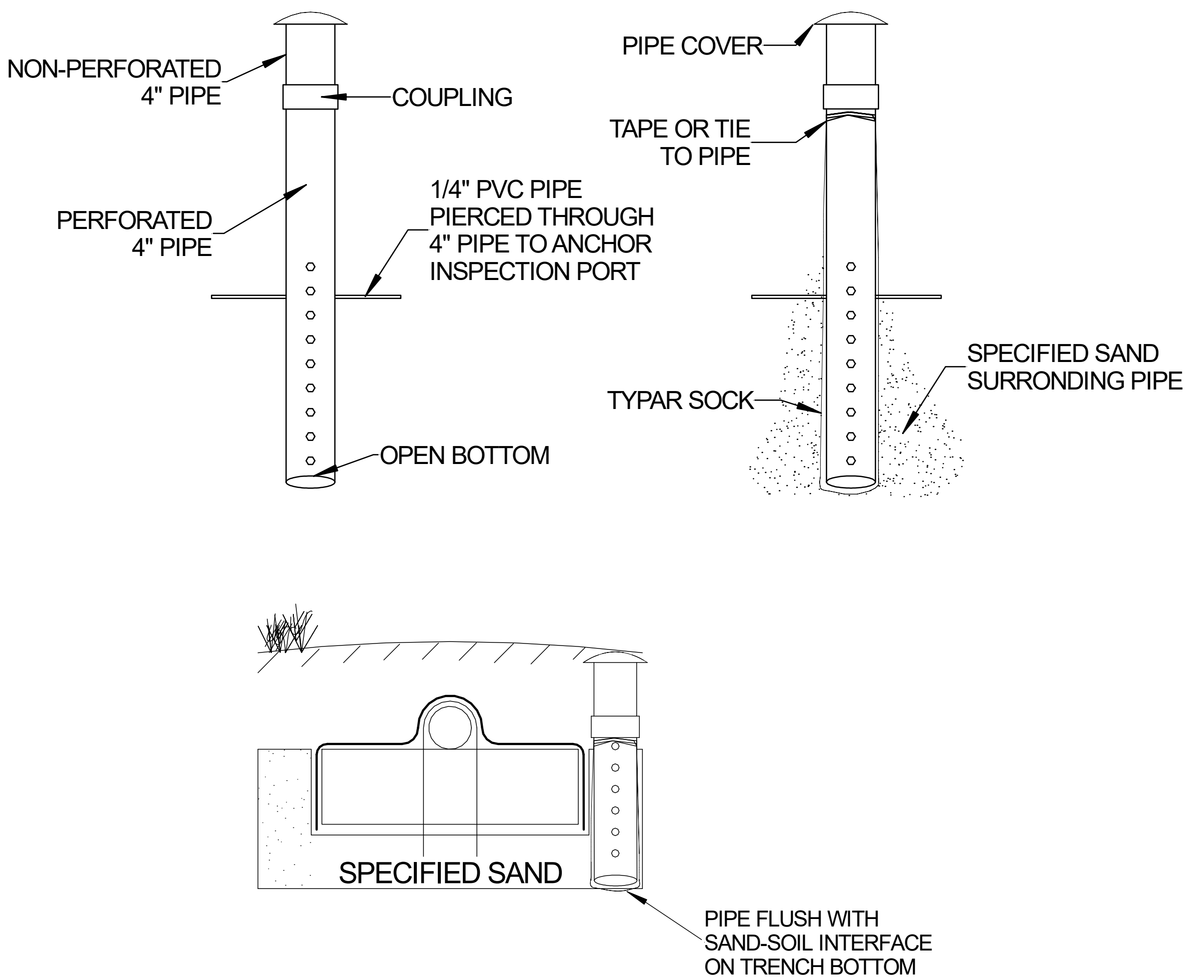
FIGURE 16: GSF WITH 4" VENT EXTENDED TO CONVENIENT LOCATION



9.0 Inspection/Monitoring Port

If the system includes an Inspection/Monitoring Port designed and installed with access from the ground surface. It shall be open and slotted at the bottom, and be void of sand or gravel to the infiltrative surface to allow visual monitoring of standing liquid in the absorption field. The figures below depict construction and placement of the Inspection/Monitoring Port.

FIGURE 17: INSPECTION PORT FOR SAND-SOIL INTERFACE



10.0 GSF Installation Check List

Prior to final backfill over the GSF modules, ensure that all of the installation check points listed below have been completed.

ALL SYSTEMS

1. ☐ Each line or row of the system is level.
2. ☐ Ensure that the painted white stripe is facing up on each module.
3. ☐ Verify there is a minimum of 6 inches of Specified Sand underneath each module in the system.
4. ☐ Based on the system design; verify the appropriate amount of Specified Sand is installed between module rows in bed systems, and along the 4-foot module length in trench systems.
5. ☐ Ensure there is a minimum of 6 inches of Specified Sand at the beginning and end of module rows in bed or trench systems.
6. ☐ The 4-inch perforated pipe on top of the module is SDR-35 or equivalent.
7. ☐ The perforated 4-inch pipe has orifices at 4 & 8 o'clock over the modules.
8. ☐ The wire clamps that fit over the 4-inch distribution pipe are installed, one per module.
9. ☐ The cover fabric is placed over the 4-inch perforated pipe, and draped over the sides of each module prior to Specified Sand placement around modules. The cover fabric shall *NOT* be pulled tightly over the 4-inch perforated pipe, which causes tenting.

PRESSURE DISTRIBUTION ONLY

1. ☐ In the LPP, there is at least one drain hole at the 6 o’clock position.
2. ☐ The LPP has its orifices at the 12 o'clock position.
3. ☐ The 4-inch perforated pipe has holes at 4 & 8 o'clock (if using).
4. ☐ Verify that there is a minimum of 2-5 feet of head depending on design at the terminal end of each lateral.
5. ☐ Verify the inclusion of lateral end cleanout.

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.

eljen CORPORATION

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TAB C: CERTIFICATION REQUIREMENTS

CERTIFICATION REQUIREMENTS

On page five of our manual, it states:

1.6 ELJEN INSTALLER CERTIFICATION: All installers are required to be trained and certified by an authorized Eljen representative. Contact your local distributor for training information.

Service providers should attend the same training as described above. Designers do not require certification from Eljen, however Eljen provides designer classes upon request.

Eljen provides product training year round, in classrooms, onsite on the job site or virtually. All you have to do is contact us at 800 – 444 – 1359 or on our website www.eljen.com/training-request.com. We are looking forward to helping you find solutions for tough sites!

TAB D: HOMEOWNER’S MANUAL

TAB E: FIELD INSPECTION AND MAINTENANCE FORM

FIELD INSPECTION AND MAINTENANCE FORM

Prior to final backfill over the GSF modules, ensure that all of the installation check points listed below have been completed.

ALL SYSTEMS

- ❑ Observation ports are installed at the sand/soil interface depth with typar sock cover the slots.
- ❑ ASTM-C33 sand placed in 6" lifts and stabilized.
- ❑ Each line or row of the system is level.
- ❑ Ensure that the painted white stripe is facing up on each module.
- ❑ Verify there is a minimum of 6 inches of specified sand underneath each module in the system.
- ❑ Based on the system design, verify the appropriate amount of Specified Sand is installed between module rows in bed, mound systems, and along the 4-foot module length in trench systems.
- ❑ Ensure there is a minimum of 6 inches of Specified Sand at the beginning and end of module rows in bed, mound or trench systems.
- ❑ The 4-inch perforated pipe on top of the module is SDR 35 or equivalent.
- ❑ The perforated 4-inch pipe has orifices at 4 & 8 o'clock over the modules.
- ❑ The wire clamps that fit over the 4-inch distribution pipe are installed, one per module.
- ❑ The cover fabric is placed over the 4-inch perforated pipe and draped over the sides of each module prior to Specified Sand placement around modules. The cover fabric shall NOT be pulled tightly over the 4-inch perforated pipe, which causes tenting.
- ❑ Vent pipes are installed if the cover is $\geq$ 18" or limits oxygen transfer.

FOR PRESSURE DISTRIBUTION SYSTEMS ONLY

- ❑ The In the LPP, there is at least one drain hole at the 6 o'clock position.
- ❑ The LPP has its orifices at the 12 o'clock position.
- ❑ The 4-inch perforated pipe has holes at 4 & 8 o'clock.
- ❑ Verify that end caps are in place around the LPP.
- ❑ Verify the inclusion of lateral end cleanout.

TAB F: TECHNICAL CONTACT INFORMATION

Technical Support Rep

- **Name:** Drew Nickoli
- **Technical Specialist**
- **Phone:** 419-706-7419
- **Email:** dnickoli@eljen.com

Mr. Nickoli served in the U.S. Army as a Combat Engineer from 2008 – 2016. Mr. Nickoli served in Operation Enduring Freedom in Afghanistan in 2013, performing counter IED and route clearance operations. He also served on the Ohio National Guard's search and extraction team after returning home from Afghanistan before retiring from the Army in 2016.

He has been in the onsite industry since 2014, and started off working at a test site servicing, installing and sampling wastewater treatment systems. Drew began his career with Eljen in April 2022.

Drew is married and a father of four. His hobbies are going out to the shooting range, golfing, playing basketball, and attending Cleveland and Ohio State sporting events. He is an active member in the "Save A Warrior" community that helps veterans and first responders to overcome the symptoms and addictions associated with Complex Post-Traumatic Stress.

Eljen Corporation Technical Support Line: 800-444-1359

TAB G: STATEMENT REGARDING MANUAL CHANGES

Any changes to the manual found in Tab B will be submitted to EGLE for review and approval prior to publishing.