WASTEWATER TECHNOLOGY

NSF/ANSI Standard 245 - *Wastewater Treatment Systems – Nitrogen Reduction*

Final Report:

SOSystems, Inc.
LooLoop SYS 201
(Previously Named RecoSept SYS 201)
15/12/055/0030

NSF International
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Evaluation Report:
LooLoop SYS 201
(Previously Named RecoSept SYS 201)- Wastewater Treatment System

Under the provisions of NSF/ANSI Standard 245
Wastewater Treatment Systems – Nitrogen Reduction

January 2020

EXECUTIVE SUMMARY

Testing of the SOSystems, Inc. LooLoop SYS 201 was conducted under the provisions of NSF/ANSI Standard 245 for Residential Wastewater Treatment Systems (April 2013 revision). NSF/ANSI Standard 245 was developed by the NSF Joint Committee on Wastewater Technology.

The performance evaluation was conducted at the NSF Wastewater Technology Testing Facility located in Waco, Texas, using wastewater diverted from the Waco municipal wastewater collection system, which serves predominantly residential development. 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. Sampling started in the winter and continued through summer, covering a range of operating temperatures.

Over the course of the evaluation, the average influent Total Nitrogen was 44.1 mg/L, ranging between 27.6 and 61.8 mg/L. The LooLoop SYS 201 produced an average effluent Total Nitrogen of 18.7 mg/L, which resulted in a 58% reduction in the influent Total Nitrogen. The LooLoop SYS 201 produced an effluent that successfully met the performance requirements established by NSF/ANSI Standard 245.

The LooLoop SYS 201 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 16 mg/L for $CBOD_5$ and 12 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 13 mg/L for $CBOD_5$ and 9 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 entire evaluation ranged between 7.2 and 7.8, within the required range of 6.0 to 9.0. The LooLoop SYS 201 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 nitrogen reduction for residential wastewater treatment systems is achieved within the provisions of NSF/ANSI Standard 245: Wastewater Treatment Systems – Nitrogen Reduction (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.

Systems conforming to Standard 245 are classified as having met the requirements of the Standard. 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 245 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 245 (revised April 2013) that the LooLoop SYS 201 manufactured by SOSystems, Inc. has fulfilled the requirements of NSF/ANSI Standard 245. The LooLoop SYS 201 has therefore been authorized to bear the NSF Mark so long as SOSystems, Inc. continues to meet the requirements of Standard 245 and NSF General and Program Specific Policies.

General performance evaluation and stress tests were performed at the Wastewater Technology Site located at the NSF Wastewater Technology Testing Facility located in Waco, Texas. 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.

Theresa Bellish
General Manager
NSF Water Systems

Sharon Steiner
Business Unit Manager
Wastewater Treatment Unit Program

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1.0 PROCESS DESCRIPTION

The SOSystems, Inc. LooLoop SYS 201 is essentially a loop in the normal flow path of a conventional septic system. The loop has a highly aerated segment and a segment that has very little oxygen. The oxygenated portion of the loop is the section containing the BioFilter Cabinet. The BioFilter Cabinet is an ultrahigh rate recirculating trickling filter containing highly porous plastic filter media. Vents at the top and bottom of the BioFilter Cabinet ensure that an oxygen rich environment is maintained.

The low oxygen (anoxic) segment is the section containing the LooLoop tank. In the aerated portion of the loop, effluent is sprayed onto the high porosity plastic filter media. Bacteria attach themselves to the media and use the trickling wastewater for food. The bacteria also convert almost all nitrogen compounds into the nitrate (NO_3) form. Some bacteria are constantly being sloughed off the media. The dislodged bacteria get carried by the trickling liquid, along with the dissolved nitrate, out the bottom of the BioFilter Cabinet back to septic Tank 1, then flow into the LooLoop tank (Tank 2). The dislodged bacteria sink or float in the tanks. The mass of floating or settled bacteria becomes what is called sludge. The number of oxygen breathing bacteria accumulated in the LooLoop tank is large. The oxygen needs of the bacteria deplete the oxygen dissolved in the water during its pass through the BioFilter Cabinet. The bacteria then turn to nitrate for their oxygen thereby releasing nitrogen gas to the atmosphere. The anoxic LooLoop tank serves as the receptacle for wastewater sludge and the reaction tank for the removal of nitrogen.

After the wastewater trickles through the BioFilter Cabinet, the wastewater flows by gravity back to the second compartment of the first septic tank (Tank 1). Note: if the existing septic tank (Tank 1) has only one chamber, the wastewater return line from the BioFilter Cabinet connects to the inlet tee of the LooLoop tank. The operation of the recirculating pump is controlled by a repeat cycle timer in the control panel. The wastewater continues to recirculate to the BioFilter Cabinet and back to the septic tanks at the rate of about 8 gallons per minute. The LooLoop tank pump chamber is equipped with an overflow pipe that allows the clean recirculating effluent water to flow to the drain field.

2.0 PERFORMANCE EVALUATION

2.1 Description of Plant Evaluated

The SOSystems, Inc. LooLoop SYS 201 includes the BioFilter Cabinet is the key component of the LooLoop system and has no moving or mechanical components other than three valves and operable vents at the top and bottom of the cabinet. Thus the BioFilter Cabinet is designed for long term performance and minimal maintenance. The BioFilter Cabinet is designed to resemble a small garden or pool equipment shed. The cabinet can be located adjacent to the house, similar to other mechanical systems, or at any other location on the property that permits gravity drainage from the cabinet back to the septic tanks. The BioFilter Cabinet is constructed with water- resistant PVC board, polystyrene foam insulation, and stainless steel vent louvers.

The BioFilter Cabinet has no actively moving parts. The process is passive and uses 27 cubic feet of crossflow plastic media. The media is stacked in three layers supported off the floor of the cabinet. The individual media bales are 12x12x36 inches laid with the bottom and top layers laid parallel with the middle layer at 90 degrees to the top and bottom.

All components of the system that contact wastewater are of stainless steel, PVC, or rubber construction for durability. The recirculating trickling filter media is a self-supporting PVC sheet media discussed above. A locally acquired 1,500-gallon, two compartment concrete was used to test the LooLoop system. The LooLoop tank submersible pump is 115V, 60 hertz, single phase, fractional horsepower motor of stainless steel and composite resin materials used in all wetted parts. The pump is the only electrically powered moving component of the LooLoop system.

The LooLoop system is supplied with a prewired repeat cycle flow controller contained in a NEMA rated enclosure and is accessible through the door on the cabinet. The controller controls the recirculating pump cycle time and is manufactured, to be programmed to produce a 20 minute on 10 minute off cycle. The weatherproof controller is equipped with a fail to start detector, a visible alarm, an audible alarm and silencer switch. The controller contains a power switch and time clock that control the recirculating pump operation. The local dealers name, address, and telephone number are displayed on the controller cover. A high level switch connected to the alarm circuit is provided to alert the user of blockages in the disposal system piping between the LooLoop and the leaching system components. The LooLoop SYS201 treatment system is capable of treating 500 gallons per day of domestic wastewater from a single-family residence.

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. Ten 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 three times per week. The influent samples are analyzed for five-day biochemical oxygen demand (BOD_5), total suspended solids (TSS), alkalinity, total Kjeldahl nitrogen (TKN), and ammonia-N. The effluent samples are analyzed for carbonaceous five-day biochemical oxygen demand ($CBOD_5$), TSS, alkalinity, TKN, ammonia-N and nitrite/nitrate-N concentrations. Onsite determinations of the influent and effluent pH, temperature and dissolved oxygen are made five days per week on grab samples.

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 system to successfully pass the Standard 245 evaluation:

(1) $CBOD_5$: The average of all effluent samples shall not exceed 25 mg/L.

(2) TSS: The average of all effluent samples shall not exceed 30 mg/L.

(3) Total Nitrogen: The average total nitrogen concentration of all effluent samples shall be less than 50% of the average total nitrogen concentration of all influent samples.

(4) pH: Individual effluent values shall remain between 6.0 and 9.0 SU.

2.3 Test Chronology

The system was installed under the direction of the manufacturer on January 8, 2016 through January 5, 2016. The infiltration/exfiltration test, during which the entire system was tested for leaks, was completed on January 5, 2016. The unit was completely pumped out then filled with fresh water to allow set up and adjustment prior to the start of dosing. The fresh water was then pumped down by approximately one-third volume in the treatment unit. Dosing was initiated at the rate of 600 gallons per day beginning January 10, 2016. After a three-week start up period, the test was officially started on January 31, 2016. The stress test sequence was started on May 23, 2016 and ended on July 13, 2016. Testing was completed on July 29, 2016.

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)	245	70	66	430	240	200- 290
Effluent ($CBOD_5$)	7	4	1	26	5	4-9
Total Suspended Solids (mg/L)						
Influent	173	49	83	350	165	140 - 190
Effluent	6	3	2	16	6	4 - 8
pH						
Influent	-	-	6.4	7.7	7.0	6.8 – 7.2
Effluent	-	-	7.2	7.8	7.5	7.4 – 7.6
Temperature (°C)						
Influent	25	3	20	31	24	22 – 27
Effluent	24	5	15	33	24	20 - 29
Dissolved Oxygen (mg/L)						
Aeration Chamber	2.8	2.0	0.3	7.7	2.3	0.8 – 4.0
Effluent	2.1	1.5	0.3	6.5	1.5	0.9 – 3.3
Alkalinity (mg/L)						
Influent	350	36	280	450	360	330-370
Effluent	240	24	200	300	230	220-250
Total Kjeldahl Nitrogen						
Influent	43.4	9	27	61.7	43.7	37-51
Effluent	5.5	4	0.83	24.7	4.2	3-7
Ammonia-N						
Influent	28.3	9	15.3	53.5	26.2	22-33
Effluent	3.1	2	0.73	12.5	2.0	2-4
Nitrite/nitrate-N (mg/L)						
Influent	0.6	1	0.05	3.9	0.1	0.1 - 1
Effluent	13.2	5	1.8	24	13.8	10-17
Total Nitrogen						
Influent	44.1	9	27.6	61.8	44.5	37-51
Effluent	18.7	5	10.5	36.8	18.2	16-21

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 LooLoop SYS 201 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. There were no such conditions during this test.

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 66 to 430 mg/L mg/L during the evaluation, with an average of 240 mg/L and median concentrations of 240 mg/L. Thirty-day average concentrations ranged from 170 to 290 mg/L. The average influent BOD_5 delivered to the treatment unit was within the influent characteristics defined under Section 8.2.1 of NSF/ANSI Standard 245.

Effluent $CBOD_5$:

Effluent $CBOD_5$ concentrations ranged from 1 to 26 mg/L over the course of the evaluation, with an average concentration of 7 mg/L. The median effluent $CBOD_5$ concentration was 5 mg/L.

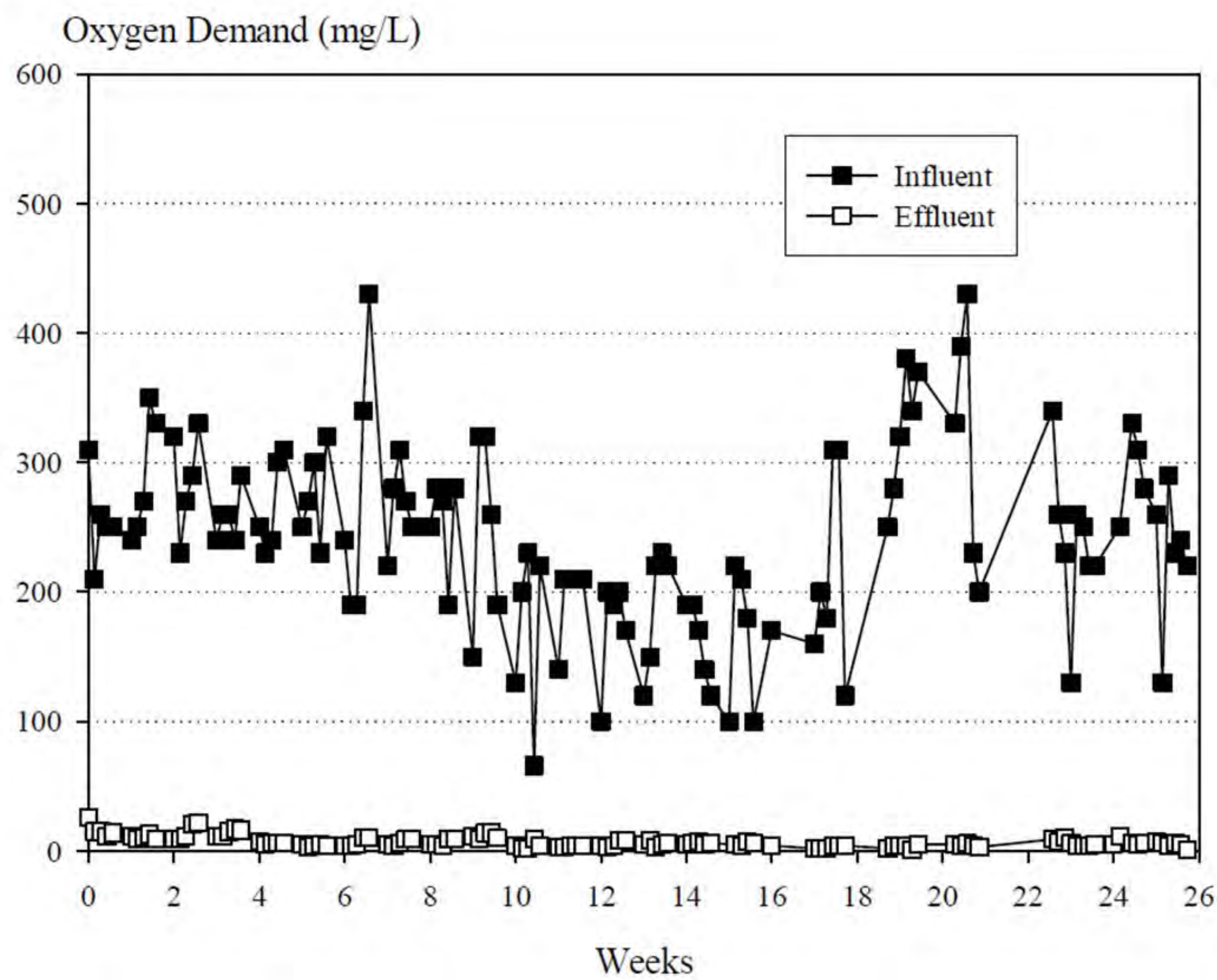

Figure 1. Biochemical Oxygen Demand

3.3 Total Suspended Solids

TSS analyses were completed using *Standard Methods for the Examination of Water and Wastewater 21*st 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 83 to 350 mg/L during the evaluation, with an average concentration of 170 mg/L and a median concentration of 165 mg/L. The 30-day average concentrations during the test ranged from 140 to 220 mg/L. The average influent TSS delivered to the treatment unit was within the influent characteristics defined under Section 8.2.1 of NSF/ANSI Standard 245.

Effluent TSS:

The effluent TSS concentration ranged from 2 to 16 mg/L during the evaluation, with an average concentration of 6 mg/L and a median concentration of 6 mg/L.

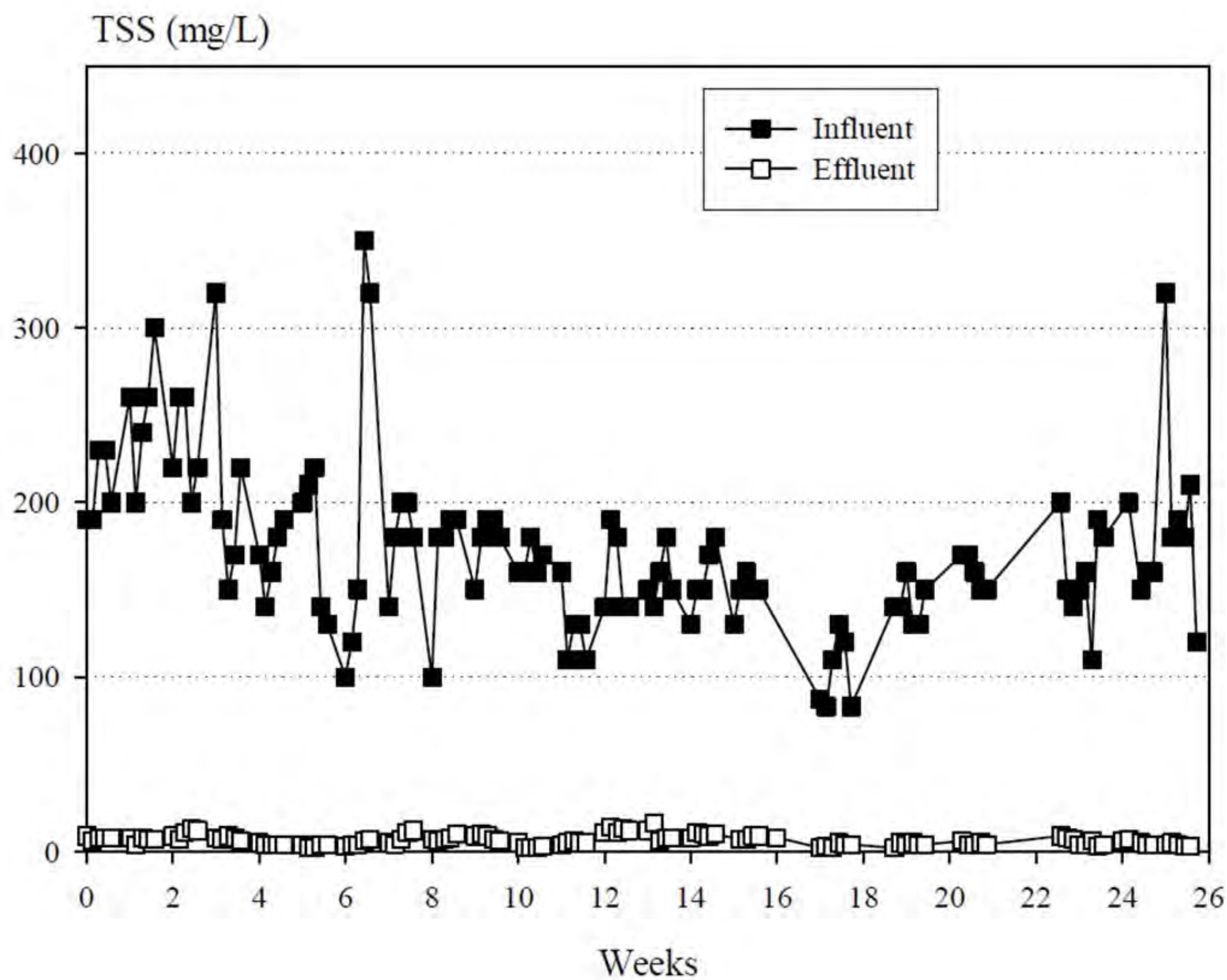

Figure 2. Total Suspended Solids

3.4 pH

Over the entire evaluation period, the influent pH ranged from 6.4 to 7.7 (median of 7.0). The effluent pH ranged from 7.2 to 7.8 during the evaluation (median of 7.5) within the 6 to 9 range required by NSF/ANSI Standard 245. The pH data for the evaluation are shown in Appendix C.

3.5 Temperature

Influent temperatures over the evaluation period ranged from 20 to 31°C (median of 24°C). The temperature data are shown in Appendix C. The Standard requires that the average influent temperature fall within 10 to 30°C. The average influent temperature was within the characteristics defined under Section 8.2.1 of NSF/ANSI Standard 245.

3.6 Dissolved Oxygen

Dissolved Oxygen (DO) was measured in the aeration chamber and effluent during the evaluation. The aeration chamber DO ranged between 0.3 and 7.7 mg/L (median of 2.3 mg/L), while the effluent DO ranged between 0.3 and 6.5 mg/L (median of 1.5 mg/L). All dissolved oxygen data are shown in Appendix C.

3.7 Alkalinity

Alkalinity analyses were completed using *Standard Methods for the Examination of Water and Wastewater* 21st edition. The alkalinity results over the entire evaluation are shown in Figure 3. The influent and effluent alkalinities were all well within the range required by the Standard, and review of the nitrogen data indicates that alkalinity was not a limiting factor for nitrification in the system.

Influent Alkalinity

The influent alkalinity averaged 350 mg/L, ranging from 280 to 450 mg/L, with a median concentration of 360 mg/L. The influent alkalinity delivered to the treatment unit was within the influent characteristics defined under Section 8.2.1 of NSF/ANSI Standard 245.

Effluent Alkalinity

The effluent Alkalinity concentration ranged from 200 to 300 mg/L during the period when alkalinity samples were collected, with an average concentration of 240 mg/L and a median concentration of 230 mg/L.

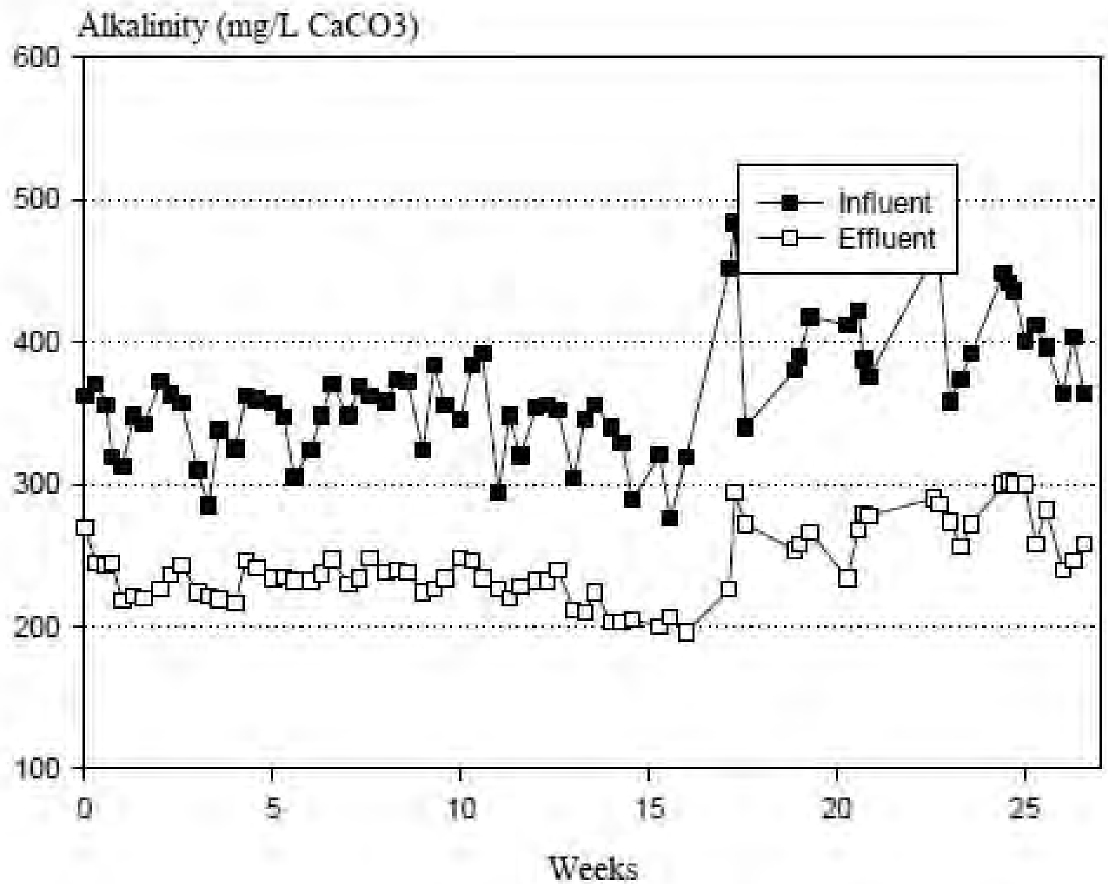

Figure 3: Alkalinity

3.8 Total Kjeldahl Nitrogen (TKN)

TKN analyses were completed using *Standard Methods for the Examination of Water and Wastewater 21st* edition. The TKN results over the entire evaluation are shown in Figure 4.

Influent TKN:

The influent TKN ranged from 27 to 61.7 mg/L during the evaluation, with an average of 43.4 mg/L and a median concentration of 43.7 mg/L. The influent TKN delivered to the treatment unit was within the influent characteristics defined under Section 8.2.1 of NSF/ANSI Standard 245.

Effluent TKN:

The effluent TKN concentration ranged from 0.83 to 24.7 mg/L during the evaluation, with an average concentration of 5.5 mg/L and a median concentration of 4.2 mg/L.

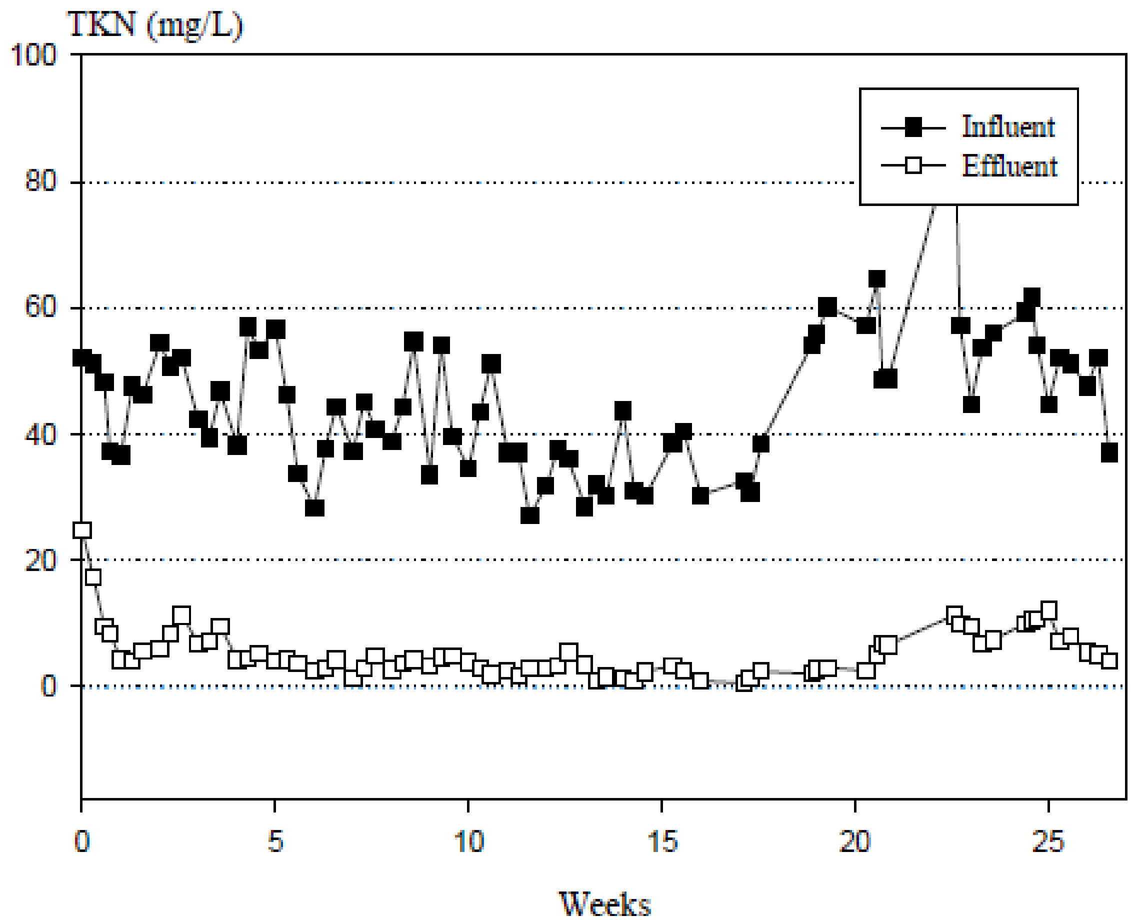

Figure 4: Total Kjeldahl Nitrogen

3.9 Ammonia-N

Ammonia-N analyses were completed using *Standard Methods for the Examination of Water and Wastewater* 21st edition. The Ammonia-N results over the entire evaluation are shown in Figure 5.

Influent Ammonia-N:

The influent Ammonia-N ranged from 15.3 to 53.5 mg/L during the evaluation, with an average of 28.3 mg/L and a median concentration of 26.2 mg/L.

Effluent Ammonia-N:

The effluent Ammonia-N concentration ranged from 0.73 to 12.5 mg/L during the evaluation, with an average of 3.1 mg/L and a median concentration of 2.0 mg/L.

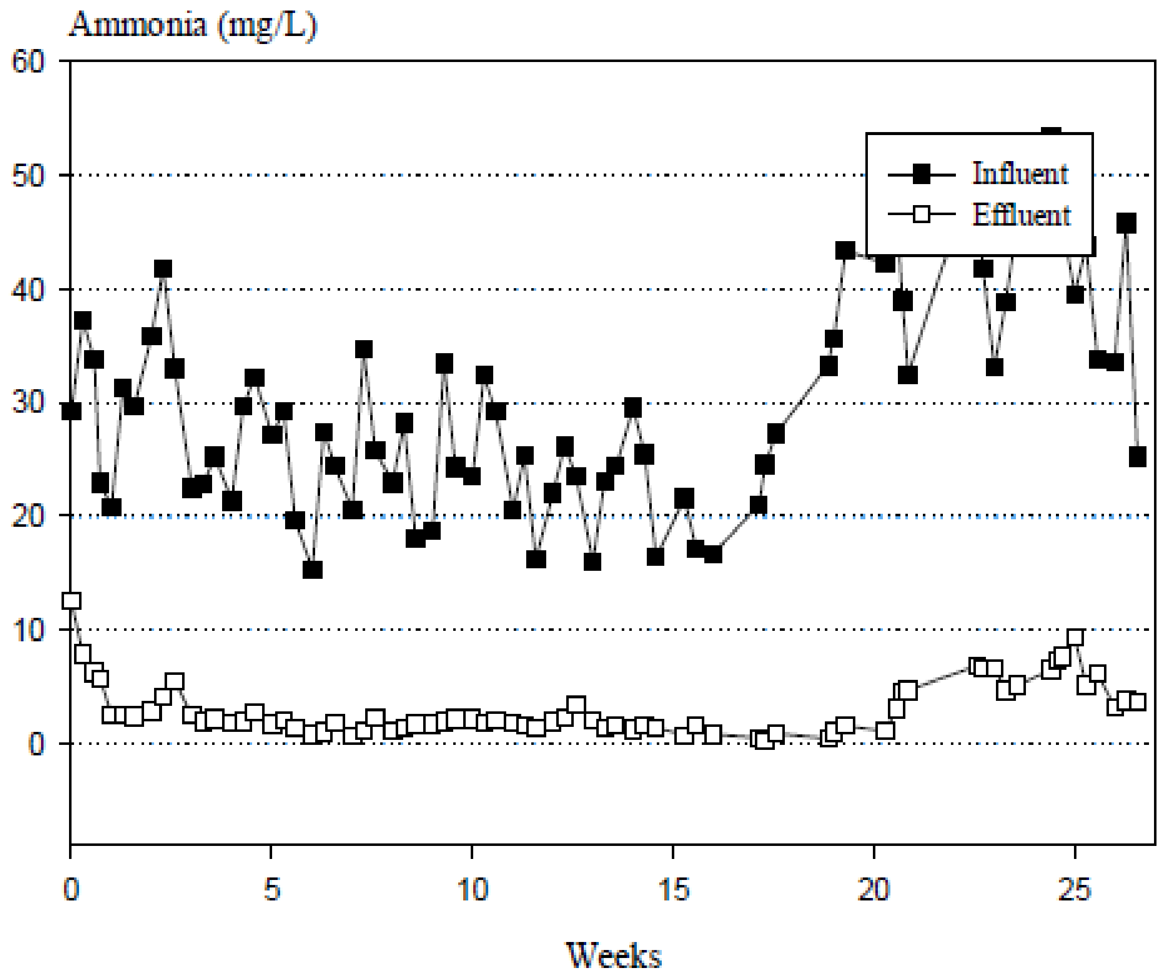

Figure 5: Ammonia

3.10 Nitrite/nitrate-N

Nitrite/nitrate-N analyses were completed using *Standard Methods for the Examination of Water and Wastewater* 21st edition. The Nitrite/nitrate-N results over the entire evaluation are shown in Figure 6.

Influent Nitrite/nitrate-N:

The influent Nitrite/nitrate-N ranged from 0.05 to 3.9 mg/L during the evaluation, with an average of 0.6 mg/L and a median concentration of 0.1 mg/L.

Effluent Nitrite/nitrate-N:

The effluent Nitrite/nitrate-N concentration ranged from 1.8 to 24 mg/L during the evaluation, with an average of 13.2 mg/L and a median concentration of 13.8 mg/L.

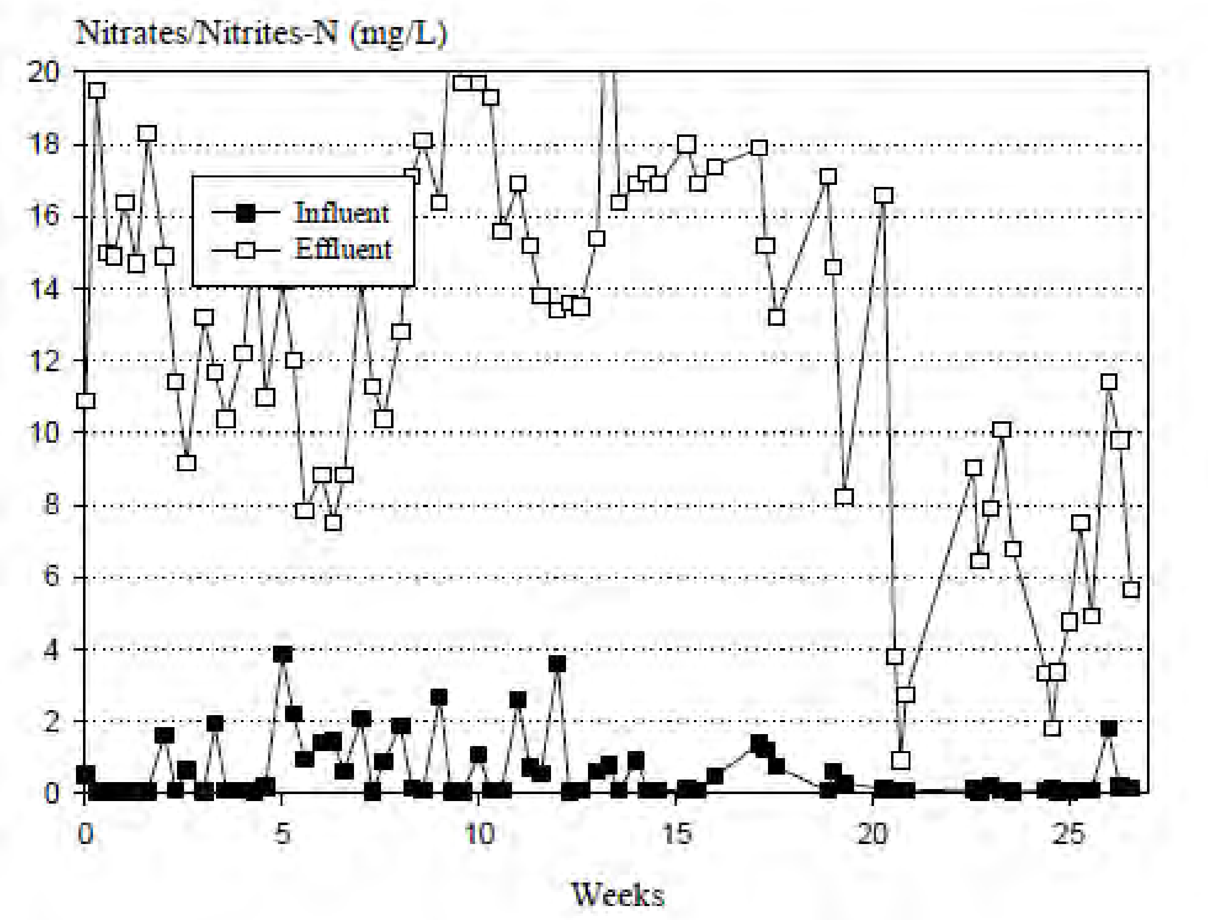

Figure 6: Effluent Nitrate/Nitrite

3.11 Total Nitrogen

Total Nitrogen (TN) is the sum of the total Kjeldahl nitrogen (TKN), nitrite (NO_2) and nitrate (NO_3) in a sample, and is expressed as mg/L as N. The TN results over the entire evaluation are shown in Figure 7.

Influent Total Nitrogen

The influent TN ranged from 27.6 to 61.8 mg/L during the evaluation, with an average of 44.1 mg/L and a median concentration of 44.5 mg/L.

Effluent Total Nitrogen:

The effluent TN concentration ranged from 10.5 to 36.8 mg/L during the evaluation, with an average concentration of 18.7 mg/L and a median concentration of 18.2 mg/L. The LooLoop SYS 201 successfully met the requirements of Standard 245 by reducing the influent TN by 58%, which exceeds the pass/fail criteria of 50%.

Nitrogen Loading:

Over the course of the evaluation the influent Total Nitrogen loading averaged 0.18 lb/day. The LooLoop SYS 201 achieved an average reduction of 0.11 lbs/day.

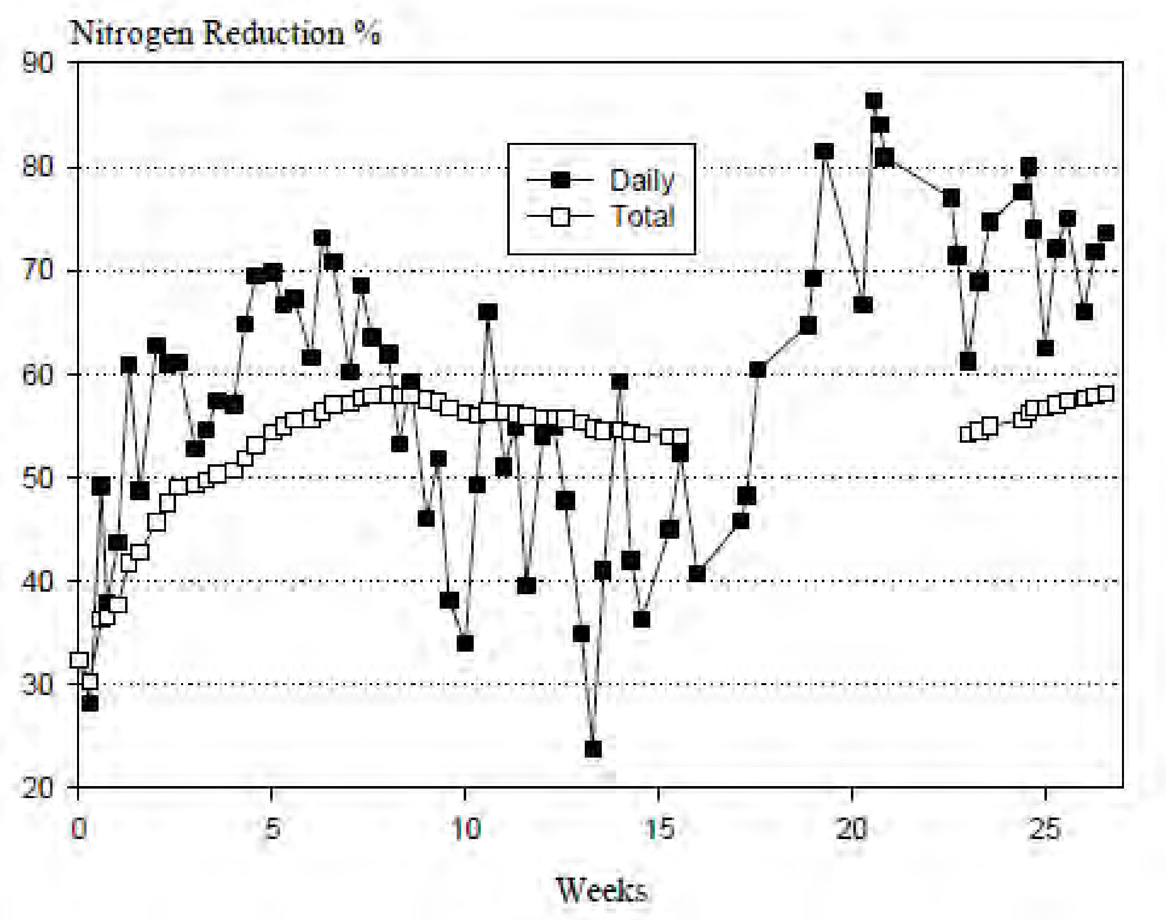

Figure 7: Total Nitrogen

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

4. NSF/ANSI 40, *Residential Wastewater Treatment Systems*

5. 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

SOSystems, Inc. - LooLoop SYS 201
500 GPD

Plant Capacity

Design Flow	500 gpd

System Hydraulic Capacity

Pretreatment Chamber	1000 gallons
Anoxic Chamber	2000 gallons
Clarifier Chamber	1500 gallons
Total Hydraulic Capacity	3000 gallons

Hydraulic Retention Time (at Design Flow)

Pretreatment Chamber	48 hours
Anoxic Chamber	96 hours
Clarifier Chamber	72 hours
Total Hydraulic Retention	96 hours

Filter Media

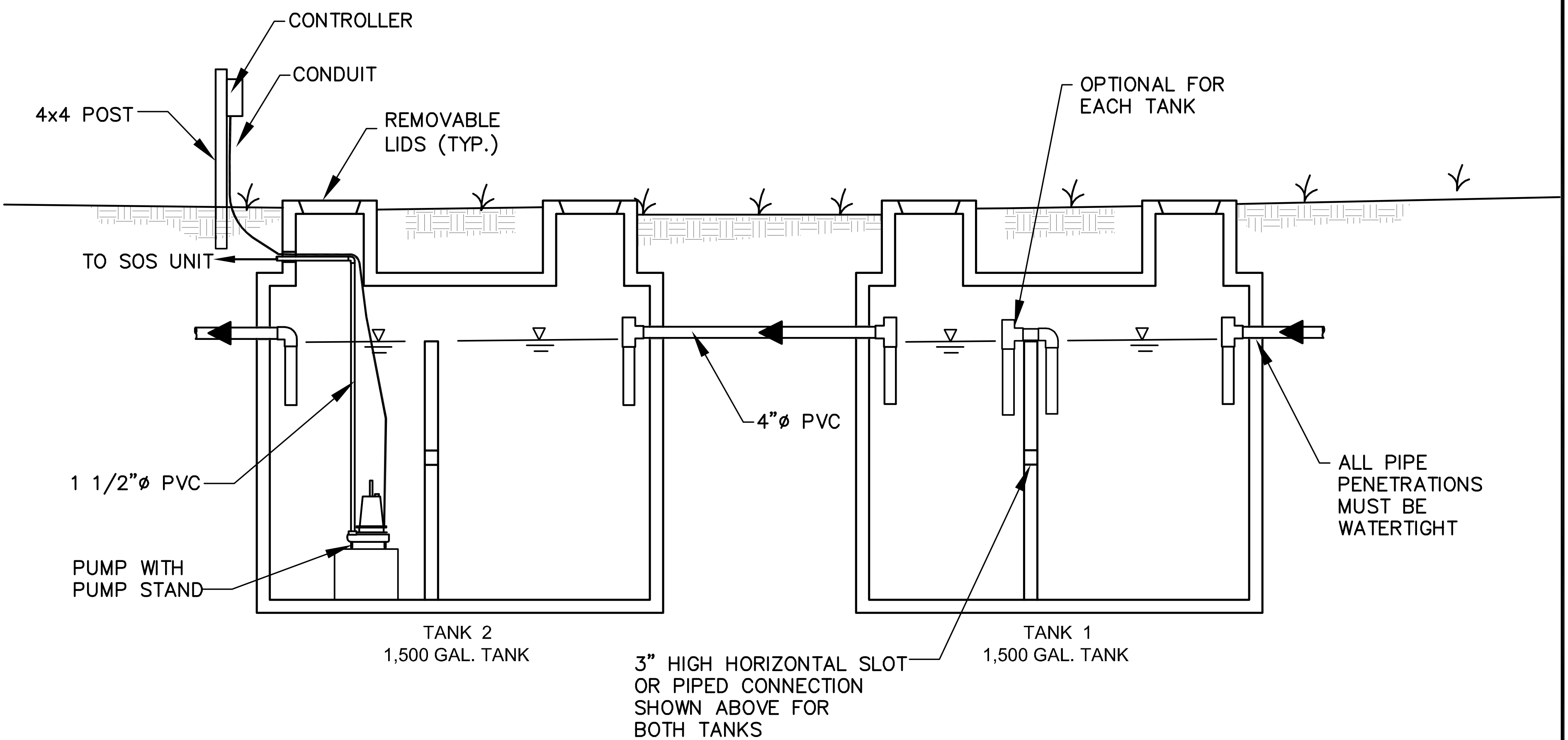
Manufacture	Raschig
Model #	DURA-PAC XF68
Shape	Modular blocks
Size	1' x 1' x 3'
Material	Thermoformed corrugated PVC sheet media

Pump

Tsurumi 50PSF2.4S	115V 60Hz 1/2 HP 10 gpm @ 50 ft. TDH

Alarm Panel

Manfufacture PDIR Instruments, Inc. (Modified Walchem WPHPW100PNN)	Model W-PHE-1-SOS062116 (Custom)!



SOS SEPTIC TANK INSTALLATION

FOR NSF INSTALLATION

NOT TO SCALE

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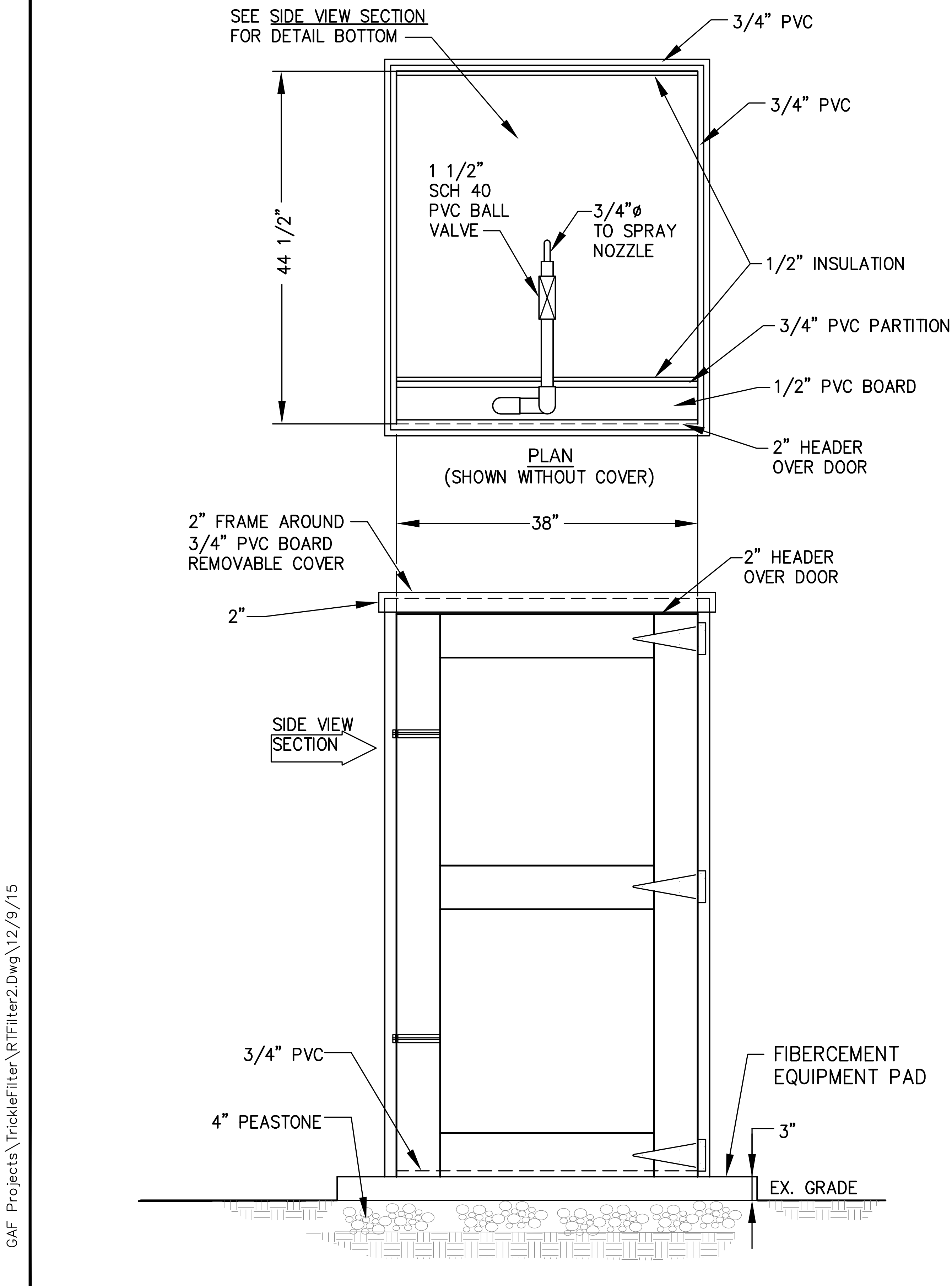
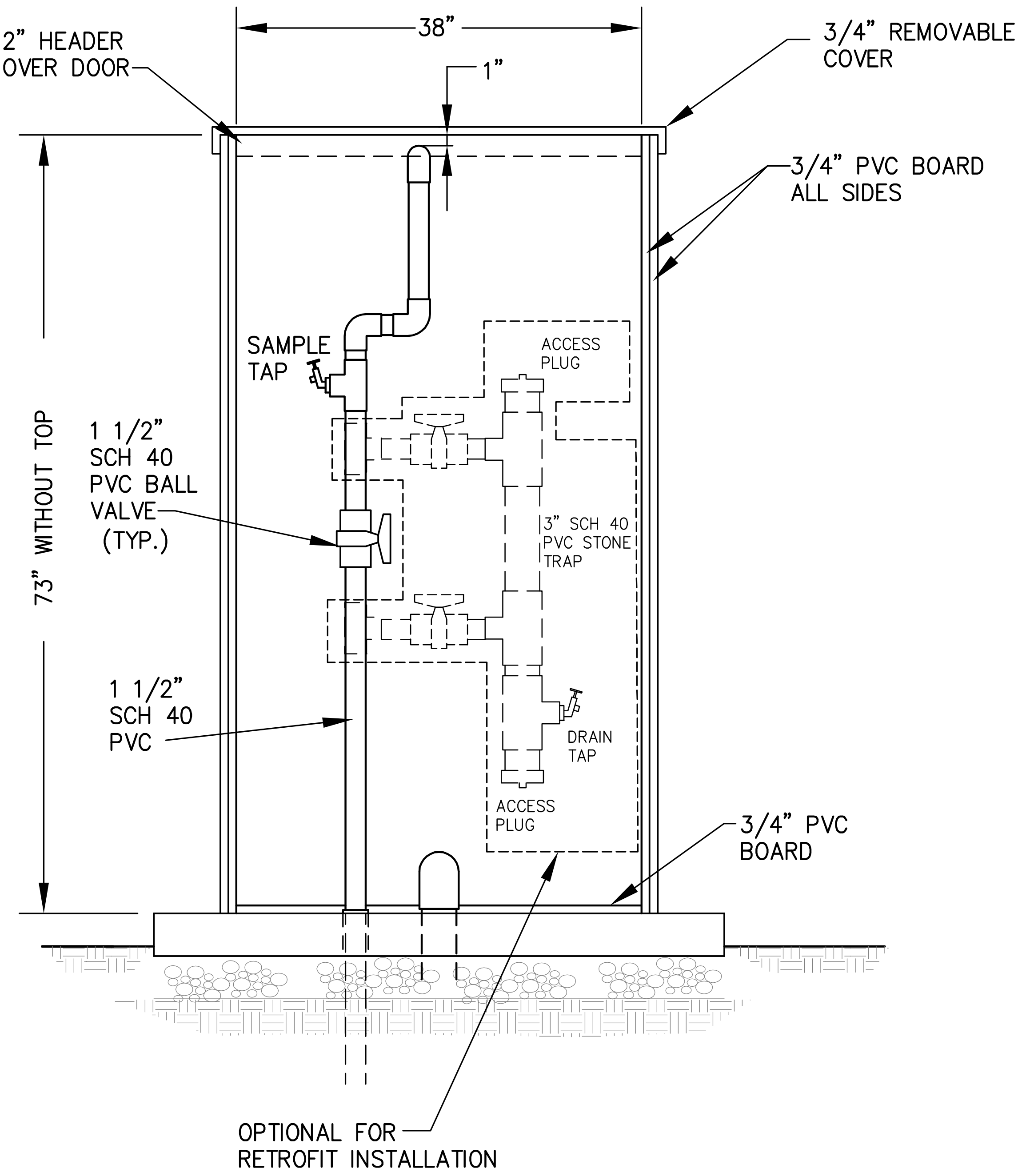


ELEVATION - FRONT VIEW CLOSED

RESIDENTIAL RECIRCULATING TRICKLING FILTER

NOT TO SCALE



ELEVATION - FRONT VIEW OPENED
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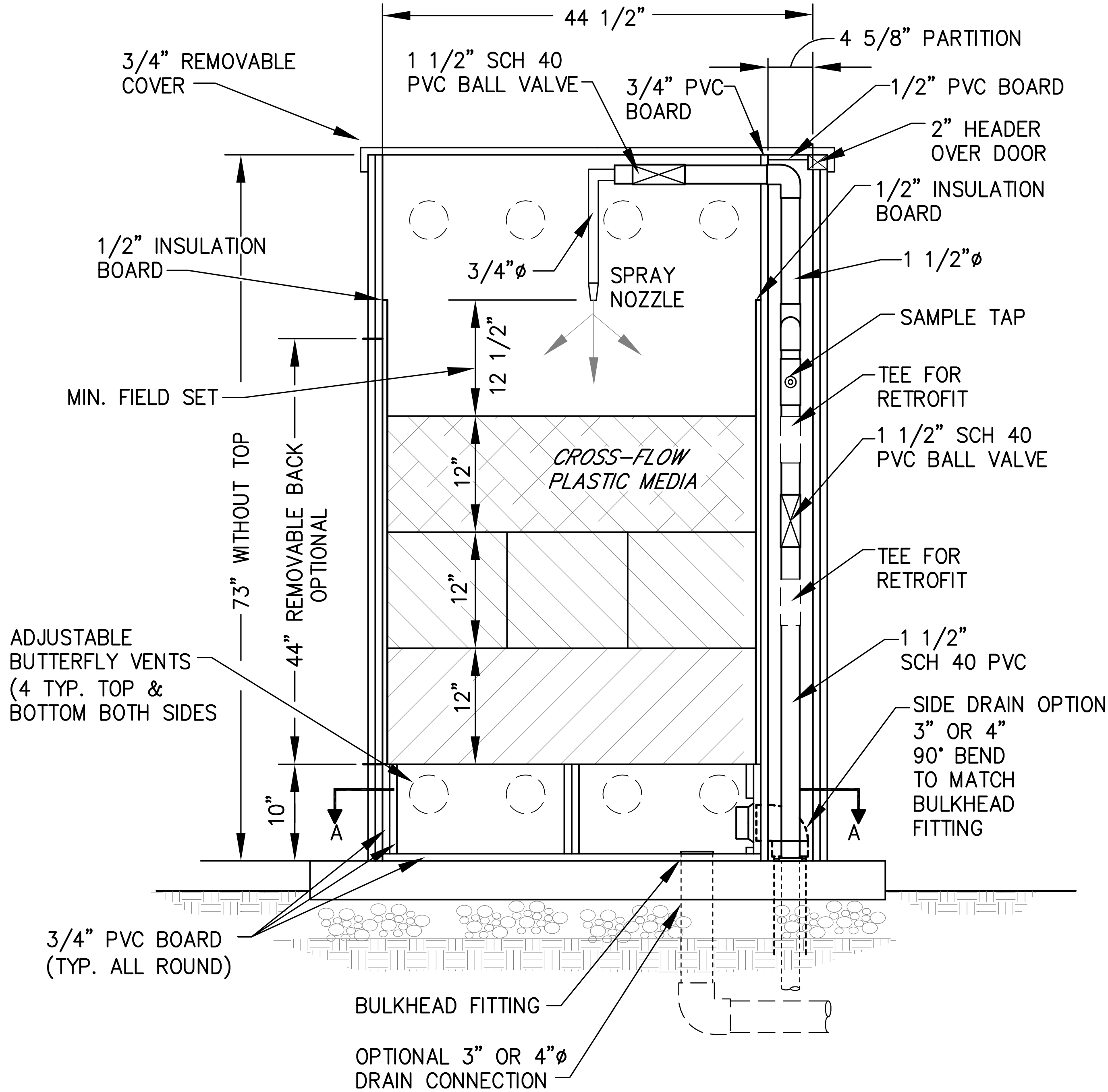

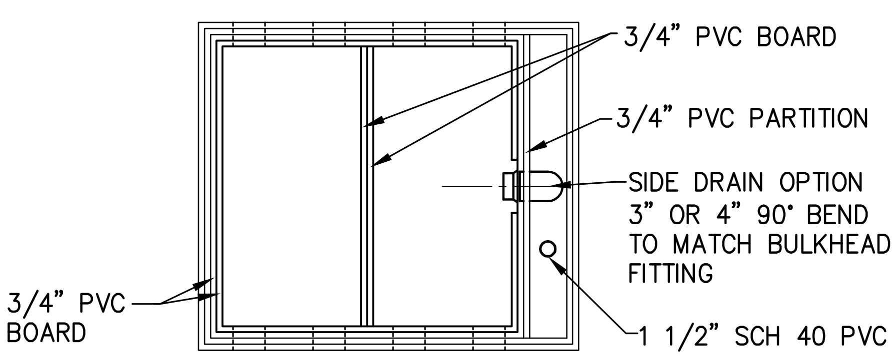

SECTION A - A

ELEVATION - SIDE VIEW SECTION
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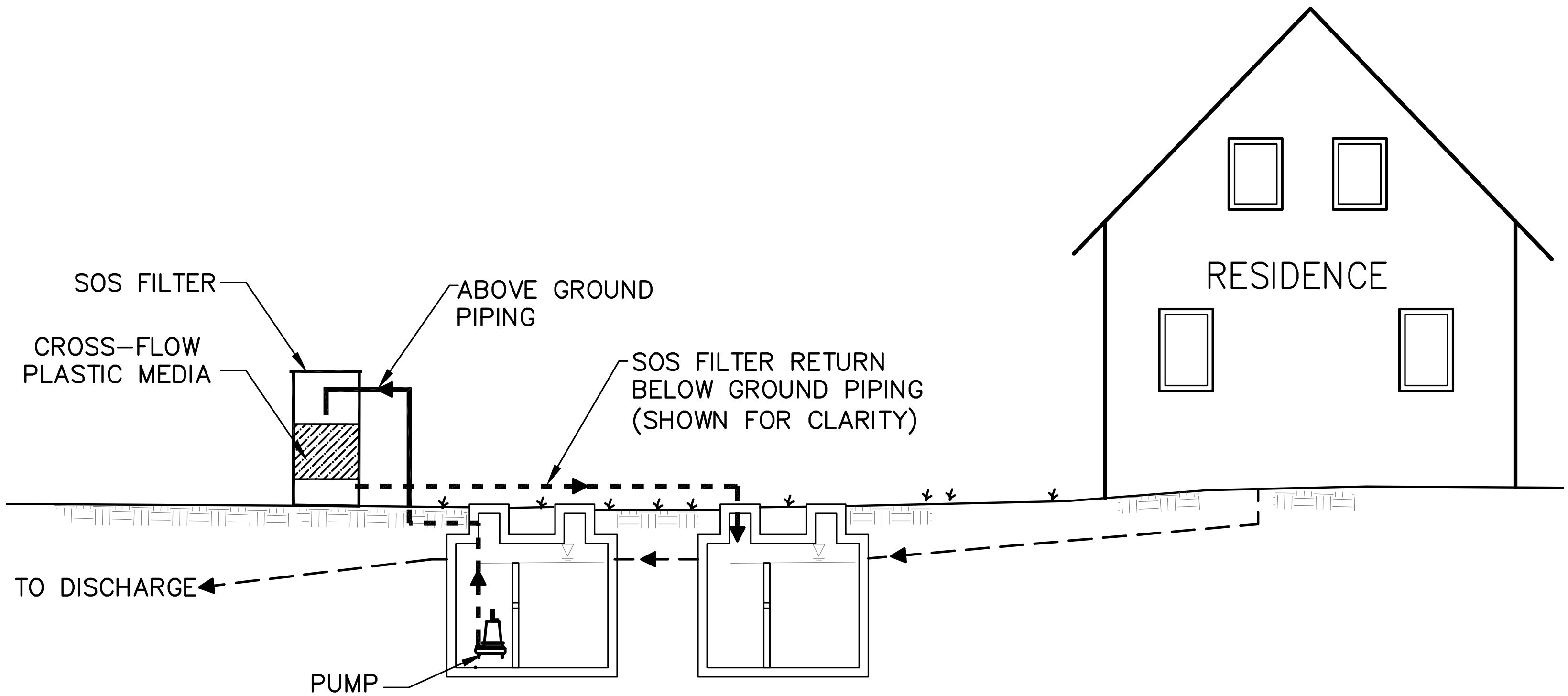

NOT TO SCALE

FLOW SCHEMATIC
RESIDENTIAL RECIRCULATING TRICKLING FILTER

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APPENDIX B

NSF STANDARD 245 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 designed to remove nitrogen from residential wastewater. Performance testing and evaluation shall not be restricted to specific seasons.

8.1 Preparations for testing and evaluation

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

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 start-up procedure, ⅔ of the system's capacity shall be
filled with water and the remaining ⅓ shall be filled with residential wastewater.

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 three weeks of filling the system and shall continue without interruption until the end of the evaluation period, except as specified in 8.4.2.

If conditions at the test 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.

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

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

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

8.2 Testing conditions, hydraulic loading and schedules

8.2.1 Influent wastewater characteristics

Except as required by NSF/ANSI 40 for systems seeking concurrent NSF/ANSI 40 and Nitrogen Reduction certification, the average wastewater characteristics delivered to the system over the course of the testing shall fall within:

− BOD_5: 100 to 300 mg/L
− TSS: 100 to 350 mg/L
− TKN: 35 to 70 mg/L as N
− alkalinity: > 175 mg/L as $CaCO_3$ (alkalinity may be adjusted if inadequate)
− temperature: 10 to 30 ºC (50 to 86 ºF)

− pH: 6.5 to 9 SU

Unless requested by the manufacturer, the raw influent shall be supplemented with sodium bicarbonate if the wastewater is found to be deficient in alkalinity. In addition, the influent shall be supplemented with urea to meet the required influent TKN concentration. The influent may also be supplemented with methanol to maintain a carbon:nitrogen ratio of no less than 5:1.

NOTE – For this testing, minimum alkalinity may be calculated as described in Annex A.
If the influent temperature drops below 10 ºC (50 ºF), impacting the nitrification process, sample collection may be suspended until the influent temperature returns to 10 ºC (50 ºF).

8.2.2 Hydraulic loading

The performance of the system shall be evaluated for a minimum of 26 wks. During the testing and evaluation
period, the system shall be subjected to 16 wks of design loading, followed by 7.5 wks (52 d) of stress loading, and an additional period of design loading to obtain a minimum of 55 influent and effluent data sets collected during non-stress dosing period.

8.2.2.1 Design loading

The system shall be dosed 7 d/wk 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 – An individual dose shall be no more than 10 gal (37.9 L), unless the dosage system is based on a continuous flow, and the doses shall be uniformly applied over the dosing period.

8.2.2.2 Stress loading

Stress loading sequences shall begin in week 17 of the testing and will be completed in the order listed in the following sections. Each stress sequence shall be separated by 7 d of design loading, as described in 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-d 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 five 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

Power/equipment failure stress simulation shall consist of a flow pattern where approximately 40% of the total
daily flow is received between 5 p. m. and 8 p. m. on the day when the power/equipment failure stress is initiated. Power to the system shall then be turned off at 9 p. m. and the flow pattern shall be discontinued for 48 h. After the 48-h period, power shall be restored and the system shall receive approximately 60% of the total daily flow over a 3-h period which shall include 1 wash load (1 wash cycle and 2 rinse cycles).

8.2.2.2.4 Vacation stress

Vacation stress simulation shall consist of a flow pattern where approximately 35% of the total daily flow is received between 6 a. m. and 9 a. m. and approximately 25% of the total daily flow is received between 11 a. m. and 2 p. m. on the day that the vacation stress is initiated. The flow pattern shall be discontinued for 8 consecutive days with power continuing to be supplied to the system. Between 5 p. m. and 8 p. m. of the ninth day, the system shall receive 60% of the total daily flow, 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.

8.3 Sample collection

8.3.1 Sampling frequency

Influent and effluent samples shall be collected three times per week during design loading periods and twice during each stress recovery period (the week following completion of each of the stress simulations described
in 8.2.2.2). This schedule shall be continued in the event that testing is extended beyond the 26-wk minimum.

8.3.2 Collection methods

All sample collection shall be in accordance with *Standard Methods*, unless otherwise specified. 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. Grab samples shall be collected for pH, temperature, and dissolved oxygen (DO). The location of the grab sample shall be appropriate to provide a sample that is representative of the influent or effluent, and shall be determined in conjunction with the manufacturer. 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.

8.3.3 Analyses

The samples collected as described in 8.3.1 and 8.3.2 shall be analyzed as follows:

		Sample location		
Parameter	Sample type	Raw influent	Treated effluent	Testing location
BOD_5	24 h composite	X		Laboratory
$CBOD_5$	24 h composite		X	Laboratory
Total suspended solids	24 h composite	X	X	Laboratory
PH	Grab	X	X	Test site
Temperature (°C)	Grab	X	X	Test site
Dissolved oxygen	Grab		X	Test site
Alkalinity (as $CaCO_3$)	24 h composite	X	X	Laboratory
TKN (as N)	24 h composite	X	X	Laboratory
Ammonia-N (as N)	24 h composite	X	X	Laboratory
Nitrite/nitrate-N (as N)	24 h composite	X	X	Laboratory

8.3.4 Analytical methods

The appropriate methods in *Standard Methods* shall be used to complete the analyses indicated in 8.3.3.

8.4 Criteria

8.4.1 Testing conditions

If conditions during the testing and evaluation period result in system upset, improper sampling, improper dosing, or influent characteristics outside 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 averages. Rationale for all data exclusions shall be documented in the final report.

8.4.2 Catastrophic site problems

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

– perform maintenance on the system, reinitiate system start-up procedures, and restart the performance testing; or
– with no routine maintenance performed, have the system brought back to pre-existing conditions and resume testing within 3 wks after the site problem has been identified and corrected. Data collected during the system recovery period shall be excluded from the effluent averages.

NOTE – “Pre-existing conditions” shall be defined as the point when the results of 1 wk’s worth of sampling are within 15% of the averages of the samples from the previous 3 wks of sampling.

8.4.3 Effluent quality

For purposes of determining system performance, only samples collected during design loading periods, described in 8.2.2, shall be used in the calculations. The data collected during the stress sequences shall not be included in the calculations, but shall be included in the final report.

8.4.3.1 CBOD5

The average CBOD5 of all effluent samples shall not exceed 25 mg/L.

8.4.3.2 TSS

The average TSS of all effluent samples shall not exceed 30 mg/L.

8.4.3.3 Total nitrogen

The average total nitrogen concentration of all effluent samples shall be less than 50% of the average total nitrogen concentration of all influent samples.

8.4.3.4 pH

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

8.5 Final report

A final report shall be prepared that presents the following:

– all data collected in accordance with the testing and evaluations within this Standard;

– a table indicating the actual percent reduction over the course of the test (included in the Executive Summary, as well as in the body, of the report);

– observations made during the testing;

– an estimation of the pounds of nitrogen loaded during the test and the pounds removed;

– any adjustments made to the alkalinity of the influent wastewater;

– a copy of the current edition of the Owner’s Manual; and

– process description and detailed dimensioned drawings of the system evaluated.

A supplemental report shall be prepared for any system(s) approved under the performance classification section (1.4) of this Standard, including process description(s) and dimensioned drawings.

APPENDIX C

ANALYTICAL RESULTS

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 31-Jan-16 Plant Code: SYS201

Weeks Into Test: 1

Weekend Dosing: Sunday 500 gallons Saturday 500 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	5.27	5.09	4.99	5.41	5.33
	effluent	4.97	4.75	4.17	4.92	4.75
Temperature (C)	influent	21	21	21	20	20
	aeration chamber	18	18	18	17	17
	effluent	18	18	15	17	17
pH	influent	7.3	7.4	7.2	7.6	7.2
	aeration chamber	7.6	7.7	7.6	7.7	7.7
	effluent	7.7	7.7	7.7	7.7	7.7
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	310	210	260	250	250
	effluent ($CBOD_5$)	26	15	15	11	14
Suspended Solids (mg/L)	influent	190	190	230	230	200
	effluent	9	6	8	8	8

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

Notes:

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 7-Feb-16 Plant Code: SYS201

Weeks Into Test: 2

Weekend Dosing: Sunday 500 gallons Saturday 500 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	7.04	7.15	6.49	5.51	5.31
	effluent	6.51	5.77	5.42	4.87	4.69
Temperature (C)	influent	20	20	20	21	21
	aeration chamber	17	16	17	17	18
	effluent	15	15	16	17	17
pH	influent	7.5	7.5	7.2	7.2	7.2
	aeration chamber	7.7	7.7	7.7	7.7	7.7
	effluent	7.7	7.7	7.7	7.6	7.6
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	240	250	270	350	330
	effluent ($CBOD_5$)	11	9	10	13	9
Suspended Solids (mg/L)	influent	260	200	240	260	300
	effluent	8	4	8	7	7

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

Notes:

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 14-Feb-16 Plant Code: SYS201

Weeks Into Test: 3

Weekend Dosing: Sunday 500 gallons Saturday 500 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	6.89	5.73	4.30	3.86	4.25
	effluent	5.52	4.55	4.06	3.57	3.88
Temperature (C)	influent	21	21	21	21	21
	aeration chamber	19	19	19	19	19
	effluent	19	18	19	19	19
pH	influent	7.0	7.3	7.4	6.8	7.2
	aeration chamber	7.6	7.6	7.6	7.6	7.6
	effluent	7.6	7.6	7.6	7.6	7.6
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	320	230	270	290	330
	effluent ($CBOD_5$)	9	9	11	21	22
Suspended Solids (mg/L)	influent	220	260	260	200	220
	effluent	9	7	11	13	12

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

Notes:

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 21-Feb-16 Plant Code: SYS201

Weeks Into Test: 4

Weekend Dosing: Sunday 500 gallons Saturday 500 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	5.00	3.40	3.75	3.96	3.96
	effluent	4.59	3.21	3.37	3.69	3.73
Temperature (C)	influent	22	21	20	21	21
	aeration chamber	20	20	18	18	18
	effluent	20	18	19	17	17
pH	influent	7.2	7.3	7.7	7.0	7.0
	aeration chamber	7.5	7.6	7.6	7.5	7.6
	effluent	7.5	7.6	7.6	7.5	7.6
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	240	260	260	240	290
	effluent ($CBOD_5$)	11	11	15	17	16
Suspended Solids (mg/L)	influent	320	190	150	170	220
	effluent	8	7	9	8	6

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

Notes:

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 28-Feb-16 Plant Code: SYS201

Weeks Into Test: 5

Weekend Dosing: Sunday 500 gallons Saturday 500 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	5.80	4.70	4.61	4.62	2.86
	effluent	5.01	4.42	3.10	4.38	2.20
Temperature (C)	influent	21	22	22	22	22
	aeration chamber	19	19	19	20	20
	effluent	19	20	19	18	20
pH	influent	7.1	7.1	7.5	7.0	7.5
	aeration chamber	7.6	7.6	7.6	7.6	7.6
	effluent	7.6	7.6	7.6	7.6	7.5
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	250	230	240	300	310
	effluent ($CBOD_5$)	7	5	6	6	6
Suspended Solids (mg/L)	influent	170	140	160	180	190
	effluent	5	4	4	4	4

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

Notes:

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 6-Mar-16 Plant Code: SYS201

Weeks Into Test: 6

Weekend Dosing: Sunday 500 gallons Saturday 500 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	3.97	3.62	2.69	2.98	3.11
	effluent	3.57	1.78	1.99	2.07	2.01
Temperature (C)	influent	22	22	21	21	21
	aeration chamber	20	21	21	21	21
	effluent	21	20	20	20	21
pH	influent	7.5	7.3	7.0	6.7	7.0
	aeration chamber	7.5	7.3	7.3	7.4	7.4
	effluent	7.5	7.4	7.4	7.4	7.4
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	250	270	300	230	320
	effluent ($CBOD_5$)	5	3	4	5	4
Suspended Solids (mg/L)	influent	200	210	220	140	130
	effluent	4	2	2	4	4

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

Notes:

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 13-Mar-16 Plant Code: SYS201

Weeks Into Test: 7

Weekend Dosing: Sunday 500 gallons Saturday 500 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	4.68	3.64	2.08	1.63	1.98
	effluent	3.53	2.68	1.61	0.95	1.13
Temperature (C)	influent	22	22	22	23	23
	aeration chamber	21	22	21	22	22
	effluent	21	22	21	22	22
pH	influent	7.2	7.0	7.3	7.2	7.1
	aeration chamber	7.5	7.4	7.5	7.6	7.5
	effluent	7.5	7.4	7.5	7.6	7.5
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	240	190	190	340	430
	effluent ($CBOD_5$)	4	4	5	10	10
Suspended Solids (mg/L)	influent	100	120	150	350	320
	effluent	3	4	4	6	7

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

Notes:

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 20-Mar-16 Plant Code: SYS201

Weeks Into Test: 8

Weekend Dosing: Sunday 500 gallons Saturday 500 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		500	500	475	500	500
Dissolved Oxygen (mg/L)	aeration chamber	5.11	4.34	2.33	0.44	1.47
	effluent	3.97	3.11	1.26	0.66	0.87
Temperature (C)	influent	22	22	23	23	23
	aeration chamber	20	20	20	20	20
	effluent	19	20	20	21	20
pH	influent	7.3	7.1	7.3	6.9	7.0
	aeration chamber	7.7	7.7	7.6	7.6	7.6
	effluent	7.7	7.7	7.6	7.6	7.6
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	220	280	310	270	250
	effluent ($CBOD_5$)	5	4	6	9	9
Suspended Solids (mg/L)	influent	140	180	200	200	180
	effluent	5	4	7	11	12

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

Notes: The first 5 doses of the mid-day dosing period were missed on 3/23 due to lab error. The issue was resolved by noon of the same day.

NSF International

Standard 40 - Residential Wastewater Treatment Systems

Plant Effluent

Week Beginning: 27-Mar-16 Plant Code: SYS201

Weeks Into Test: 9

Weekend Dosing: Sunday 500 gallons Saturday 500 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	3.95	3.57	1.80	0.50	0.74
	effluent	2.65	2.37	1.41	0.31	0.62
Temperature (C)	influent	23	23	23	24	24
	aeration chamber	20	21	21	22	22
	effluent	19	20	22	23	22
pH	influent	7.4	7.0	7.0	7.0	7.1
	aeration chamber	7.6	7.6	7.6	7.6	7.6
	effluent	7.6	7.5	7.5	7.6	7.6
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	250	280	270	190	280
	effluent ($CBOD_5$)	5	5	4	9	9
Suspended Solids (mg/L)	influent	100	180	180	190	190
	effluent	7	6	7	8	10

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

Notes:

NSF International

Standard 40 - Residential Wastewater Treatment Systems

Plant Effluent

Week Beginning: 3-Apr-16 Plant Code: SYS201

Weeks Into Test: 10

Weekend Dosing: Sunday 500 gallons Saturday 500 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	1.50	0.41	0.57	0.48	0.75
	effluent	1.78	0.77	1.12	0.92	0.81
Temperature (C)	influent	23	24	24	24	24
	aeration chamber	21	22	22	22	22
	effluent	21	22	22	22	22
pH	influent	7.1	7.1	6.8	6.8	6.8
	aeration chamber	7.4	7.5	7.5	7.5	7.5
	effluent	7.4	7.5	7.4	7.4	7.5
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	150	320	320	260	190
	effluent ($CBOD_5$)	11	9	14	14	10
Suspended Solids (mg/L)	influent	150	180	190	190	180
	effluent	9	10	9	7	6

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

Notes:

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 10-Apr-16 Plant Code: SYS201

Weeks Into Test: 11

Weekend Dosing: Sunday 500 gallons Saturday 500 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	1.89	2.11	1.91	2.06	1.96
	effluent	1.41	1.52	1.04	0.91	1.13
Temperature (C)	influent	24	24	24	24	24
	aeration chamber	23	23	23	22	23
	effluent	23	23	22	22	22
pH	influent	6.7	6.8	6.6	6.9	6.8
	aeration chamber	7.5	7.5	7.3	7.4	7.4
	effluent	7.5	7.5	7.3	7.4	7.4
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	130	200	230	66	220
	effluent ($CBOD_5$)	4	2	2	9	4
Suspended Solids (mg/L)	influent	160	160	180	160	170
	effluent	5	2	2	2	3

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

Notes: The lab confirmed the influent BOD result on 4/14/16.

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 17-Apr-16 Plant Code: SYS201

Weeks Into Test: 12

Weekend Dosing: Sunday 500 gallons Saturday 500 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	2.46	2.77	1.72	1.47	1.35
	effluent	1.51	1.09	1.33	1.31	1.11
Temperature (C)	influent	23	24	23	23	23
	aeration chamber	23	23	23	23	23
	effluent	22	22	23	23	23
pH	influent	6.7	7.3	6.4	6.7	6.6
	aeration chamber	7.2	7.4	7.3	7.3	7.3
	effluent	7.3	7.4	7.4	7.4	7.4
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	140	210	210	210	210
	effluent ($CBOD_5$)	3	3	4	4	4
Suspended Solids (mg/L)	influent	160	110	130	130	110
	effluent	4	5	6	5	5

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

Notes:

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 24-Apr-16 Plant Code: SYS201

Weeks Into Test: 13

Weekend Dosing: Sunday 500 gallons Saturday 500 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	3.42	2.87	1.18	0.99	0.68
	effluent	2.87	2.67	1.07	0.82	0.60
Temperature (C)	influent	24	24	24	24	24
	aeration chamber	24	24	24	24	25
	effluent	24	24	24	24	25
pH	influent	7.3	6.8	6.8	6.8	7.1
	aeration chamber	7.6	7.4	7.4	7.3	7.5
	effluent	7.6	7.4	7.4	7.4	7.5
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	100	200	190	200	170
	effluent ($CBOD_5$)	4	3	4	8	8
Suspended Solids (mg/L)	influent	140	190	180	140	140
	effluent	11	14	11	13	12

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

Notes:

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 1-May-16 Plant Code: SYS201

Weeks Into Test: 14

Weekend Dosing: Sunday 500 gallons Saturday 500 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	3.34	2.97	2.31	2.93	2.01
	effluent	2.78	2.46	2.06	2.59	1.39
Temperature (C)	influent	24	24	24	24	24
	aeration chamber	24	23	23	24	24
	effluent	24	24	24	24	23
pH	influent	7.4	7.1	6.7	6.8	6.9
	aeration chamber	7.6	7.4	7.3	7.3	7.4
	effluent	7.6	7.4	7.3	7.4	7.4
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	120	150	220	230	220
	effluent ($CBOD_5$)	5	8	3	5	6
Suspended Solids (mg/L)	influent	150	140	160	180	150
	effluent	12	16	6	8	8

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

Notes:

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Standard 40 - Residential Wastewater Treatment Systems

Plant Effluent

Week Beginning: 8-May-16 Plant Code: SYS201

Weeks Into Test: 15

Weekend Dosing: Sunday 500 gallons Saturday 500 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	1.92	1.13	0.77	1.94	2.15
	effluent	1.87	1.29	1.05	2.13	2.09
Temperature (C)	influent	25	24	25	25	25
	aeration chamber	24	25	25	25	25
	effluent	24	25	25	25	25
pH	influent	7.1	7.1	6.7	6.9	6.8
	aeration chamber	7.4	7.4	7.3	7.2	7.2
	effluent	7.5	7.4	7.4	7.3	7.3
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	190	190	170	140	120
	effluent ($CBOD_5$)	5	6	7	5	6
Suspended Solids (mg/L)	influent	130	150	150	170	180
	effluent	8	11	10	9	10

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

Notes: Color, odor, oily film and foam were measured on 5/11:
Color: 30 Pt-Co unit
Odor: 20 T.O.N.
Oily film and foam: Not Detected

NSF International

Standard 40 - Residential Wastewater Treatment Systems

Plant Effluent

Week Beginning: 15-May-16 Plant Code: SYS201

Weeks Into Test: 16

Weekend Dosing: Sunday 500 gallons Saturday 500 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	3.93	3.09	1.40	1.73	2.00
	effluent	3.42	2.17	1.34	1.39	1.42
Temperature (C)	influent	25	25	25	25	24
	aeration chamber	25	25	25	25	24
	effluent	25	24	24	24	23
pH	influent	6.9	6.7	6.8	6.8	6.6
	aeration chamber	7.3	7.3	7.3	7.2	7.2
	effluent	7.4	7.3	7.4	7.3	7.3
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	95	220	210	180	100
	effluent ($CBOD_5$)	a	5	4	7	6
Suspended Solids (mg/L)	influent	130	150	160	150	150
	effluent	a	7	7	9	9

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

Notes: The composite effluent samples were contaminated on 5/16 due to a problem with test site effluent handling system.

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 22-May-16 Plant Code: SYS201

Weeks Into Test: 17

		Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Dosed Volume (gallons)		500	500	500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber		3.69	1.97	0.28	0.58	0.31	0.89
	effluent		3.44	1.61	0.64	0.94	0.58	1.06
Temperature (C)	influent		24	25	26	26	26	26
	aeration chamber		25	26	26	26	26	26
	effluent		25	26	26	26	26	26
pH	influent		7.2	6.9	7.1	6.8	7.1	6.9
	aeration chamber		7.4	7.6	7.4	7.6	7.3	7.6
	effluent		7.5	7.6	7.2	7.6	7.2	7.6
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)		170					
	effluent ($CBOD_5$)		4					
Suspended Solids (mg/L)	influent		74 (a)					
	effluent		8					

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

Notes: Wash day stress 5/23 through 5/27.
The lower than normal TSS concentratin on 5/23 was due to a problem with the mixing system in the test site influent tank. The problem was resolved on the morning of 5/23.

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 29-May-16 Plant Code: SYS201

Weeks Into Test: 18

		Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Dosed Volume (gallons)		500	500	500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	1.21	3.34	5.28	3.93	3.04	0.94	3.48
	effluent	0.98	2.87	3.59	1.95	1.96	0.50	1.41
Temperature (C)	influent	26	26	26	26	26	26	26
	aeration chamber	26	26	26	26	26	26	26
	effluent	26	26	26	26	25	26	26
pH	influent	7.1	7.3	7.5	7.2	6.9	6.9	6.6
	aeration chamber	7.6	7.7	7.9	7.5	7.6	7.6	7.4
	effluent	7.6	7.6	7.8	7.6	7.5	7.6	7.3
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)		160	200	180	310	310	120
	effluent ($CBOD_5$)		2	2	2	4	4	4
Suspended Solids (mg/L)	influent		87	83	110	130	120	83
	effluent		2	3	2	5	4	4

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

Notes: Working Parent Stress started on 6/4.

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Standard 40 - Residential Wastewater Treatment Systems

Plant Effluent

Week Beginning: 5-Jun-16 Plant Code: SYS201

Weeks Into Test: 19

		Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Dosed Volume (gallons)		500	500	500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	3.80	4.37	4.48	3.92	3.14	4.09	2.93
	effluent	3.48	3.85	3.81	2.59	3.72	3.33	1.31
Temperature (C)	influent	26	26	26	26	26	26	27
	aeration chamber	26	26	26	27	27	27	28
	effluent	27	26	26	27	27	27	29
pH	influent	6.8	6.6	6.4	6.7	6.6	6.8	6.8
	aeration chamber	7.6	7.5	7.5	7.7	7.5	7.6	7.7
	effluent	7.5	7.4	7.4	7.6	7.6	7.5	7.6
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)							250
	effluent ($CBOD_5$)							2
Suspended Solids (mg/L)	influent							140
	effluent							2

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

Notes: Working Parent Stress completed on 6/8.

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Plant Effluent

Week Beginning: 12-Jun-16 Plant Code: SYS201

Weeks Into Test: 20

		Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Dosed Volume (gallons)		500	500	500	500	500	0	300
Dissolved Oxygen (mg/L)	aeration chamber	7.62	7.66	7.66	7.58	7.60		
	effluent	0.68	1.15	0.88	0.34	0.67		
Temperature (C)	influent	27	27	27	28	28		
	aeration chamber	29	29	29	29	29		
	effluent	29	29	29	29	29		
pH	influent	7.2	7.1	6.8	7.2	7.2		
	aeration chamber	7.6	7.7	7.7	7.6	7.6		
	effluent	7.6	7.6	7.6	7.5	7.6		
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	280	320	380	340	370		
	effluent ($CBOD_5$)	4	4	4	1	5		
Suspended Solids (mg/L)	influent	140	160	130	130	150		
	effluent	5	4	5	4	4		

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

Notes: Power Failure Stress 6/16 through 6/18.
Color, odor, oily film and foam were measured on 6/15:
Color: 30 Pt-Co unit
Odor: 50 T.O.N.
Oily film and foam: Not Detected

NSF International
Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 19-Jun-16 Plant Code: SYS201

Weeks Into Test: 21

		Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Dosed Volume (gallons)		500	500	500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	2.33	2.27	2.73	1.72	0.43	0.51	0.55
	effluent	2.67	2.62	2.58	1.66	0.62	0.42	0.38
Temperature (C)	influent	28	27	28	28	28	28	28
	aeration chamber	29	29	30	30	30	30	30
	effluent	29	30	30	30	30	31	31
pH	influent	6.9	6.8	6.9	7.0	6.8	7.6	7.2
	aeration chamber	7.5	7.4	7.5	7.6	7.5	7.6	7.6
	effluent	7.5	7.4	7.6	7.6	7.5	7.6	7.6
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)				330	390	430	230
	effluent ($CBOD_5$)				5	4	6	4
Suspended Solids (mg/L)	influent				170	170	160	150
	effluent				6	4	4	5

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

Notes:

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Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 26-Jun-16 Plant Code: SYS201

Weeks Into Test: 22

		Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Dosed Volume (gallons)		300	0	0	0	0	0	0
Dissolved Oxygen (mg/L)	aeration chamber	0.56						
	effluent	0.37						
Temperature (C)	influent	28						
	aeration chamber	30						
	effluent	31						
pH	influent	7.0						
	aeration chamber	7.6						
	effluent	7.6						
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	200						
	effluent ($CBOD_5$)	3						
Suspended Solids (mg/L)	influent	150						
	effluent	4						

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

Notes: Vaction Stress started on 6/26, after the mid-day dosing period.

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Standard 40 - Residential Wastewater Treatment Systems

Plant Effluent

Week Beginning: 3-Jul-16 Plant Code: SYS201

Weeks Into Test: 23

Parameter		Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Dosed Volume (gallons)		0	0	300	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber				0.57	0.49	0.45	0.30
	effluent				0.83	0.73	0.66	0.45
Temperature (C)	influent				29	29	29	30
	aeration chamber				31	31	31	32
	effluent				33	31	32	33
pH	influent				6.9	6.9	7.0	7.1
	aeration chamber				7.4	7.5	7.5	7.6
	effluent				7.5	7.5	7.6	7.6
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)						340	260
	effluent ($CBOD_5$)						9	7
Suspended Solids (mg/L)	influent						200	150
	effluent						9	8

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

Notes: Vaction Stress completed on 7/5.

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Standard 40 - Residential Wastewater Treatment Systems

Plant Effluent

Week Beginning: 10-Jul-16 Plant Code: SYS201

Weeks Into Test: 24

Saturday 500 gallons

Parameter		Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		500	500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	0.57	1.23	0.77	0.61	0.73	0.52
	effluent	0.78	0.96	1.11	1.35	0.66	0.65
Temperature (C)	influent	29	29	29	29	29	30
	aeration chamber	31	31	31	31	31	31
	effluent	31	31	32	32	31	31
pH	influent	7.0	6.7	7.0	7.0	6.6	6.7
	aeration chamber	7.4	7.4	7.4	7.5	7.4	7.4
	effluent	7.4	7.4	7.4	7.5	7.4	7.4
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	230	130	260	250	220	220
	effluent ($CBOD_5$)	10	6	4	4	4	5
Suspended Solids (mg/L)	influent	140	150	160	110	190	180
	effluent	7	4	4	6	3	4

(a) Site problem
coffeecup
system under test
(c) Weather problem
(d) Other

Notes:

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Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 17-Jul-16 Plant Code: SYS201

Weeks Into Test: 25

Weekend Dosing: Sunday 500 gallons Saturday 500 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday (23-Jul)
Dosed Volume (gallons)		500	500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	0.70	0.64	0.57	0.36	0.42	0.59
	effluent	0.62	0.71	0.97	0.62	0.65	0.72
Temperature (C)	influent	30	30	30	30	30	31
	aeration chamber	32	32	32	32	32	32
	effluent	33	33	30	31	32	33
pH	influent	6.6	6.6	6.8	6.8	6.8	6.7
	aeration chamber	7.2	7.4	7.6	7.6	7.6	7.6
	effluent	7.3	7.4	7.6	7.6	7.6	7.6
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	d	250	a	330	310	280
	effluent ($CBOD_5$)	5	11	a	6	5	6
Suspended Solids (mg/L)	influent	d	200	a	150	160	160
	effluent	6	7	a	5	4	4

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

Notes: Influent composite sample missed on 7/18 due to lab error.
No samples on 7/20 due to a problem with the test site effluent handling system. The problem was resolved later that day.
Saturday, 7/23 was added as a sample day to make up for missing samples on 7/20.

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Standard 40 - Residential Wastewater Treatment Systems
Plant Effluent

Week Beginning: 24-Jul-16 Plant Code: SYS201

Weeks Into Test: 26

Weekend Dosing: Sunday 500 gallons Saturday 500 gallons

		Monday	Tuesday	Wednesday	Thursday	Friday
Dosed Volume (gallons)		500	500	500	500	500
Dissolved Oxygen (mg/L)	aeration chamber	0.57	0.53	0.64	0.69	0.58
	effluent	0.68	0.73	0.81	0.92	0.86
Temperature (C)	influent	30	30	30	30	30
	aeration chamber	32	32	32	32	32
	effluent	33	32	32	32	32
pH	influent	6.6	6.4	6.7	6.7	6.7
	aeration chamber	7.4	7.1	7.1	7.3	7.2
	effluent	7.4	7.2	7.2	7.2	7.2
Biochemical Oxygen Demand (mg/L)	influent (BOD_5)	260	130	290	230	240
	effluent ($CBOD_5$)	7	6	4	6	5
Suspended Solids (mg/L)	influent	320	180	190	180	210
	effluent	4	5	4	3	3

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

Notes:

APPENDIX D

ANALYTICAL RESULTS – Nitrogen Analyses

	Date	Ammonia Nitrogen (mg/L)		Total Kjeldahl Nitrogen (mg/L)		Nitrate/Nitrite (mg/L)		Total Nitrogen (mg/L)		Total Alkalinity (mg/L CaCO3)	
		Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
startup wo	01/25/16	32.6	32	43.7	42.4	0.88	1.11	44.6	43.5	355	333
	01/27/16	39.2	27.3	47.6	37	0.08	0.23	47.7	37.2	362	326
	01/29/16	34.5	25.6	49.7	45.3	0.09	1.11	49.8	46.4	360	331
Week 1	02/01/16	29.2	12.5	52.1	24.7	0.51	10.9	52.6	35.6	362	270
	02/03/16	37.3	7.9	51.2	17.3	0.05	19.5	51.3	36.8	371	245
	02/05/16	33.8	6.31	48.1	9.48	0.05	15	48.2	24.5	356	243
	02/06/16	23	5.67	37.3	8.33	0.05	14.9	37.4	23.2	319	245
Week 2	02/08/16	20.8	2.5	36.7	4.28	0.05	16.4	36.8	20.7	313	218
	02/10/16	31.3	2.48	47.7	3.99	0.05	14.7	47.8	18.7	348	222
	02/12/16	29.7	2.38	46.3	5.49	0.06	18.3	46.4	23.8	342	220
Week 3	02/15/16	35.9	2.84	54.4	6.01	1.63	14.9	56.0	20.9	372	226
	02/17/16	41.8	4.10	50.7	8.38	0.08	11.4	50.8	19.8	363	236
	02/19/16	33.0	5.50	52.0	11.3	0.66	9.18	52.7	20.5	357	243
Week 4	02/22/16	22.5	2.44	42.3	6.77	0.06	13.2	42.4	20.0	310	224
	02/24/16	22.8	1.89	39.4	7.02	1.94	11.7	41.3	18.7	285	222
	02/26/16	25.3	2.13	46.8	9.56	0.09	10.4	46.9	20.0	338	219
Week 5	02/29/16	21.4	1.76	38.2	4.23	0.07	12.2	38.3	16.4	325	217
	03/02/16	29.7	1.93	57.0	4.37	0.05	15.7	57.1	20.1	362	246
	03/04/16	32.3	2.73	53.3	5.30	0.18	11.0	53.5	16.3	360	241
Week 6	03/07/16	27.2	1.69	56.6	4.02	3.86	14.2	60.5	18.2	357	234
	03/09/16	29.3	2.04	46.3	4.17	2.19	12.0	48.5	16.2	347	235
	03/11/16	19.7	1.37	33.8	3.53	0.94	7.84	34.7	11.4	305	232
Week 7	03/14/16	15.3	0.78	28.2	2.5	1.42	8.83	29.6	11.4	324	232
	03/16/16	27.5	1.05	37.6	2.97	1.45	7.51	39.1	10.5	348	237
	03/18/16	24.4	1.82	44.4	4.3	0.61	8.85	45.0	13.1	371	247
Week 8	03/21/16	20.6	0.73	37.3	1.37	2.06	14.3	39.4	15.7	348	230
	03/23/16	34.7	1.19	45.1	2.88	0.05	11.3	45.2	14.2	369	234
	03/25/16	25.8	2.25	40.8	4.77	0.87	10.4	41.7	15.2	362	248
Week 9	03/28/16	23	1.19	38.9	2.7	1.88	12.8	40.8	15.5	358	238
	03/30/16	28.2	1.4	44.3	3.68	0.16	17.1	44.5	20.8	374	240
	04/01/16	18.1	1.7	54.6	4.25	0.08	18.1	54.7	22.4	372	238
Week 10	04/04/16	18.7	1.68	33.6	3.18	2.67	16.4	36.3	19.6	324	224
	04/06/16	33.5	1.9	54.0	4.62	0.05	21.4	54.1	26.0	384	226
	04/08/16	24.3	2.12	39.6	4.84	0.05	19.7	39.7	24.5	356	234
Week 11	04/11/16	23.5	2.16	34.6	3.85	1.08	19.7	35.7	23.6	346	248
	04/13/16	32.4	1.8	43.5	2.79	0.09	19.3	43.6	22.1	384	246
	04/15/16	29.3	2.04	51.2	1.9	0.09	15.6	51.3	17.5	392	234
Week 12	04/18/16	20.5	1.85	37	2.48	2.60	16.9	39.6	19.4	294	226
	04/20/16	25.4	1.57	37	1.8	0.71	15.2	37.7	17.0	348	220
	04/22/16	16.2	1.36	27	2.87	0.57	13.8	27.6	16.7	320	228
Week 13	04/25/16	22.1	1.9	31.7	2.8	3.58	13.4	35.3	16.2	354	232
	05/27/16	26.2	2.23	37.4	3.25	0.06	13.6	37.5	16.9	356	232
	04/29/16	23.6	3.42	36.1	5.4	0.08	13.5	36.2	18.9	352	240

Week 14	05/02/16	16	2.1	28.4	3.49	0.63	15.4	29.0	18.9	304	212
	05/04/16	23.1	1.38	32	1.0	0.79	24	32.8	25.0	346	210
	05/06/16	24.4	1.62	30.2	1.45	0.09	16.4	30.3	17.9	356	224
Week 15	05/09/16	29.6	1.23	43.7	1.26	0.91	16.9	44.6	18.2	340	203
	05/11/16	25.5	1.6	31	0.83	0.1	17.2	31.1	18.0	329	203
	05/13/16	16.4	1.38	30.1	2.3	0.07	16.9	30.2	19.2	289	205
Week 16	05/18/16	21.6	0.75	38.6	3.29	0.12	18	38.7	21.3	321	200
	05/20/16	17.2	1.63	40.4	2.36	0.08	16.9	40.5	19.3	276	207
week 17	05/23/16	16.7	0.8	30.3	0.86	0.48	17.4	30.78	18.3	319	196
week 18	05/31/16	21.1	0.49	32.6	0.5	1.39	17.9	33.99	18.4	452	226
	06/01/16	24.6	0.16	30.8	1.36	1.23	15.2	32.03	16.6	484	294
	06/03/16	27.3	0.88	38.5	2.34	0.74	13.2	39.24	15.5	340	272
week 19											
week 20	06/12/16	33.3	0.43	54	1.98	0.07	17.1	54.07	19.1	380	254
	06/13/16	35.7	1.05	55.8	2.72	0.63	14.6	56.43	17.3	390	258
	06/15/16	43.4	1.56	60.2	2.95	0.3	8.23	60.5	11.2	418	266
week 21	06/22/16	42.3	1.09	57.1	2.44	0.11	16.6	57.21	19.0	412	234
	06/24/16	46.9	3.03	64.5	4.98	0.09	3.8	64.59	8.8	422	268
	06/25/16	39	4.54	48.5	6.81	0.09	0.92	48.59	7.7	388	280
week 22	06/26/16	32.5	4.69	48.8	6.55	0.07	2.74	48.87	9.3	376	278
week 23											
	07/08/16	51.5	6.86	88.2	11.3	0.12	9.03	88.32	20.3	460	290
	07/09/16	41.8	6.59	57.3	9.94	0.06	6.43	57.36	16.4	460	286
week 24	07/11/16	33.1	6.69	44.7	9.5	0.22	7.9	44.9	17.4	358	274
	07/13/16	38.9	4.71	53.8	6.66	0.09	10.1	53.9	16.8	374	256
	07/15/16	45.9	5.12	56	7.4	0.05	6.78	56.1	14.2	392	272
Week 25	07/21/16	53.5	6.5	59.3	10.0	0.09	3.32	59.4	13.3	448	300
	07/22/16	46.7	7.28	61.7	10.5	0.13	1.83	61.8	12.3	442	302
	07/23/16	45.4	7.65	54.1	10.7	0.05	3.37	54.2	14.1	436	300
Week 26	07/25/16	39.6	9.33	44.6	12	0.06	4.76	44.7	16.8	400	300
	07/27/16	43.8	5.15	52.1	7.02	0.08	7.51	52.2	14.5	412	258
	07/29/16	33.8	6.2	51.1	7.86	0.1	4.93	51.2	12.8	396	282
Week 27	08/01/16	33.6	3.18	47.6	5.39	1.81	11.4	49.4	16.8	364	240
	08/03/16	45.8	3.8	52.1	4.95	0.18	9.81	52.3	14.8	404	246
	08/05/16	25.3	3.64	37	4.12	0.17	5.65	37.2	9.8	364	258

Data in yellow is stress data and not used in the nitrogen reduction calculations per 8.4.3.

APPENDIX E

OWNERS MANUAL

SOSYSTEMS

LOOLOOP

Owner's Manual

LooLoop Wastewater Treatment System

An SOSystems Technologies Product

181 Admiral Cochrane Blvd.
Suite 275
Annapolis, MD 21401
(703) 966-1084

Thank You

Thank you for purchasing a LooLoop wastewater treatment system. You have purchased the most robust, easy to operate, effective, yet technically simple onsite wastewater treatment system on the market today. LooLoop system is designed to remove a majority of the nitrogen from your home's wastewater as well as most of the drain field clogging contaminants. Nitrogen run-off is the primary cause of algae growth in our lakes, bays, and waterways. Algae growth contributes to the depletion of oxygen that is critical to sustaining our waterways. The LooLoop system helps you make a difference in watershed recovery efforts and leave a better world for future generations.

The LooLoop system has been tested and is listed under NSF/ANSI Standard 40 for Class 1 treatment systems and NSF/ANSI Standard 245 for nutrient removal systems.

LooLoop System Introduction

The LooLoop wastewater treatment system technology is an enhancement to conventional onsite septic tank systems. LooLoop efficiently and effectively treats septic system wastewater resulting in an effluent that meets the highest standards and expectations for environmental and water quality protection. The LooLoop process is simple and reliable, thereby avoiding the complications and costs associated with other nitrogen-removal products. LooLoop requires minimal maintenance, is simple to repair, and is fabricated using generic components that are universally available.

How the LooLoop System Treatment Process Works

The LooLoop process transforms traditional septic tank effluent to clean, almost odorless, and low nutrient water that prevents leach field failure. In more technical terms, it converts oxygen-starved anaerobic septic tank effluent to oxygen-rich aerobic effluent low in Biological Oxygen Demand (BOD), Total Suspended Solids (TSS, the leach filed clogging material) and nitrogen. As an enhancement to an existing septic system, the LooLoop system (see Figure 1) requires one additional standard 1500 gallon underground two chamber septic tank placed adjacent to your existing septic tank and the installation of the LooLoop BioFilter Cabinet. The BioFilter Cabinet is a 4' X 4' x 6' tall pre-assembled cabinet that can be placed at any location on your property that drains by gravity back to your septic tanks.

The existing septic tank (Tank 1) continues to be where solids are settled and anaerobically digested. Unlike your current system, however, the wastewater from the first tank is not displaced into the drain field. Instead, the wastewater flows into the LooLoop tank (Tank 2) where additional treatment takes place and a small pump sends effluent to the LooLoop BioFilter Cabinet.

The BioFilter Cabinet is where it all happens. The BioFilter Cabinet is an ultra-high rate recirculating trickling filter containing highly porous plastic filter media with a very high surface area per unit of volume. Wastewater from the second tank is pumped to the BioFilter Cabinet and sprayed directly onto the filter media. The plastic filter media is where aerobic bacteria live and grow using the nutrients and organic materials from the wastewater as their food source. Vents at the top and bottom of the BioFilter Cabinet ensure that an oxygen rich environment is maintained, allowing aerobic bacteria to survive and multiply. The aerobic bacteria consume the organic material in the home's wastewater faster than the anaerobic bacteria growing in the existing septic tank. The aerobic bacteria turn this food into carbon dioxide gas and more bacteria. The bacteria grow so there is just enough of them to consume almost all the "food" available.

The aerobic bacteria also play a key role in reducing nitrogen levels in the effluent reaching the drain field and the nearby groundwater by performing the first key step-converting nitrogen compounds in the wastewater to nitrate. After the nitrified wastewater drains from the BioFilter Cabinet, it flows by gravity back to existing septic tank where it mixes with septic tank effluent. The residual contamination in the BioFilter Cabinet flow plus the added food in the septic tank effluent stimulate bacterial growth and activity. The bacterial population's need for oxygen depletes the oxygen in the water. With the oxygen depleted, the aerobic bacteria (that can't survive without oxygen) get the oxygen needed by splitting it off the nitrate molecule which has 1 nitrogen and 3 oxygen atoms. Relieved of the oxygen atoms, the nitrogen is released to the air as a gas. Nitrogen gas is 70% of the air we breathe, so nitrogen in the air, and not in the water, is the way nature intended things to be.

The wastewater continues to recirculate to the BioFilter Cabinet and back to the septic tanks at the rate of about 7,000 gallons per day. The RecoSept tank pump chamber's final feature is an overflow pipe that allows the clean recirculating effluent water, containing low levels of nitrogen, TSS and BOD, flow to the drain field.

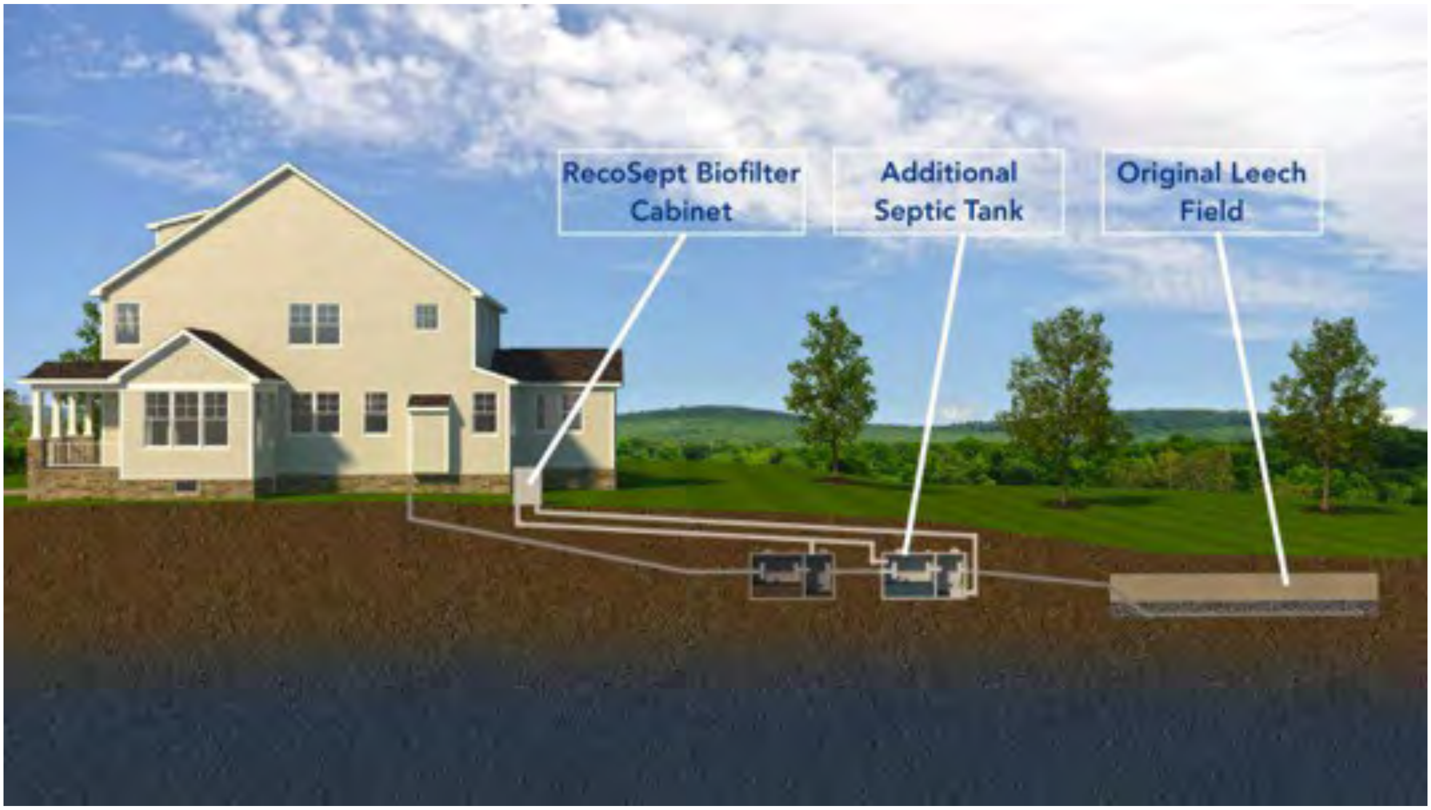

Figure 1. LooLoop System

In Figure 1, note that both tanks have 2 compartments. The LooLoop system can be added to any existing sep- tic system by inserting a second tank between the existing tank and the soil disposal system, or an entirely new system can be installed. For those systems without a compartmented septic tank, the return from the trickling filter can be connected to the LooLoop tank.

Features and Advantages

The standard LooLoop treatment system consists of the following components:

- The BioFilter Cabinet is the key component of the LooLoop system and has no moving or mechanical components other than three valves and operable vents at the top and bottom of the cabinet. Thus, the BioFilter Cabinet is designed for long term performance and minimal maintenance. The BioFilter Cabinet is designed to resemble a small garden or pool equipment shed that can easily be placed adjacent to the house, similar to other mechanical systems, or on any other part of the property that drains by gravity to the septic tanks. The BioFilter Cabinet is constructed with water-resistant PVC board, polystyrene foam insulation, and stainless steel vent louvers. All components of the system that contact wastewater are of stainless steel, PVC, or rubber construction for durability. The recirculating trickling filter media is a self-supporting PVC sheet media.
- The LooLoop tank is a 1,500-gallon, two compartment concrete or plastic septic tank. The standard tank is sized with ¾ capacity for the first compartment and ¼ for the second compartment. Compartment capacities may vary but in no instance shall the capacity of the first compartment be less than 2/3 total capacity and the second compartment no more than 1/3 of tank capacity. These criteria are flexible to accommodate local tank suppliers. A LooLoop sales agent will determine site-specific tank selection.
- The LooLoop tank submersible pump is 115V, 60 hertz, single phase, fractional horsepower motor of stainless steel and composite resin materials used in all wetted parts. The pump is expected to operate for at least 60,000 hours or about 9 years. The pump is the only electrically powered component of the LooLoop system.
- The LooLoop system is supplied with a prewired repeat cycle flow controller contained in a NEMA rated enclosure and is accessible through the door on the cabinet. The controller controls the recirculating pump cycle time from 5 minutes per hour of operation to 55 minutes per hour of operation. A LooLoop representative will determine the pump cycle time for the specific installation. The weatherproof controller is equipped with a fail to start detector, a visible alarm, an audible alarm and silencer switch. The controller contains a power switch and time clock that control the recirculating pump operation. The local dealers name, address, and telephone number are displayed on a placard located on the wall of the BioFilter Cabinet beside the controller. A high level switch connected to the alarm circuit is provided to alert the user

of blockages in the disposal system piping between the LooLoop and the leaching system components. The backup alarm is provided for the convenience or the owner and is not integral to the LooLoop system.

- The LooLoop treatment system is capable of treating 500 gallons per day of domestic wastewater from a single-family residence or 250 gallons per day from two single-family residences.

LooLoop System Performance

The performance of the LooLoop system complies with and is listed under NSF/ANSI 40 Class 1 treatment systems and NSF/ANSI 245 for nutrient removal systems. The LooLoop system is certified with a Class 1 rating after successfully completing the 6 month Standard 40 test protocol, with an averaged effluent of < 6 mg/L CBOD and < 7 mg/L TSS and <19 mg/L Total Nitrogen.

Operational Requirements

The LooLoop system is designed to treat only wastewater generated from a typical residence. Typical domestic wastewater streams include those from kitchen sinks, bathroom sinks, utility sinks, mop basins, shower stalls, bathtubs, clothes washers, dishwashers, drinking fountains, wash sinks, toilets, and whirlpool baths. The LooLoop system is designed to handle typical amounts of wastewater from the kitchen, bathroom, or laundry. The use of the detergents, bleach, and drain cleaners as recommended by the manufacturer is acceptable. The following is summary of items that should not be disposed of into the plumbing system:

Septic System Operation	
	Don't Dispose of These Items
Household Waste	Feminine hygiene products, wipes, paper towels, condoms and their wrappers, cotton swabs, cotton balls, and bandages should not be discharged to the septic tank. The real concern with these items is that they can block the house plumbing and cause a backup. Frequent discharges will necessitate more frequent septic tank pump outs.
Kitchen Waste	**Grease and oil** should not be dumped down the drain. The residual grease on eating utensils is OK but a quick wipe with a paper towel is best before washing. Excessive grease disposal will necessitate more frequent septic tank pumping. Tip, after cooking oils have cooled, place them in an empty jar with screw on lid or a premium grade sealable freezer bag and dispose of them with the dry trash. **Garbage grinders** should not be used unless the capacity of the first compartment of the septic tank is increased by a factor of 2 and the first compartment of the septic tank pumped no less than once every 3 years.
Household Maintenance Waste	Flammable solvents, gasoline, kerosene, toxic liquids, paints, pesticides, liquid fertilizers, and any liquid where you are uncertain about the disposal method should not be disposed of in the septic tank. Call your local solid waste management authority for guidance. Cleaning water soluble paint brushes (in moderation) should not impair the operation of the septic tank or LooLoop. The main concern regarding these household wastes in not the effect that they have on the performance of the septic tank or LooLoop. The concern is that these liquids may not be treated by the septic or aerobic process and could be a source of fire or explosion or they could to get into the groundwater via the soil disposal system.
Medical Waste	Liquid antibiotics and other medicines should not be disposed on in the septic tank. The ability of these substances to pass through wastewater treatment systems unaffected by the treatment process is a developing concern.

In addition, all water softener backwash, roofing down spouts, sump pump piping, footer drains, basement and garage floor drains, must not be connected to the domestic wastewater plumbing system.

Electrical Requirements

The LooLoop controller must be wired to a dedicated 115 VAC, single phase, 15 amp circuit with a lockable disconnect switch mounted in the immediate vicinity of the BioFilter Cabinet. The controller wiring diagram is provided in Appendix 1. All electrical work must be completed in accordance with the National Electrical Code and all applicable local codes. A qualified electrician should make all electrical connections, using proper procedures and safety guidelines.

The LooLoop tank submersible pump is 115V, 60 hertz, single phase, fractional horsepower motor of stainless steel and composite resin materials used in all wetted parts. The pump is expected to operate for at least 60,000 hours or about 9 years.

CAUTION: Prior to performing any service or maintenance, first shut off and lock the lockable disconnect switch for the electrical circuit. Next shut off the power switch to the LooLoop controller. Failure to do so could result in serious personal injury or equipment damage.

LooLoop Operating Instructions

Upon completion of the installation of the system components, the LooLoop tank is filled with clean water to allow the operating system to establish a high oxygen concentration in the water to develop the biological process to treat the wastewater. This procedure will minimize the potential for any odors to be present. The startup and maturation of the biological processes can take from 3 weeks to 2 months, depending on the time of the year. Initially, odors, if any, should be confined to immediate vicinity around the BioFilter Cabinet during start up. Once the biological processes have matured, no noticeable odors should be present. Contact a LooLoop representative if a strong septic system odor is present in the vicinity of the BioFilter Cabinet.

In the event that a problem arises with the system or service is required, please contact SOSystems, 181 Admiral Cochrane Blvd Suite 275, Annapolis, MD 21401, phone (703)966-1084. You can also refer to the LooLoop system data plate located conveniently inside the door of the BioFilter Cabinet where the system piping and LooLoop controller are located. A service data plate is also located adjacent to the visible alarm located on the exterior of the BioFilter Cabinet.

During the startup of the LooLoop System, the recirculating pump cycle time will be set using the repeat cycle flow controller. The cycle timer should only be adjusted by a LooLoop representative.

The LooLoop system is designed for minimal and ease of maintenance. The responsibility of the owner for the LooLoop wastewater treatment system is limited to the following:

The septic system tank (Tank 1) and LooLoop tank should be pumped every three years. The BioFilter Cabinet has 16 vents, eight on the upper part of the BioFilter Cabinet (4 vents on each side) and eight on the lower part of the BioFilter Cabinet (4 vents on each side). The vents can be opened or closed from the outside of the BioFilter Cabinet using the toggle attached to the movable closure of each vent. All vents should be open from April 1 through October 31. From November 1 through March 31, one vent on each side of the BioFilter Cabinet (both top and bottom) should be open and the others closed.

Intermittent or extended periods of non-use:

- The LooLoop system performance is robust and not affected by vacations and extended periods of little or no use. The system can continue to operate without damage.
- If the period of non-use is foreseeable, the LooLoop representative should be contacted to adjust the pump cycle time to reduce electricity consumption and pump

wear to a minimum.

- If the period of non-use is expected to be 6 months or more, the system can be turned off without damage to the equipment. Prior to restarting the system after a long period of being off, contact a LooLoop representative to restore power to the system and the reset the controller one week prior to initiating use of the wastewater system.
- Should the house be vacated for 5 or more days, the alarm can be silenced to avoid annoying neighbors if the alarm were to sound during your absence.

Power Outage:

- If a power outage occurs at the house, the only thing that will happen is the pump in the LooLoop tank will not pump the wastewater to the BioFilter Cabinet. Instead, any wastewater that flows from the house will displace effluent in the septic tanks to the drain field - operating as a standard septic system until power is restored. There is no chance for back-ups or overflows.

Alarm:

- Should an alarm occur, signaling the pump is not operational, silence the alarm using the silencing switch on the alarm box located on the exterior of the BioFilter Cabinet and notify the LooLoop representative.
- Similar to the conditions of a power outage, the only thing that will happen is the pump in the LooLoop tank will not pump the wastewater to the BioFilter Cabinet. Instead, any wastewater that flows from the house will displace effluent in the septic tanks to the drain field - operating as a standard septic system until power is restored. There is no chance for back-ups or overflows.
- If the alarm were to sound in the middle of the night or on a holiday or weekend, do not worry. An alarm condition is not an emergency. The LooLoop representative can be contacted on the next business day.

Maintain the plumbing and septic system:

- Be aware of the do’s and don’ts regarding the home septic system.
- Have the septic tank and LooLoop tank pumped every 3 years.
- Repair plumbing leaks promptly. Unless the leak is large, most leaks will not affect the LooLoop system; however, the leak may overload the drain field system. Note, the most expensive component of the home wastewater septic system is the drain field system.

Routine Cleaning and Maintenance

The LooLoop system is designed for minimal and ease of maintenance - four inspection/service visits are required during the first two years and annual visits after that. Completion of the required inspection/service visits are required to maintain the LooLoop system warranty. See Table 1 and Table 2 for maintenance schedule summary.

Table 1: LooLoop System Maintenance Schedule Years One and Two

LooLoop System Component	Maintenance Frequency
Spray Piping and Nozzle	Semi-annual inspection and cleaning
Pump/Controller/Alarms	Inspect Semi-annually
BioFilter Cabinet	Inspect Semi-annually
Trickling Filter Media	Inspect Semi-annually
Existing Septic Tank (Tank 1)	Inspect Semi-annually
LooLoop Tank (Tank 2)	Inspect Semi-annually

Table 2. LooLoop Maintenance Schedule Year Three and Beyond

LooLoop System Component	Maintenance Frequency
Spray Piping and Nozzle	Annual cleaning
Pump/Controller/Alarms	Inspect Annually
BioFilter Cabinet	Inspect Annually
Trickling Filter Media	Inspect Annually
Existing Septic Tank (Tank 1)	Inspect Annually and Pump every 3 years
LooLoop Tank (Tank 2)	Pump every 3 years

Trouble Shooting and Repair: LooLoop Treatment System

This trouble shooting and repair section is written to help you identify the cause of system problems that may occur at times. Whenever a problem is identified, it is important to take steps to eliminate the cause. Note that all areas of installation, including those typically the responsibility of the contractor, excavator, electrician, plumber, and owner are covered. It is possible that many problems have root causes other than the system or its components.

The trouble shooting guide provides efficient solutions to most wastewater treatment problems when used with the recommended inspection and service procedures performed by a LooLoop representative.

LooLoop System Operational Trouble Shooting

Problem	Possible Cause	Potential Solutions
Mud or Silt in the System	Influent sewer line separated at a joint or fitting	Have contractor excavate and repair
	Sewer line crushed	Have contractor excavate and replace
Septic Odor	Incomplete treatment due to hydraulic overloading	See “Hydralulic Overloading”
	Insufficient flow from pump to BioFilter Cabinet	- Clean spray nozzle - Open all valves - Clear pump intake - Restore pump operation
Hydraulic Overloading	Ground water entering system	- Install curtain drain to lower water table - Install new water tight septic tank - Repair defective valves in building - Disconnect sump pump from sewer line - Raise or regrade around tank risers to shed water - Disconnect roof leaders, footing drains, garage drain, basement floor drain, yard drains from septic system

Problem	Possible Cause	Potential Solutions
Controller Pump Alarm Activated	Pump fails to start	- Check pump wire connections - Replace pump
	Pump motor failure	Replace pump
	High water level in LooLoop tank	Blockage in leaching system
No Electrical Power from Electrical Disconnect to Controller	Circuit breaker tripped	Turn breaker to “off” position, then turn “on”
	Defective circuit breaker	Replace circuit breaker
	Power connection from disconnect to controller severed	Locate break and repair
No Electrical Power from Controller to Pump	Loose wiring connection	- Check all connections - Pump plug not inserted in controller receptacle properly

-

RecoSept Service Program

The SOSystems contact information, address and phone number, is conveniently located inside the door of the BioFilter Cabinet.
Included with your purchase of a LooLoop system is a 5-year operations and maintenance contract that includes four inspection/service visits during the first two years by a certified LooLoop service provider to test and verify system performance, and annual visits for the next three years. Verification of system performance will include evaluation of effluent quality including color, turbidity, scum overflow, and odor. A copy of the Field Inspection and Service Form will be provided to the owner, including any system operation issues that cannot be remedied at the time of inspection.

An extended service policy for annual inspection/service visits is available for purchase by the owner through SOSystems.

Service and Maintenance Agreement

The following represents an example of a LooLoop O&M Agreement

Agreement for Operating and Maintenance (O&M) Services for a LooLoop Wastewater

Treatment System is made on ________________(date) between

__________________________________(name) and **SOSystems Inc.** for the dureation of

this contract beginning ________________(date), and concluding

________________(date)(5 years). SOSystems shall operate and maintain the

wastewater treatment systems installed at ________________________________(site).

---

1. Service Provider agrees to submit biannually, in years one and two, and annually, in years three through five, to the Owner, a report including an operation and maintenance summary and analysis of effluent quality sampling (color, turbidity, scum overflow, and color), as required.

2. Service Provider shall perform on a regularly scheduled biannual service inspection (years 1 and 2) and annually (years 3 through 5) including the following procedures:

   A. Observe the general condition of the area over the LooLoop components to identify potential under- ground leaks.
   B. Open all manways and observe the condition of the contents for unusual conditions.
   C. Open the cover of the BioFilter Cabinet to assess the condition of the filter media, the uniformity of the spray, and to remove and clean the spray nozzle.
   D. Check all valves for proper operation
   E. Connect a hose to the faucet on the feed pipe and flush the media.
   F. Collect a sample of the treated wastewater for analysis.
   G. Samples shall be analyzed for the following:

      a. COD
      b. TSS
      c. Total Nitrogen (TN)
      d. Color
      e. Turbidity
      f. Scum overflow
      g. Odor

LooLoop System Limited Warranty

All components of the LooLoop system are warranted to be free from defects in material and workmanship, under normal use and service, for two years from the date of installation. The two year limited warranty is included in the original purchase price of every LooLoop system.

Warranty Registration

Complete the Warranty Registration card and return to SOSystems within thirty days of the installation date for the warranty to be effective from the installation date. The serial number is located on the data plate conveniently inside the door of the BioFilter Cabinet where the system piping and LooLoop controller are located.

LooLoop Warranty Registration

First Name: ______________________ Last Name: ______________________

Street Address: _______________________ Address 2: _____________________

City: _____________________ State: _______ Zip Code: _________________

Phone Number: _____________________ Email: ___________________________

Serial No.:__________________

APPENDIX

APPENDIX