



Florida Onsite Sewage Nitrogen Reduction Strategies Study

Task B.7

B-HS5 Field System Monitoring Report No. 8

Progress Report

December 2014

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Environmental Engineers & Scientists

In association with:



AET
Applied Environmental Technology

**Otis Environmental
Consultants, LLC**

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TASK B.7 PROGRESS REPORT

B-HS5 Field System Monitoring Report No. 8

Prepared for:

Florida Department of Health
Division of Disease Control and Health Protection
Bureau of Environmental Health
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1.0 Background

Task B of the Florida Onsite Sewage Nitrogen Reduction Strategies Study (FOSNRS) includes performing field experiments to critically evaluate the performance of nitrogen removal technologies that were identified in FOSNRS Task A.9 and pilot tested in Task A.26. To meet this objective, full scale treatment systems are being installed at various residential sites in Florida and monitored over an extended timeframe under actual onsite conditions. The Task B Quality Assurance Project Plan (Task B.5) documents the objectives, monitoring framework, sample frequency and duration, and analytical methods to be used at the home sites. This report documents the eighth and final sample event of the passive nitrogen reduction system at home site B-HS5 in Seminole County, Florida.

2.0 Purpose

Operation of the B-HS5 system was initiated on July 9, 2013. This monitoring report documents data collected from the eighth B-HS5 monitoring and sampling event conducted on December 15, 2014 (Experimental Day 524). This monitoring event consisted of collecting flow measurements from the household water use meter, treatment system flow meters, recording electricity use, monitoring of field parameters, collection of water samples from nine points in the treatment system, and chemical analyses of water samples by a NELAC certified laboratory.

3.0 Materials and Methods

3.1 Project Site

The B-HS5 field site is located in Seminole County, FL. The nitrogen reducing onsite treatment system for the single family residence was installed in June 2013. Design and construction details were presented previously in the Task B.6 document. Figure 1 is a system schematic showing the system components and layout of the installation. A flow schematic of the system is shown in Figure 2. The passive nitrogen reduction system (PNRS) consists of three process tanks that were added to the existing permitted

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onsite system: a 1500 gallon plastic tank housing a Stage 1 unsaturated media filter; a 300 gallon concrete pump tank; and a 1,500 gallon two chamber concrete tank housing a Stage 2 saturated media biofilter. The existing 1,350 gallon concrete septic tank continues to provide primary treatment prior to the PNRS system. Based on measured average wastewater flow and tank volumes, there is over a ten day transit time through the treatment system prior to dispersal. The denitrified treated effluent is discharged into the soil via the existing drainfield which is a standard bed.

3.2 PNRS System Modification

The PNRS system was designed with two operational modes for Stage 1: single pass and recirculation. In single pass mode, 100 percent of the Stage 1 effluent was discharged to the Stage 2 biofilter. In recirculation mode the pump tank discharge is split via two throttling gate valves to provide for recycling of a portion of the Stage 1 biofilter effluent to Stage 1 influent, with the balance of Stage 1 effluent proceeding to the Stage 2 biofilter.

The Stage 1 biofilter was operated in single pass mode since system startup, but was switched to recirculation mode on April 25, 2014 (Experimental Day 290) following the fourth sample event. In recirculation mode, a portion (3:1 target ratio) of the Stage 1 effluent was recirculated to the top of the Stage 1 biofilter and dispersed via five spray nozzles. The recirculated, nitrified effluent would have an opportunity to mix with incoming septic tank effluent discharged by the distribution box. In recirculation mode, the Stage 1 biofilter received both forward wastewater flow and recirculated Stage 1 effluent, and overall hydraulic loading on the Stage 1 biofilter is increased.

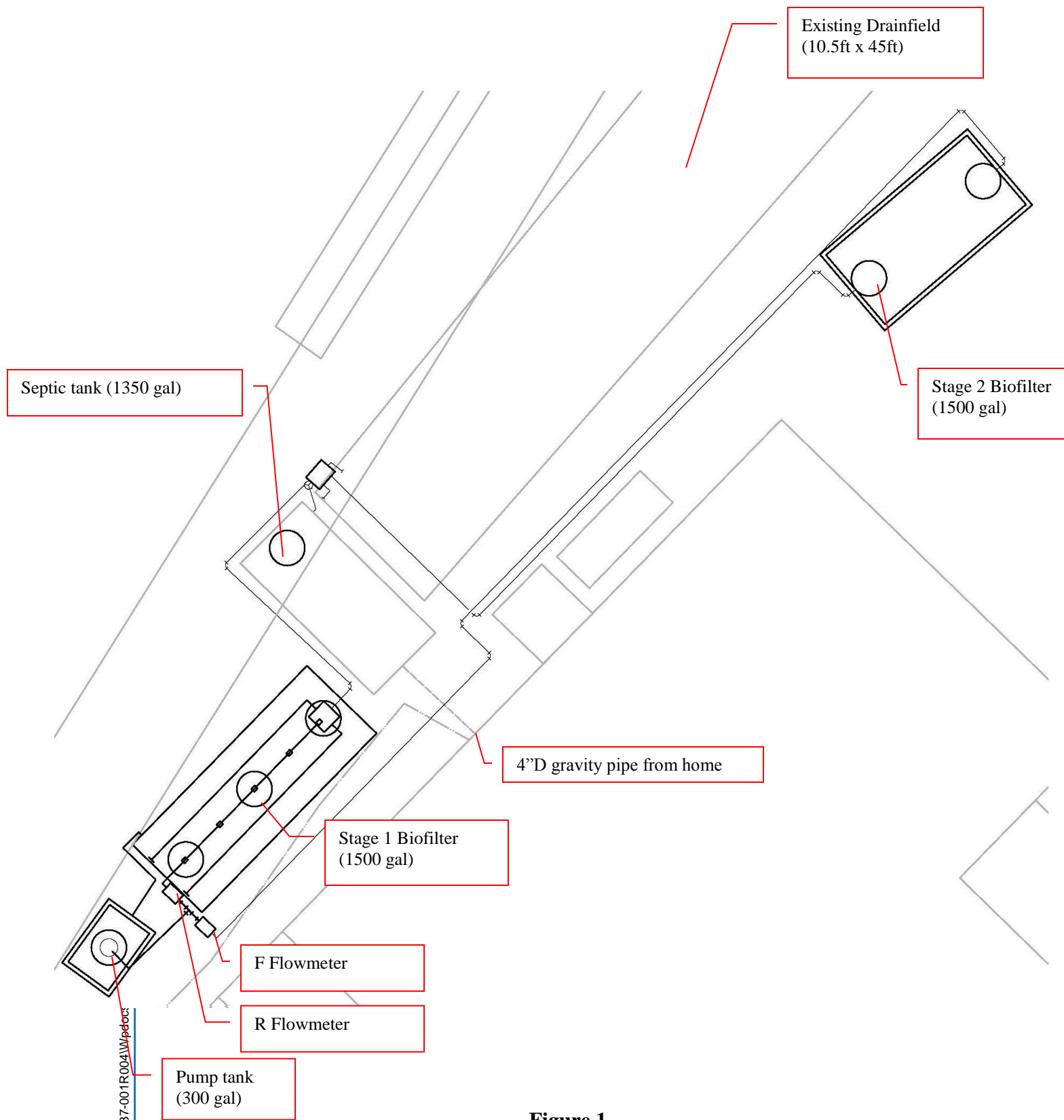


Figure 1
Plan View of B-HS5 System Layout

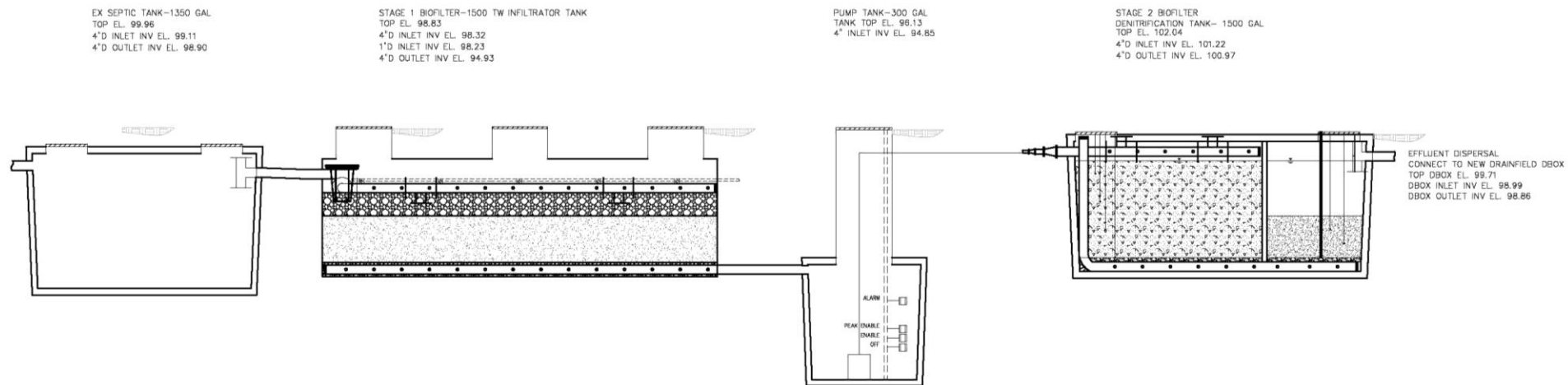


Figure 2
Flow Schematic of B-HS5 PNRS

3.3 Monitoring and Sample Locations and Identification

This monitoring event included sample collection from nine points within the treatment system (Figure 3). Household wastewater enters the primary tank and exits as septic tank effluent (STE) through an effluent filter screen into the Stage 1 biofilter. The first monitoring point, B-HS5-STE, is the STE sampled approximately 1.5 feet below the surface of the primary tank prior to the effluent filter (Figure 4). Samples from monitoring point B-HS5-STE are representative of the whole household wastewater and represent the influent to the passive nitrogen reduction system.

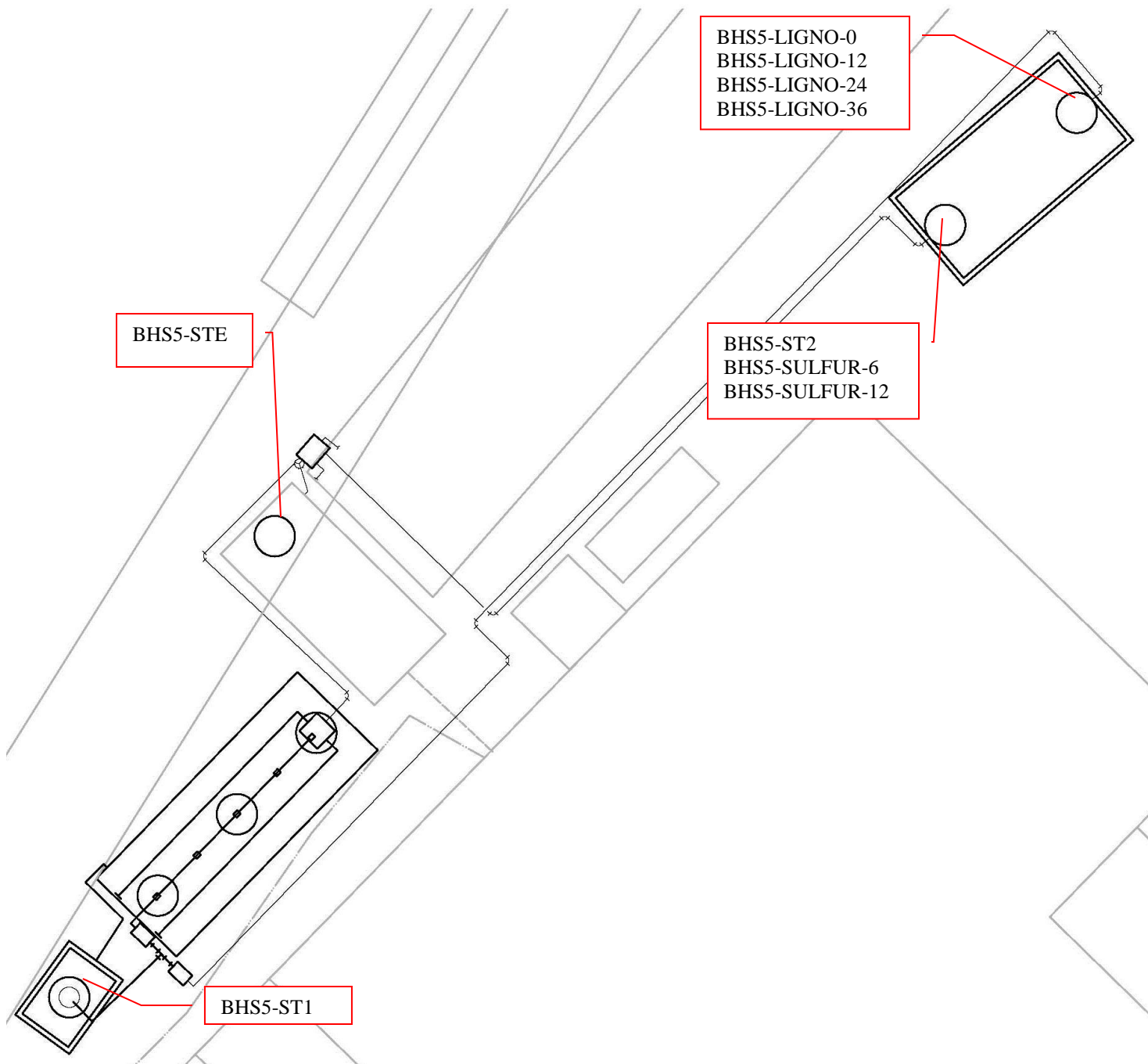


Figure 3
B-HS5 Sample and Monitoring Locations

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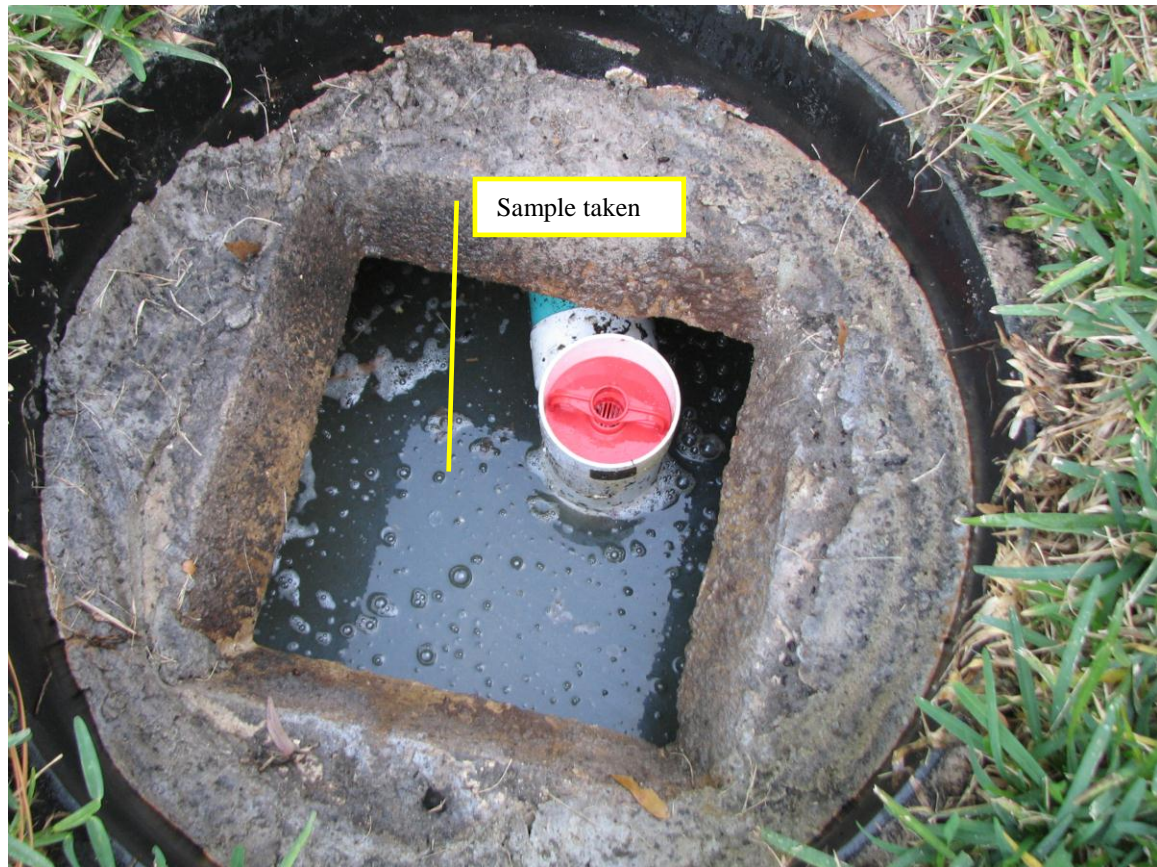


Figure 4
Primary Tank (B-HS5-STE sample)

The primary tank contents are discharged by gravity to a distribution box, located inside the Stage 1 biofilter, which splits the flow between three perforated distribution pipes that run along the top of the unsaturated Stage 1 biofilter media. In the Stage 1 biofilter, wastewater percolates downward through the unsaturated expanded clay media where nitrification occurs. The Stage 1 biofilter contains 12.8 inches of coarse expanded clay media (Riverlite™ 1/4; 1.1 to 4.8 mm) above 21 inches of finer expanded clay media (Riverlite™ 3/16; 0.6 to 2.4 mm). Stage 1 biofilter effluent flows into the pump tank by gravity. The second sampling point (B-HS5-ST1), is sampled approximately 1.5 feet below the surface of the pump tank representing the Stage 1 biofilter effluent (Figure 5).

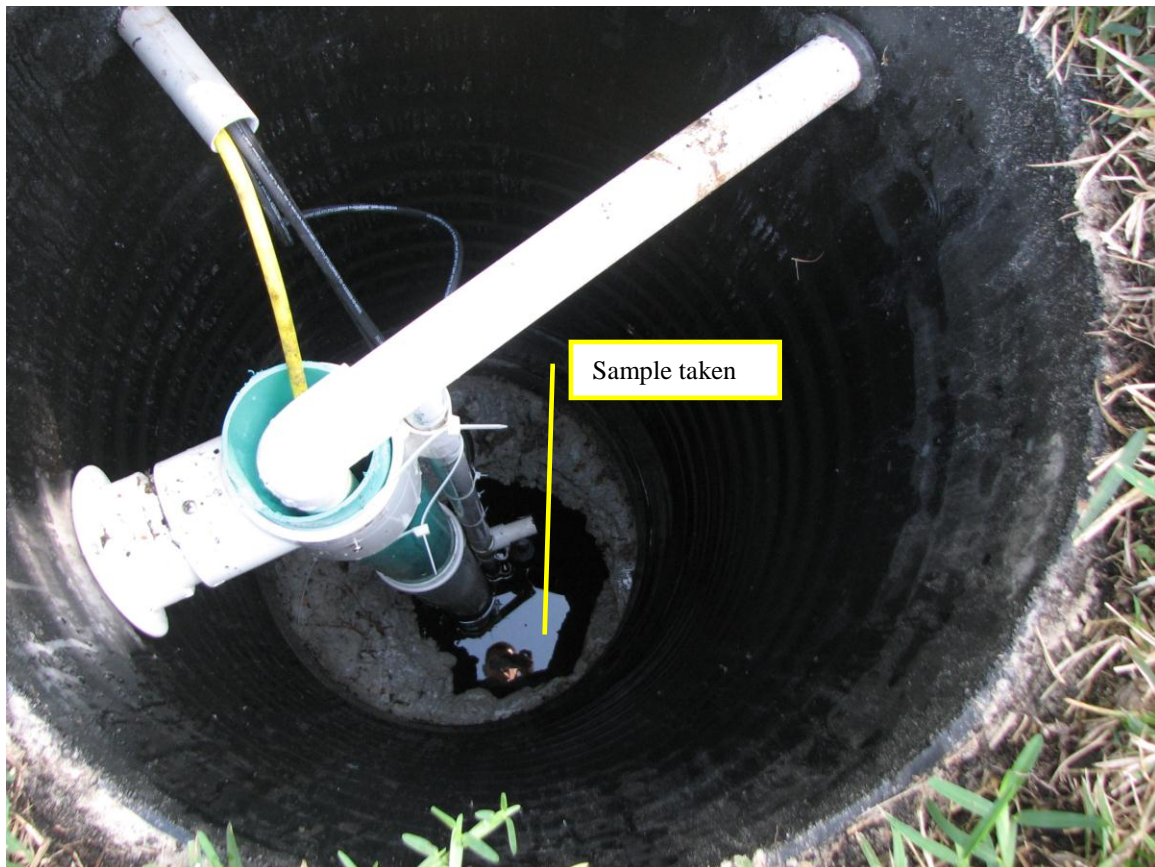


Figure 5
Stage 1 Effluent in Pump Tank (B-HS5-ST1 sample)

The pump tank discharge is split via two throttling gate valves which allow for optional recycling of a portion of the Stage 1 biofilter effluent with the balance proceeding to the Stage 2 biofilter. As described previously, the system was designed with two operational modes. In the first mode, 100 percent of the Stage 1 effluent is discharged to the Stage 2 biofilter. Initial operation of B-HS5 was in the non-recirculation mode, which was in effect from system start-up through Experimental Day 290. The system was switched thereafter to the second operating mode in which a portion of Stage 1 effluent is recirculated to the top of the Stage 1 biofilter and dispersed via five spray nozzles. The recirculated, nitrified effluent has an opportunity to mix with incoming septic tank effluent discharged by the distribution box. Recirculation back to the Stage 1 biofilter increases the overall hydraulic loading on the Stage 1 biofilter.

Effluent from the unsaturated (Stage 1) media tank enters the denitrification (Stage 2) biofilter at the top of the media in the first chamber (lignocellulosic media), flows downward through the media, moves laterally through the baffle wall to the bottom of the

second chamber, and upward through the media in the second chamber (elemental sulfur and oyster shell).

The first chamber of the Stage 2 biofilter contains 42-inches of lignocellulosic media as a supplemental carbon source for denitrification, a blended urban waste wood from Mother's Organics, Inc., Thonotosassa, FL. Stainless steel samplers are positioned at 12-inch increments for vertical profiling throughout the lignocellulosic media. The third primary sampling point is a stainless steel sampler positioned at the bottom of the lignocellulosic media (B-HS5-LIGNO-0) with tubing to the surface. Twelve inches above B-HS5-LIGNO-0 is another stainless steel drivepoint sampler B-HS5-LIGNO-12, and so forth (B-HS5-LIGNO-24 and B-HS5-LIGNO-36). The B-HS5-LIGNO-0 sample represents the lignocellulosic media effluent (Figure 6).

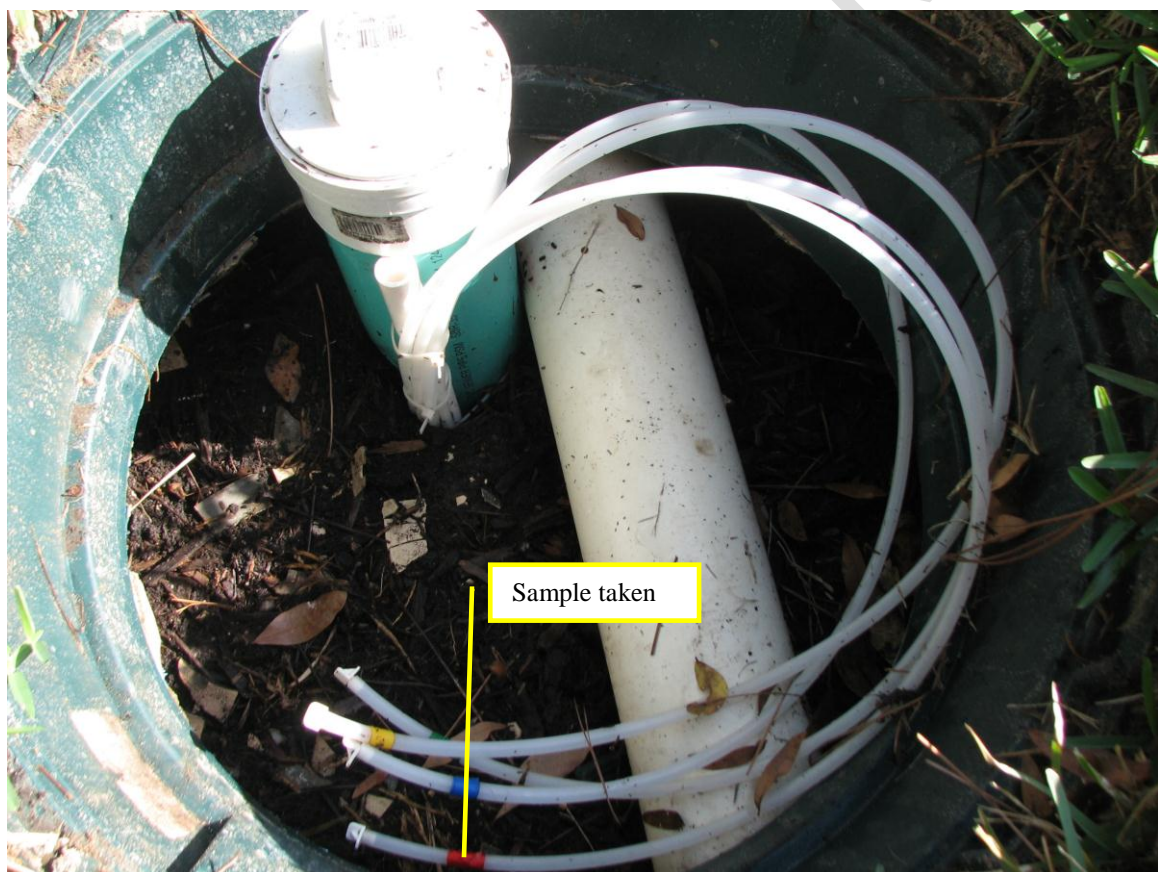


Figure 6
First chamber of Stage 2 biofilter (B-HS5-LIGNO-0" sample)

A collection pipe along the bottom transfers the first chamber (lignocellulosic media) effluent to the second chamber, which contains 18-inches of elemental sulfur mixed with oyster shell media. Similar to the lignocellulosic media chamber, stainless steel drivepoint samplers are positioned to create a vertical profile. B-HS5-SULFUR-6 and B-HS5-SULFUR-12 are positioned 6-inches and 12-inches, respectively, above the bottom of the sulfur media. The fourth primary sampling point, B-HS5-ST2, is the second chamber of the Stage 2 biofilter effluent which is sampled approximately 1 foot below the surface of the effluent baffle tee. This sample location is after passage through the sulfur media; it is the final effluent from the treatment system prior to being discharged to the soil infiltration system, or drainfield (Figure 7).



Figure 7
Second chamber of Stage 2 biofilter (B-HS5-ST2 sample)

3.4 Operational Monitoring

Start-up of the system occurred on July 9, 2013 (Experimental Day 0). The PNRS system has operated continually since that date. For this eighth formal sampling event, the water meter for the house and treatment system flow meters were read and recorded on December 15, 2014. The household water meter is located on the potable water line from the onsite well prior to entering the household plumbing. The water meter does not include the irrigation water use. Therefore, the water meter reading should be indicative of the wastewater flow to the system.

As previously discussed in Section 3.2, the pump tank discharge is split via two throttling gate valves which allow for a portion of the Stage 1 biofilter effluent to be sent back to the Stage 1 biofilter spray nozzles (for recirculation) with the rest proceeding to the Stage 2 biofilter. The treatment system flow meters (Figure 1) are located on the pump tank discharge lines following the flow split, and record the cumulative flow in gallons pumped from the pump chamber to the Stage 1 biofilter (R flowmeter) and Stage 2 biofilter (F flowmeter).

3.5 Energy Consumption

Energy consumption was monitored using an electrical meter installed between the main power box for the house and the control panel. The electrical meter records the cumulative power usage of the system in kilowatt-hours. The power usage of the system is primarily due to the single lift station pump installed within the pump tank, although a small amount of power is used by the control panel itself. There are no chemicals added to the system. However, the Stage 2 biofilter media (lignocellulosic and sulfur) are “reactive” media which will be consumed during operation. The Stage 2 biofilter was initially filled with 42 inches of lignocellulosic media and 18 inches of sulfur and oyster shell mixture media, which ostensibly will last for many years without replenishment or replacement.

3.6 Water Quality Sample Collection and Analyses

The eighth formal sample event was conducted on December 15, 2014 (Experimental Day 524). A full suite of influent, intermediate and effluent water quality samples were collected from the system for water quality analysis. Samples were collected at each of the nine monitoring points described in Section 3.3: B-HS5-STE, B-HS5-ST1, B-HS5-LIGNO-0, BHS5-LIGNO-12, BHS5-LIGNO-24, BHS5-LIGNO-36, BHS5-SULFUR-6, BHS5-SULFUR-12 and B-HS5-ST2. A peristaltic pump was used to collect samples and route them directly into analysis-specific containers after sufficient flushing of the tubing had occurred. Field parameters were then recorded.

A field sample duplicate was taken of B-HS5-ST1 which was collected immediately subsequent to the regular samples.

A field blank (FB), equipment blank (EB) and field duplicate sample were taken. The field blank was collected by filling sample containers with deionized water that had been transported into the field along with other sample containers. In addition, an equipment blank (B-HS7-EB) sample was taken by pumping deionized water through the cleaned pump tubing. Lastly, the field sample duplicate (B-HS4-ST1) was collected immediately subsequent to the regular samples. These samples were then analyzed for the same parameters as the monitoring samples.

The analysis-specific containers were supplied by the analytical laboratory and contained appropriate preservatives. The analysis-specific containers were labeled, placed in coolers and transported on ice to the analytical laboratories. Each sample container was secured in packing material as appropriate to prevent damage and spills, and was recorded on chain-of-custody forms supplied by the laboratory. Chain of custody forms, provided in Appendix A, were used to document the transfer of samples from field personnel to the analytical laboratory.

Field parameters were measured using portable electronic probes and included temperature (Temp), dissolved oxygen (DO), oxidation-reduction potential (ORP), pH, and specific conductance. The field parameters were measured by placing the analytical probes in a container overflowing with sample water. The influent, intermediate, and effluent primary monitoring samples were analyzed by the laboratory for: Carbonaceous Biological Oxygen Demand (CBOD₅), chemical oxygen demand (COD), total Kjeldahl nitrogen (TKN), ammonia nitrogen (NH₃-N), nitrate nitrogen (NO₃-N), nitrite nitrogen (NO₂-N), total phosphorus (TP), sulfate, sulfide, hydrogen sulfide (unionized), total suspended solids (TSS), total organic carbon (TOC), fecal coliform (fecal), and E.coli. The Stage 2 intermediate drivepoint samples were analyzed for: Carbonaceous Biological Oxygen Demand (CBOD₅), total Kjeldahl nitrogen (TKN), ammonia nitrogen (NH₃-N), nitrate nitrogen (NO₃-N), nitrite nitrogen (NO₂-N), and sulfate. All analyses were performed by an independent and fully NELAC certified analytical laboratory (Southern Analytical Laboratory). Table 1 lists the analytical parameters, analytical methods, and detection limits for laboratory analyses.

Table 1
Analytical Parameters, Method of Analysis, and Detection Limits

Analytical Parameter	Method of Analysis	Method Detection Limit (mg/L)
Chemical Oxygen Demand (COD)	EPA 410.4	10 mg/L
Total Kjeldahl Nitrogen (TKN-N)	EPA 351.2	0.05 mg/L
Ammonia Nitrogen (NH ₃ -N)	EPA 350.1	0.005 mg/L
Nitrate Nitrogen (NO ₃ -N)	EPA 300.0	0.01 mg/L
Nitrite Nitrogen (NO ₂ -N)	SM 4500NO2-B	0.01 mg/L
Nitrate+Nitrite Nitrogen (NOX-N)	EPA 353.2	0.02 mg/L
Total Phosphorus (TP)	SM 4500P-E	0.01 mg/L
Orthophosphate as P (Ortho P)	EPA 300.0	0.01 mg/L
Carbonaceous Biological Oxygen Demand (CBOD ₅)	SM5210B	2 mg/L
Total Suspended Solids (TSS)	SM 2540D	1 mg/L
Total Organic Carbon (TOC)	SM 5310B	0.06 mg/L
Sulfate	EPA 300.0	2.0 mg/L
Sulfide	SM 4500SF	0.10 mg/L
Hydrogen Sulfide (unionized)	SM 4550SF	0.01 mg/L
Fecal Coliform (fecal)	SM 9222D	1 ct/100mL
E.coli	SM 9223B	2 ct/100mL

4.0 Results and Discussion

4.1 Operational Monitoring

Table 2 provides a summary of the household water use since the water meter installation on February 12, 2013. The treatment system flow meter readings for the B-HS5 field site are summarized in Table 3. The operation and maintenance log which includes actions taken since start-up is provided in Appendix B. Summary tables of the Vericomm PLC recorded data are provided in Appendix C, Table C.1 and Table C.2. These include daily and cumulative pump runtime and system alarms that are used to check general pump operation and performance. From PNRS start-up through October 21, 2014, the average household water use was 132.3 gallons per day with periods of higher and lower flows (Table 2).

Table 2
Summary of Household Water Use Flowmeter

Date and Time Read	Cumulative Volume (gallons)	Average Daily Household Flow between readings, Q (gpd)	Average Daily Household Flow Since start-up, Q (gpd)
2/12/2013 10:30	166.0	INSTALLED	INSTALLED
2/21/2013 10:45	1,130.3	107.0	107.0
2/28/2013 11:45	2,323.9	169.5	134.4
3/7/2013 10:25	2,832.1	73.2	115.9
6/14/2013 13:00	13,460.9	107.2	108.9
6/25/2013 8:53	14,860.1	129.2	110.5
7/9/2013 15:20	PNRS start-up		
7/23/2013 8:31	17,659.4	100.0	
7/29/2013 11:10	18,769.2	181.6	181.6
8/15/2013 12:28	21,078.4	135.4	147.6
8/27/2013 9:15	22,427.8	113.7	136.1
9/27/2013 10:40	25,738.3	106.6	122.2
11/8/2013 10:30	31,992.8	148.9	132.6
11/27/2013 11:12	34,400.8	126.5	131.7
12/4/2013 14:34	35,292.8	124.9	131.3
12/23/2013 12:38	37,649.1	124.5	130.5
1/23/2014 10:00	42,526.6	157.9	135.1
1/31/2014 13:00	43,688.6	143.0	135.4
2/3/2014 8:40	43,688.6	0.0	133.5
2/4/2014 11:45	43,841.1	135.1	133.5
2/5/2014 9:45	43,928.5	95.3	133.3
2/6/2014 8:20	44,029.1	106.9	133.2
2/7/2014 10:30	44,175.2	134.0	133.2
2/12/2014 11:00	44,987.4	161.8	133.9
3/14/2014 9:50	48,684.9	123.5	132.6
4/11/2014 9:00	52,272.6	128.3	132.1
4/25/2014 10:05	54,087.0	128.9	131.9
4/29/2014 11:45	54,618.0	131.5	131.9
5/28/2014 10:00	59,552.4	170.6	135.5
6/11/2014 9:45	65,290.1	410.1	147.4
8/18/2014 11:00	69,750.1	65.5	133.2
9/19/2014 9:00	73,358.2	113.0	131.7
10/21/2014 12:21	77,223.0	120.3	130.9
11/21/2014 9:45	81,164.2	127.6	130.7
12/15/2014 12:22	85,132.8	164.6	132.3

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Table 3
Summary of Treatment System Flowmeters

Date	Recirculation Pumped Flow, R Water Meter Reading	Recirculation Pumped Flow, R Water Meter Reading	Average Recirc Ratio	Stage 2 Biofilter Pumped Flow, Q Water Meter Reading	Average Daily Stage 2, Q between readings
	Cumulative Volume (gal)	Gallons/Day	R:Q	Cumulative Volume (gal)	Gallons/Day
7/5/2013 12:00	286.1	0.0	0.0		Installed
7/9/2013 15:20	286.1	0.0	0.0	167.5	Start-up
7/12/2013 14:13	286.1	0.0	0.0	207.4	13.5
7/17/2013 9:02	286.1	0.0	0.0	995.6	164.8
7/23/2013 8:31	286.1	0.0	0.0	1,642.9	108.3
7/29/2013 11:10	286.1	0.0	0.0	2,733.4	178.5
8/6/2013 8:51	286.1	0.0	0.0	3,894.7	146.9
8/15/2013 11:40	286.1	0.0	0.0	4,884.6	108.6
8/27/2013 9:15	286.1	0.0	0.0	6,135.4	105.1
9/27/2013 10:40	286.1	0.0	0.0	9,035.2	93.4
11/8/2013 10:30	286.1	0.0	0.0	14,347.7	126.5
11/27/2013 10:55	286.1	0.0	0.0	16,591.6	118.0
12/4/2013 13:45	286.1	0.0	0.0	17,474.0	124.0
12/23/2013 12:38	286.1	0.0	0.0	19,610.1	112.7
1/23/2014 10:00	286.1	0.0	0.0	24,359.1	153.7
1/31/2014 13:00	286.1	0.0	0.0	25,506.3	141.2
2/3/2014 8:40	286.1	0.0	0.0	25,551.0	15.9
2/4/2014 11:45	286.1	0.0	0.0	25,659.1	95.7
2/5/2014 9:45	286.1	0.0	0.0	25,737.2	85.3
2/6/2014 8:20	286.1	0.0	0.0	25,836.3	105.3
2/7/2014 10:30	286.1	0.0	0.0	25,952.1	106.2
2/12/2014 11:00	286.1	0.0	0.0	26,756.2	160.2
3/14/2014 9:50	286.1	0.0	0.0	30,148.2	113.3
4/11/2014 9:00	286.1	0.0	0.0	33,578.8	122.7
4/25/2014 10:50	286.1	0.0	0.0	35,326.6	124.2
Total average start-up to 4/25/14		0.0	0.0		121.3
Switched to recirculation mode of operation: Stage 1 sprayers					
4/25/2014 12:00	314.1	0.0		35,355.0	
4/29/2014 13:00	1,626.0	324.6	3.2:1	35,768.8	102.4
5/28/2014 10:22	13,966.4	427.1	3.4:1	39,443.6	127.2
7/11/2014 9:45	30,112.5	367.2	3.2:1	44,416.3	113.1
8/18/2014 11:00	43,938.8	363.4	3.2:1	48,763.1	114.2
9/19/2014 9:00	56,562.2	395.5	3.1:1	52,793.5	126.3

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Table 3 (con't)
Summary of Treatment System Flowmeters

Date	Recirculation Pumped Flow, R Water Meter Reading	Recirculation Pumped Flow, R Water Meter Reading	Average Recirc Ratio	Stage 2 Biofilter Pumped Flow, Q Water Meter Reading	Average Daily Stage 2, Q between readings
	Cumulative Volume (gal)	Gallons/Day	R:Q	Cumulative Volume (gal)	Gallons/Day
10/21/2014 12:20	69,070.3	389.2	3.0:1	56,912.7	128.2
11/21/2014 9:45	79,362.6	333.2	3.1:1	60,198.4	106.4
12/15/2014 12:22	92,433.8	542.2	3.2:1	64,303.6	170.3
Total average 4/25/2014 to 12/15/14		393.6	3.2:1		123.7

The two throttling gate valves control the fraction of Stage 1 effluent that is recirculated and the fraction sent to the Stage 2 biofilter. As previously discussed, the recirculation mode of operation was modified following the fourth sample event. The gate valves were set so that 3 parts went back to the Stage 1 sprayers and 1 part went to the Stage 2 tank (3:1 recycle ratio). The average recirculated pumped flow (to the Stage 1 biofilter), following the modification to the recirculation mode of operation, was 393.6 gallons per day, and the average forward flow to the Stage 2 biofilter was 123.7 gallons per day. Following the switch to the recirculation mode of operation, the average recirculation ratio was 3.2:1 (Table 3).

4.2 Energy Consumption

Energy consumption was monitored using an electrical meter installed between the main power box for the house and the control panel to record cumulative power usage of the pump in kilowatt-hours. The recorded electrical use for the system is summarized in Table 4.

Table 4
Summary of System Electrical Use

Date and Time Read	Electrical Meter Reading	Average Daily Electrical Use between readings	Average Electrical Use per Gallon Treated	Average Electrical Use Per 1,000 Gallons Treated
	Cumulative (kWh)	(kWh/day)	(kWh/gal)	(kWh/1000 gal)
7/5/2013 12:00		Installed		
7/9/2013 15:20	0.3	Start-up		
7/12/2013 14:13	0.4	0.03	0.0025	2.5063
7/17/2013 9:02	0.6	0.04	0.0003	0.2537
7/23/2013 8:32	0.8	0.03	0.0003	0.3089
7/29/2013 11:10	1.2	0.07	0.0004	0.3669
8/6/2013 8:51	1.5	0.04	0.0003	0.2583
8/15/2013 11:40	1.8	0.03	0.0003	0.3030
8/27/2013 9:15	2.2	0.03	0.0003	0.3198
9/27/2013 10:40	3.1	0.03	0.0003	0.3104
11/8/2013 10:30	4.8	0.04	0.0003	0.3200
11/27/2013 10:55	5.5	0.04	0.0003	0.3119
12/4/2013 13:45	5.8	0.04	0.0003	0.3400
12/23/2013 12:38	6.5	0.04	0.0003	0.3277
1/23/2014 10:00	8.0	0.05	0.0003	0.3159
1/31/2014 13:00	8.4	0.05	0.0003	0.3487
2/3/2014 8:40	8.4	0.00	0.0000	0.0000
2/12/2014 11:00	8.8	0.04	0.0002	0.2487
3/14/2014 9:50	9.9	0.04	0.0003	0.3243
4/11/2014 9:00	11.0	0.04	0.0003	0.3206
4/25/2014 10:50	11.6	0.04	0.0003	0.3433
Total average start-up to 4/25/14		0.04	0.0003	0.3214
Switched to recirculation mode of operation: Stage 1 sprayers				
4/25/2014 12:00	11.6			
4/29/2014 13:00	12.1	0.12	0.0012	1.2083
5/28/2014 10:22	16.5	0.15	0.0012	1.1973
7/11/2014 9:45	22.1	0.13	0.0011	1.1261
8/18/2014 11:00	27.1	0.13	0.0012	1.1503
9/19/2014 9:00	31.6	0.14	0.0011	1.1165
10/21/2014 12:20	36.2	0.14	0.0011	1.1167
11/21/2014 9:45	39.9	0.12	0.0011	1.1261
12/15/2014 12:22	44.5	0.19	0.0011	1.1205
Total average 4/25/14 to 12/15/14		0.14	0.0011	1.1365

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The total average electrical use prior to switching to the recirculation mode of operation (through April 25, 2014) was 0.04 kWh per day, corresponding to an average electrical use of 0.3214 kWh per 1,000 gallons treated. Following the switch from single pass to recirculation mode, the average electrical use increased, as expected. Average electrical use after switching to the recirculation mode of operation was 0.14 kWh per day, corresponding to an average electrical use of 1.1365 kWh per 1,000 gallons treated.

4.3 Water Quality

Water quality analytical results for Sample Event No. 8 are listed in Table 5. Key results are graphically displayed in Figure 8. A summary of the water quality data collected to date for the test system is presented in Table 6. The laboratory report containing the raw analytical data is included in Appendix A. The following discussion summarizes the water quality analytical results. The performance of the various system components was compared by considering the changes through treatment of nitrogen species (TKN, $\text{NH}_3\text{-N}$, and $\text{NO}_x\text{-N}$), as well as supporting water quality parameters.

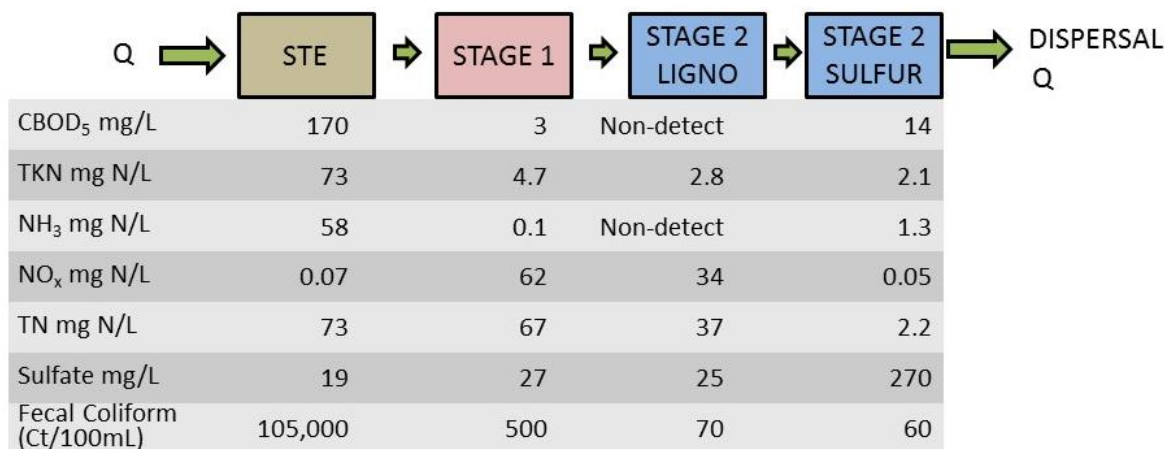


Figure 8
Graphical Representation of Nitrogen Results
Sample Event No. 8, December 15, 2014 (Experimental Day 524)

Septic Tank Effluent (STE) Quality: The water quality characteristics of STE collected in Sample Event 8 were within the typical range generally expected for domestic STE. The measured STE total nitrogen (TN) concentration was 73 mg/L, which is within the high end of the range that has been typically reported for Florida single family residence STE.

Stage 1 Effluent (ST1): The Stage 1 effluent $\text{NH}_3\text{-N}$ level was 0.1 mg/L with a DO level at 5.4 mg/L (Table 5). The Stage 1 effluent TSS concentration was below the method detection limit of 1 mg/L and CBOD_5 concentration was 3 mg/L. The Stage 1 biofilter showed nearly complete nitrification with an effluent $\text{NH}_3\text{-N}$ concentration of 0.1 mg/L and TKN of 4.7 mg/L. The Stage 1 effluent $\text{NO}_x\text{-N}$ was 62.1 mg/L. The Stage 1 effluent TN was 66.8 mg/L, a nine percent reduction in nitrogen.

Stage 2 Biofilter Effluent (LIGNO-0" and ST2): The Stage 2 system produced a reducing environment and achieved essentially complete $\text{NO}_x\text{-N}$ reduction. Effluent $\text{NO}_x\text{-N}$ from the Stage 2 biofilter monitoring point was 0.05 mg/L. The low $\text{NO}_x\text{-N}$ was accompanied by a measured 0.2 mg/L DO and -232 mV ORP. The lignocellulosic media effluent $\text{NO}_x\text{-N}$ was 34.2 mg/L. The total nitrogen (TN) in the treatment system final effluent was 2.15 mg/L, a 97 percent reduction in nitrogen relative to the influent STE. The Stage 2 biofilter lignocellulosic media effluent CBOD_5 concentration was below the method detection limit of 2 mg/L and was 14 mg/L in the sulfur biofilter effluent. The Stage 2 effluent sulfate concentration was 270 mg/L.

As previously discussed in Section 3.3, Sample Event 8 also included Stage 2 biofilter profile samples. As depicted in Figure 9, the unsaturated Stage 1 biofilter effluent is pumped to the top of the first chamber of the Stage 2 biofilter which contains lignocellulosic media. The effluent flows downward through the lignocellulosic media, moves laterally in a perforated 4-inch pipe through the baffle wall to the bottom of the second chamber, and upward through the sulfur media mixture in the second chamber. The nitrogen results at the various depths of the Stage 2 biofilter are graphically displayed in Figure 9. Each stainless steel drivepoint sampler was assigned a unique identification indicating the depth (in inches) the sampler was placed above the bottom of the media. For example LIGNO-36 is a stainless steel drivepoint sampler located at 36 inches above the bottom of the lignocellulosic media. The profile results from this event indicate that the $\text{NO}_x\text{-N}$ was effectively reduced below the method detection limit at profile sampler SULFUR-6. The $\text{NO}_x\text{-N}$ concentration progressively decreased with passage through the lignocellulosic media in the downflow biofilter, which accounted for approximately 44.8 percent of the $\text{NO}_x\text{-N}$ reduction. Residual $\text{NO}_x\text{-N}$ in the effluent of the downflow biofilter was reduced to 0.03 mg/L at the 6-inch depth through the sulfur media.

2A Lignocellulosic Compartment				2B Sulfur Compartment			
FROM PUMP	TKN	NH3-N	NOX-N		TKN	NH3-N	NOX-N
Influent	4.7	0.10	62.1	Effl. Sulfur	2.1	1.3	0.05
LIGNO-36	5.1	0.05	41.1				
LIGNO-24	4.1	0.01	32.1				
LIGNO-12	3.3	0.01	33.0	SULFUR-12	1.9	1.0	0.03
LIGNO-0	2.8	0.01	34.2	SULFUR-6	2.3	1.2	0.03

Figure 9
Graphical Representation of Stage 2 Biofilter Profile Nitrogen Results

Blanks (FB and EB): The field blank (FB) was collected by filling sample containers with deionized water that had been transported into the field along with other sample containers. The equipment blank (EB) was collected by pumping deionized water through the cleaned pump tubing. Both samples were then analyzed for the same parameters as the monitoring samples. As expected, most parameters measured were at or below the method detection limit. However the TKN was 0.1 and 0.08 mg/L and the total phosphorus was 0.48 and 0.49 mg/L for FB and EB, respectively.

Table 5
Sample Event No. 8 Water Quality Results

Sample ID	Sample Date/Time	Temp (°C)	pH	Specific Conductance (uS/cm)	DO (mg/L)	ORP (mV)	Total Alkalinity (mg/L)	TSS (mg/L)	VSS (mg/L)	CBOD ₅ (mg/L)	COD (mg/L)	TN (mg/L N) ¹	TKN (mg/L N)	Organic N (mg/L N) ²	NH ₃ -N (mg/L N)	NO ₃ -N (mg/L N)	NO ₂ -N (mg/L N)	NO _x (mg/L N)	TIN (mg/L N) ³	TP (mg/L)	Ortho P (mg/L P)	Sulfate (mg/L)	Hydrogen Sulfide (mg/L)	Sulfide (mg/L)	Fecal (Ct/100 mL)	E-coli (Ct/100 mL)	TOC (mg/L)
BHSS-STE	12/15/2014 11:10	19.8	7.43	1222	0.05	-293.7		31		170	240	73.07	73	15.00	58	0.02	0.05	0.07	58.07	0.63		19	0.01	5.6	105000	100000	28
BHSS-ST1	12/15/2014 10:55	20.2	6.93	1187	5.43	120.7		1		3	10	66.75	4.7	4.60	0.1	62	0.05	62.05	62.15	3.3		27	0.01	0.2	500	420	3.4
BHSS-LIGNO-36	12/15/2014 10:35	20	6.87	1122	1.26	24				2		46.15	5.1	5.05	0.054	41	0.05	41.05	41.10			26					
BHSS-LIGNO-24	12/15/2014 10:25	20.1	6.97	1107	1.75	-17.2				2		36.15	4.1	4.09	0.009	32	0.05	32.05	32.06			25					
BHSS-LIGNO-12	12/15/2014 10:20	19.8	6.92	1110	0.23	-122.3				5		36.34	3.3	3.29	0.009	33	0.04	33.04	33.05			26					
BHSS-LIGNO-0	12/15/2014 10:05	19.6	6.94	1111	0.38	-190.1		1		2	12	37.03	2.8	2.79	0.009	34	0.23	34.23	34.24	2.8		25	0.01	0.1	70	56	4.6
BHSS-SULFUR-6	12/15/2014 9:55	19.7	6.62	1209	0.3	-264.4				19		2.33	2.3	1.10	1.2	0.02	0.01	0.03	1.23			240					
BHSS-SULFUR-12	12/15/2014 9:50	19.2	6.33	1301	0.5	-265.4				28		1.93	1.9	0.92	0.98	0.02	0.01	0.03	1.01			260					
BHSS-ST2	12/15/2014 9:25	19.1	6.77	1306	0.2	-231.8		5		14	41	2.15	2.1	0.80	1.3	0.02	0.03	0.05	1.35	2.5		270	0.01	6.8	60	41	5.5
BHSS-ST2-DUP	12/15/2014 9:30	19.1	6.77	1306	0.2	-231.8		1		13	37	2.05	2	0.60	1.4	0.02	0.03	0.05	1.45	2.5		310	0.01	6.6	60	37	5.5
BHSS-FB	12/15/2014 11:35	18.1	6.59	4.36	8.41	106.4		1		2	10	0.13	0.1	0.09	0.009	0.02	0.01	0.03	0.04	0.48		0.2	0.01	0.1	1	2	0.06
BHSS-EB	12/15/2014 11:45	18.3	6.23	2.06	8.42	110.4		1		2	10	0.11	0.08	0.07	0.009	0.02	0.01	0.03	0.04	0.49		0.2	0.01	0.1	1	2	0.06

Notes:

¹Total Nitrogen (TN) is a calculated value equal to the sum of TKN and NO_x.

²Organic Nitrogen (ON) is a calculated value equal to the difference of TKN and NH₃.

³Total Inorganic Nitrogen (TIN) is a calculated value equal to the sum of NH₃ and NO_x.

Gray-shaded data points indicate values below method detection level (mdl), mdl value used for statistical analyses.

Yellow-shaded data points indicate the reported value is between the laboratory method detection limit and the laboratory practical quantitation limit, value used for statistical analysis.

PRELIMINARY

4.4 Water Quality Monitoring Summary

A summary of the water quality data collected for the test system is presented in Table 6. Figure 12 provides a time series of influent and effluent TN over the study period. Figures 13 through 19 show box and whisker plots of the various monitoring points for the key parameters measured during the study period.

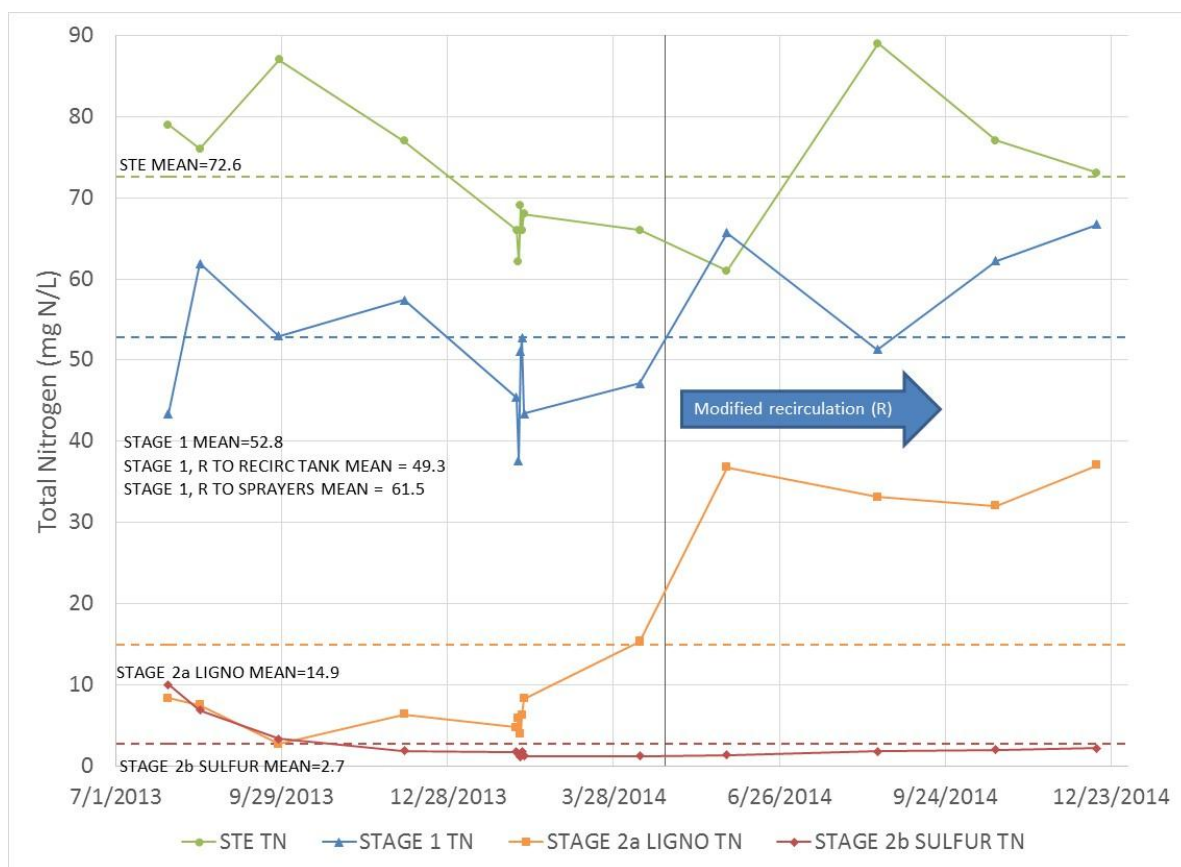


Figure 12
Total Nitrogen Time Series Graph
July 29, 2013 through December 15, 2014

Table 6
Summary of Water Quality Analytical Results

Sample ID	Statistics	Temp (°C)	pH	Specific Conductance (uS/cm)	DO (mg/L)	ORP (mV)	Total Alkalinity (mg/L)	TSS (mg/L)	VSS (mg/L)	CBOD ₅ (mg/L)	COD (mg/L)	TN (mg/L N) ¹	TKN (mg/L N)	Organic N (mg/L N) ²	NH ₃ -N (mg/L N)	NO ₃ -N (mg/L N)	NO ₂ -N (mg/L N)	NO _x (mg/L N)	TIN (mg/L N) ³	TP (mg/L P)	Ortho P (mg/L P)	Sulfate (mg/L)	Hydrogen Sulfide (mg/L)	Sulfide (mg/L)	Fecal (Ct/100 mL)	E-coli (Ct/100 mL)	TOC (mg/L)
STE	n	14	14	14	14	14	11	14	11	14	12	14	14	14	14	14	14	14	14	12	11	14	14	14	12	12	12
	MEAN	23.67	7.26	1200.21	0.06	-285.88	411.82	38.07	33.55	86.14	156.50	72.60	72.57	12.41	60.16	0.02	0.02	0.03	60.19	6.85	5.27	6.27	3.10	7.71	51,361	10,730	37
	STD. DEV.	3.80		65.64	0.03	37.96	20.89	12.68	13.68	32.51	68.19	8.68	8.68	15.41	19.00	0.02	0.01	0.02	19.00	2.65	0.80	6.24	1.82	2.73			10
	MIN	19.10	6.99	1048.00	0.01	-341.90	370.00	22.00	12.00	32.00	37.00	61.02	61.00	0.00	0.26	0.01	0.01	0.02	0.28	0.63	3.70	1.30	0.01	1.40	3,100	1,700	20
	MAX	28.90	7.63	1305.00	0.11	-226.80	440.00	60.00	56.00	170.00	270.00	89.02	89.00	60.74	79.00	0.08	0.05	0.08	79.02	12.00	6.50	19.00	6.90	12.00	160,000	120,000	51
Stage 1	n	14	14	14	14	14	11	12	11	12	12	14	14	14	14	13	13	14	14	12	11	10	9	9	12	12	12
	MEAN	23.39	6.87	1157.50	3.00	14.84	202.73	1.83	1.73	8.17	14.50	52.79	6.07	3.40	2.67	45.38	0.35	46.72	49.39	2.54	1.70	29.30	0.18	0.33	1,003	117	6
	STD. DEV.	3.23		70.10	1.29	95.76	18.49	1.03	1.10	5.24	7.20	9.00	2.47	1.42	2.69	8.73	0.49	9.26	8.48	0.45	0.23	5.08	0.26	0.35			2
	MIN	20.11	6.65	1057.00	1.64	-127.90	170.00	1.00	1.00	2.00	10.00	37.60	3.60	1.60	0.10	33.00	0.01	34.00	34.39	2.00	1.30	21.00	0.01	0.10	82	2	3
	MAX	28.20	7.18	1249.00	5.43	134.50	230.00	4.00	4.00	18.00	33.00	66.75	10.00	6.50	7.50	62.00	1.80	62.05	62.15	3.30	1.90	37.00	0.79	1.20	8,100	3,600	12
Stage 2a Ligno	n	14	14	14	14	14	11	14	11	14	12	14	14	14	14	13	13	14	14	12	11	11	10	10	12	12	12
	MEAN	23.74	6.65	1082.21	0.54	-104.66	344.55	4.86	2.91	11.57	35.08	14.86	3.04	2.31	0.73	9.21	0.83	11.82	12.55	1.41	0.73	25.36	0.17	0.29	212	25	11
	STD. DEV.	4.27		69.08	0.64	92.87	56.28	6.00	1.87	9.38	35.57	13.41	2.11	1.22	1.34	12.89	0.78	13.74	13.21	0.67	0.45	3.26	0.23	0.28			6
	MIN	18.40	6.25	946.00	0.03	-230.80	260.00	1.00	1.00	2.00	12.00	2.70	0.88	0.00	0.01	0.01	0.01	0.02	0.42	0.51	0.13	18.00	0.01	0.10	43	2	5
	MAX	30.20	7.38	1182.00	2.50	63.10	410.00	24.00	6.00	38.00	140.00	37.03	8.30	4.32	4.60	34.00	2.00	35.00	35.07	2.80	1.60	30.00	0.63	0.81	1,000	740	29
Stage 2b Sulfur	n	14	14	14	14	14	11	12	11	12	12	14	14	14	14	14	14	14	14	12	12	14	14	14	12	12	12
	MEAN	23.08	6.71	1218.86	0.15	-257.90	353.64	2.58	2.36	11.42	34.58	2.68	2.64	1.32	1.32	0.03	0.01	0.04	1.36	1.25	0.65	128.79	6.93	10.78	27	9	10
	STD. DEV.	4.51		208.09	0.10	49.84	71.03	1.44	1.29	8.82	7.98	2.57	2.58	0.97	1.70	0.04	0.01	0.04	1.69	0.50	0.38	93.18	11.69	16.54			5
	MIN	18.30	6.41	991.00	0.03	-357.00	200.00	1.00	1.00	2.00	23.00	1.12	1.00	0.65	0.16	0.01	0.01	0.02	0.18	0.42	0.00	29.00	0.01	0.40	1	2	6
	MAX	30.40	7.04	1781.00	0.38	-195.40	480.00	5.00	5.00	33.00	50.00	10.02	10.00	4.20	5.80	0.17	0.03	0.18	5.82	2.50	1.40	330.00	45.00	64.00	1,000	74	25

Notes:

Includes first two preliminary sample events which appear to be during maturation of the system.

¹Total Nitrogen (TN) is a calculated value equal to the sum of TKN and NO_x.

²Organic Nitrogen (ON) is a calculated value equal to the difference of TKN and NH₃.

³Total Inorganic Nitrogen (TIN) is a calculated value equal to the sum of NH₃ and NO_x.

⁴Fecal coliform and pH values are reported as geometric mean.

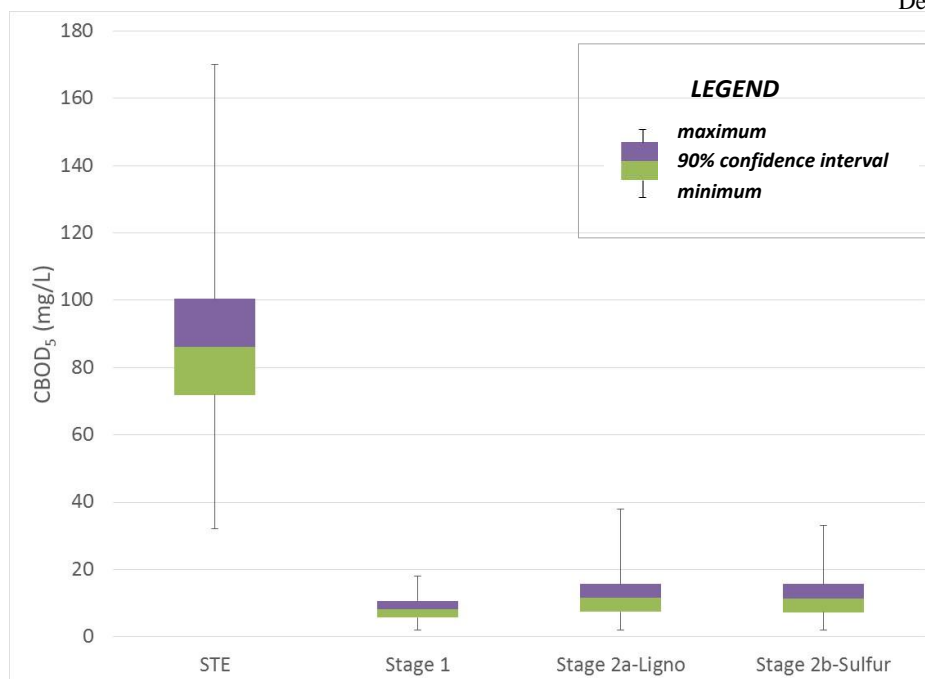


Figure 13
CBOD₅ Box and Whisker Plot

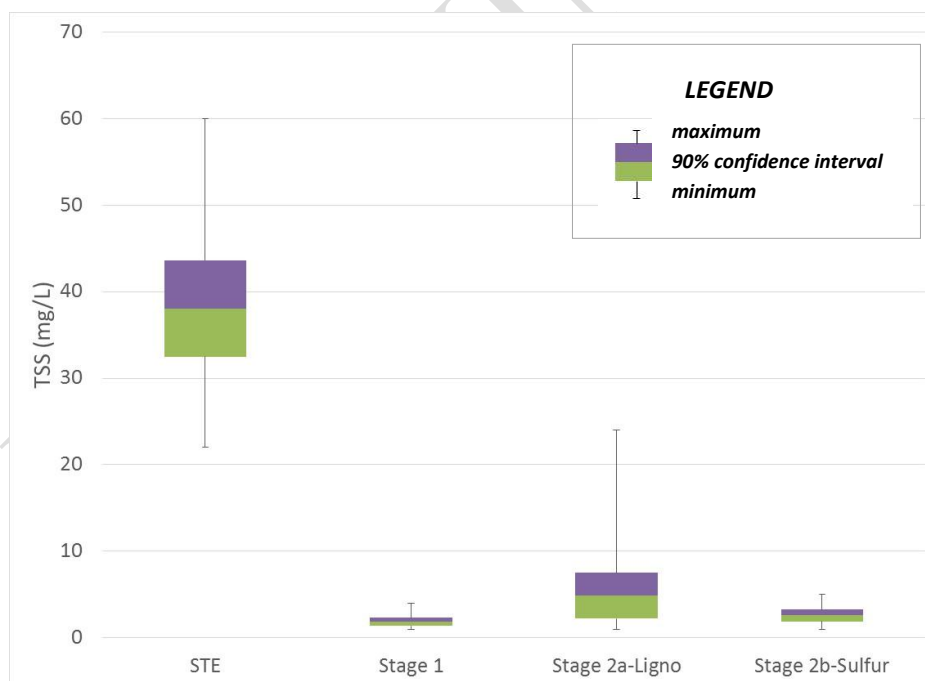


Figure 14
TSS Box and Whisker Plot

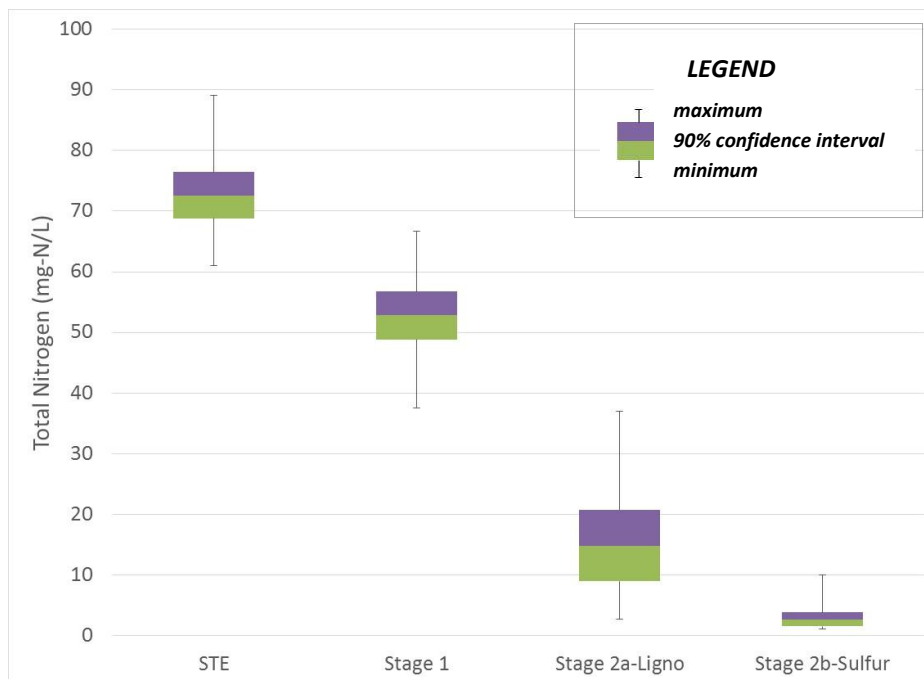


Figure 15
Total Nitrogen (TN) Box and Whisker Plot

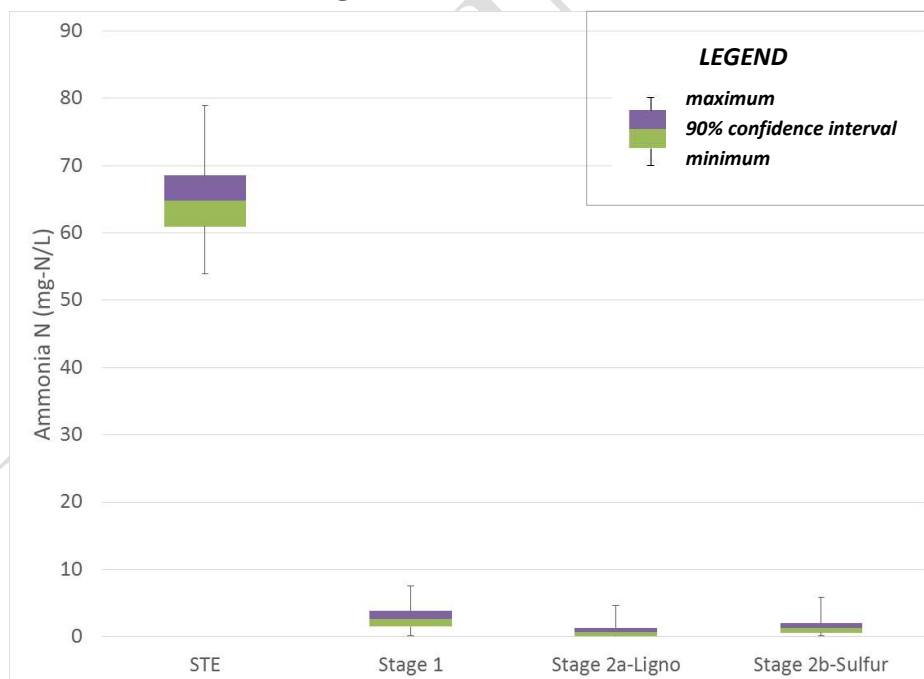


Figure 16
Ammonia N (NH₃-N) Box and Whisker Plot

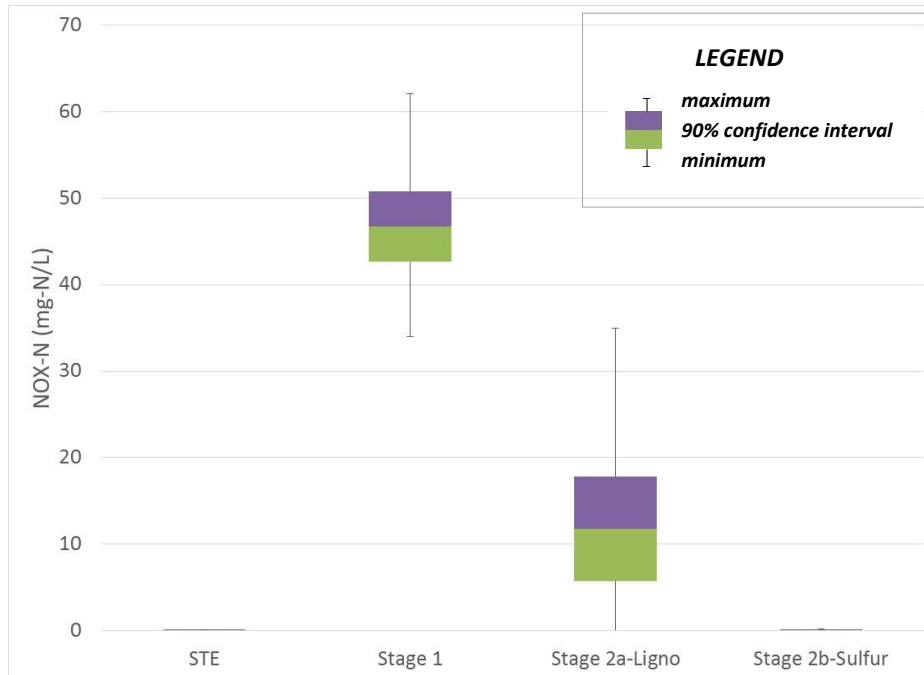


Figure 17
Nitrate+Nitrite Nitrogen (NO_x-N) Box and Whisker Plot

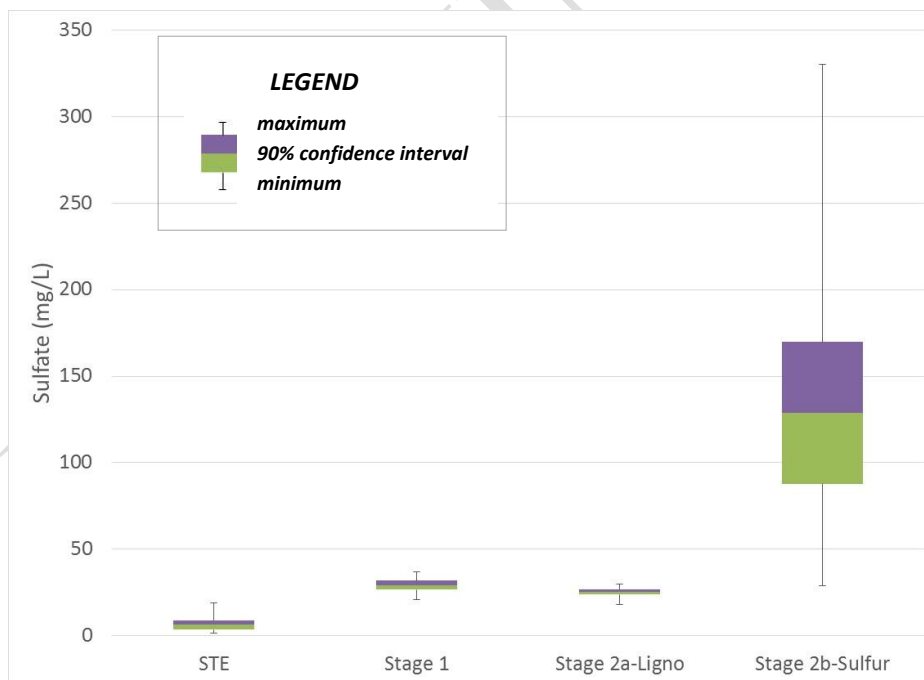


Figure 18
Sulfate (SO₄) Box and Whisker Plot

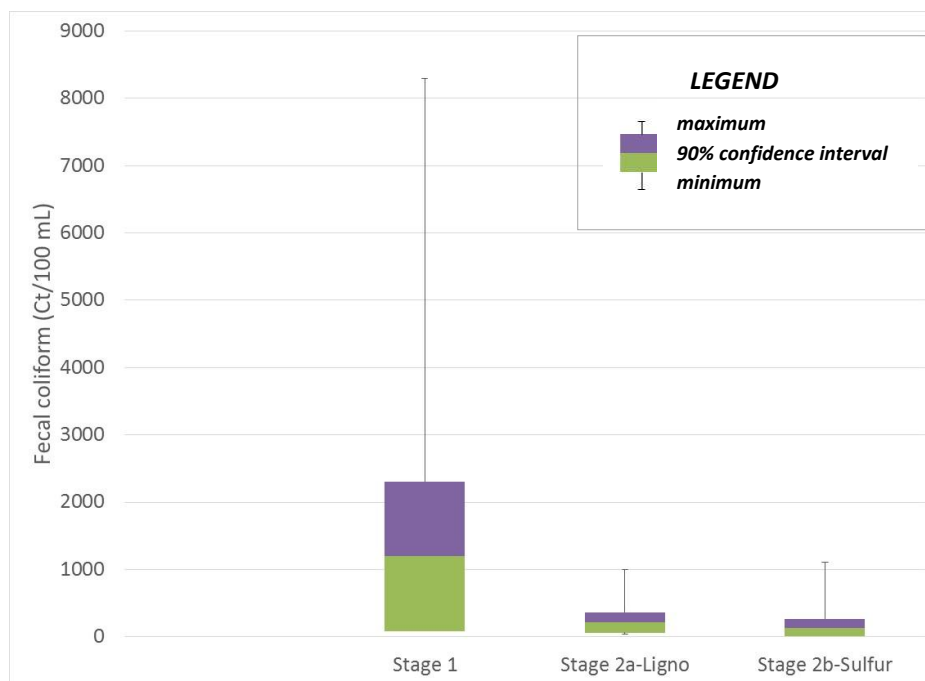


Figure 19
Fecal Coliform Box and Whisker Plot

4.5 Mode of Operation Performance Comparison

As previously discussed, the recirculation mode of operation was modified following the fourth sample event. Single pass mode was initially tested, where 100 percent of the Stage 1 effluent was discharged to the Stage 2 biofilter. A summary of the water quality data collected for the test system during testing of single pass operation (which was initially tested) is presented in Table 7. Following the fourth sample event, the recirculation mode was initiated. In recirculation mode, a portion (3:1 target ratio) of the Stage 1 effluent was recirculated to the top of the Stage 1 biofilter and dispersed via five spray nozzles. The recirculated, nitrified effluent would have an opportunity to mix with incoming septic tank effluent discharged by the distribution box. A summary of the water quality data collected for the test system during testing of the second option is presented in Table 8. A comparison of the two modes of operation for key parameters is provided in Table 9.

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Table 7
Summary of Water Quality Data
Option 1: Single Pass Operation

Sample ID	Statistics	Temp (°C)	pH	Specific Conductance (uS/cm)	DO (mg/L)	ORP (mV)	Total Alkalinity (mg/L)	TSS (mg/L)	VSS (mg/L)	CBOD ₅ (mg/L)	COD (mg/L)	TN (mg/L N) ¹	TKN (mg/L N)	Organic N (mg/L N) ²	NH ₃ -N (mg/L N)	NO ₃ -N (mg/L N)	NO ₂ -N (mg/L N)	NO _x (mg/L N)	TIN (mg/L N) ³	TP (mg/L)	Ortho P (mg/L P)	Sulfate (mg/L)	Hydrogen Sulfide (mg/L)	Sulfide (mg/L)	Fecal (Ct/100 mL)	E-coli (Ct/100 mL)	TOC (mg/L)
STE	n	10	10	10	10	10	8	10	8	10	8	10	10	10	10	10	10	10	10	8	8	10	10	10	8	8	8
	MEAN	23.1	7.3	1180.7	0.1	-286.2	406.3	39.8	35.4	77.2	141.0	71.6	71.6	8.7	62.9	0.02	0.01	0.03	62.9	7.5	5.0	3.8	3.4	8.5	42034.7	4908.3	35.5
	STD. DEV.	3.9		64.7	0.0	40.7	20.7	14.3	13.6	24.8	76.6	7.8	7.8	7.2	6.8	0.02	0.00	0.02	6.8	2.0	0.7	3.7	1.6	2.1			9.6
	MIN	19.1	7.0	1048.0	0.0	-341.9	370.0	22.0	22.0	32.0	37.0	62.1	62.0	0.0	54.0	0.01	0.01	0.02	54.0	5.9	3.7	1.3	1.6	5.1	3100.0	1700.0	20.0
	MAX	28.9	7.6	1294.0	0.1	-226.8	430.0	60.0	56.0	120.0	270.0	87.0	87.0	25.0	76.0	0.08	0.01	0.08	76.0	12.0	5.5	14.0	6.9	12.0	160000.0	24000.0	49.0
Stage 1	n	10	10	10	10	10	8	8	8	8	8	10	10	10	10	10	10	10	10	8	8	6	5	5	8	8	8
	MEAN	23.1	6.9	1145.4	2.3	-13.2	212.5	2.3	2.0	10.3	16.3	49.3	6.7	3.0	3.7	42.3	0.4	42.6	46.3	2.5	1.7	29.3	0.3	0.4	2406.3	171.1	6.8
	STD. DEV.	3.4		77.1	0.7	96.6	8.9	1.0	1.2	5.1	8.3	7.3	2.7	1.5	2.5	6.5	0.5	6.5	7.1	0.5	0.2	6.5	0.3	0.5			2.2
	MIN	20.1	6.8	1057.0	1.6	-127.9	200.0	1.0	1.0	2.0	10.0	37.6	3.6	1.6	0.4	33.0	0.0	34.0	34.4	2.0	1.4	21.0	0.0	0.1	1000.0	10.0	5.3
	MAX	28.2	7.2	1249.0	3.4	130.0	230.0	4.0	4.0	18.0	33.0	61.9	10.0	6.5	7.5	52.0	1.8	52.0	57.1	3.1	1.9	37.0	0.8	1.2	8100.0	3600.0	12.0
Stage 2a Ligno	n	10	10	10	10	10	8	10	8	10	8	10	10	10	10	10	10	10	10	8	8	7	6	6	8	8	8
	MEAN	23.1	6.6	1064.6	0.7	-107.9	373.8	5.9	3.0	14.6	44.1	6.9	3.2	2.2	1.0	2.7	1.0	3.7	4.7	1.1	0.5	24.1	0.1	0.3	416.1	35.9	13.4
	STD. DEV.	4.4		71.4	0.7	83.5	30.7	6.8	1.6	9.5	41.2	3.5	2.5	1.4	1.5	3.8	0.8	3.6	3.2	0.4	0.3	3.3	0.2	0.3			6.5
	MIN	18.4	6.3	946.0	0.1	-230.8	310.0	2.0	1.0	2.0	12.0	2.7	0.9	0.0	0.0	0.0	0.0	0.0	0.4	0.5	0.1	18.0	0.0	0.1	200.0	2.0	9.3
	MAX	30.2	7.4	1182.0	2.5	9.7	410.0	24.0	6.0	38.0	140.0	15.3	8.3	4.3	4.6	12.0	2.0	12.0	12.5	1.6	1.0	27.0	0.5	0.8	1000.0	740.0	29.0
Stage 2b Sulfur	n	10	10	10	10	10	8	8	8	8	8	10	10	10	10	10	10	10	10	8	8	10	10	10	8	8	8
	MEAN	22.6	6.8	1191.0	0.2	-259.5	381.3	2.3	2.3	9.4	33.0	3.0	3.0	1.5	1.5	0.04	0.01	0.04	1.5	1.1	0.7	81.3	8.3	12.6	23.4	8.7	11.6
	STD. DEV.	4.9		243.5	0.1	54.8	43.9	1.4	1.4	6.1	7.0	3.0	3.0	1.1	2.0	0.05	0.00	0.05	2.0	0.3	0.3	45.6	13.7	19.5			5.7
	MIN	18.3	6.6	991.0	0.0	-357.0	350.0	1.0	1.0	2.0	23.0	1.1	1.0	0.7	0.2	0.01	0.01	0.02	0.2	0.4	0.2	29.0	0.3	0.4	1.0	2.0	7.1
	MAX	30.4	7.0	1781.0	0.4	-195.4	480.0	5.0	5.0	19.0	43.0	10.0	10.0	4.2	5.8	0.17	0.01	0.18	5.8	1.5	1.0	200.0	45.0	64.0	1000.0	52.0	25.0

Notes:

Includes first two preliminary sample events which appear to be during maturation of the system.

¹Total Nitrogen (TN) is a calculated value equal to the sum of TKN and NO_x.²Organic Nitrogen (ON) is a calculated value equal to the difference of TKN and NH₃.³Total Inorganic Nitrogen (TIN) is a calculated value equal to the sum of NH₃ and NO_x.⁴Fecal coliform and pH values are reported as geometric mean.

Table 8
Summary of Water Quality Data
Option 2: Recirculation to Stage 1 Sprayers

Sample ID	Statistics	Temp (°C)	pH	Specific Conductance (uS/cm)	DO (mg/L)	ORP (mV)	Total Alkalinity (mg/L)	TSS (mg/L)	VSS (mg/L)	CBOD ₅ (mg/L)	COD (mg/L)	TN (mg/L N) ¹	TKN (mg/L N)	Organic N (mg/L N) ²	NH ₃ -N (mg/L N)	NO ₃ -N (mg/L N)	NO ₂ -N (mg/L N)	NO _x (mg/L N)	TIN (mg/L N) ³	TP (mg/L)	Ortho P (mg/L P)	Sulfate (mg/L)	Hydrogen Sulfide (mg/L)	Sulfide (mg/L)	Fecal (Ct/100 mL)	E-coli (Ct/100 mL)	TOC (mg/L)
STE	n	4	4	4	4	4	3	4	3	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4
	MEAN	25.08	7.25	1249.00	0.04	-285.05	426.67	33.75	28.67	108.50	187.50	75.05	75.00	21.69	53.32	0.02	0.03	0.05	53.36	5.63	6.00	12.48	2.32	5.83	76,681	51,274	40.50
	STD. DEV.	3.63		41.01	0.02	35.56	15.28	6.80	15.63	42.38	37.75	11.55	11.55	26.67	36.57	0.01	0.02	0.03	36.58	3.63	0.78	7.43	2.41	3.43			10.47
	MIN	19.80	7.09	1215.00	0.02	-319.10	410.00	27.00	12.00	74.00	150.00	61.02	61.00	1.00	0.26	0.01	0.01	0.02	0.28	0.63	5.10	3.30	0.01	1.40	48,000	24,000	28.00
	MAX	28.10	7.43	1305.00	0.05	-235.00	440.00	43.00	43.00	170.00	240.00	89.02	89.00	60.74	79.00	0.02	0.05	0.07	79.02	8.50	6.50	19.00	4.60	9.70	140,000	120,000	51.00
Stage 1	n	4	4	4	4	4	3	4	3	4	4	4	4	4	4	3	3	4	4	4	3	4	4	4	4	4	4
	MEAN	24.08	6.83	1187.75	4.61	84.85	176.67	1.00	1.00	4.00	11.00	61.50	4.48	4.34	0.13	55.67	0.04	57.03	57.16	2.60	1.70	29.25	0.08	0.20	174.16	55.16	4.90
	STD. DEV.	3.17		42.06	0.82	50.81	5.77	0.00	0.00	2.16	2.00	7.07	0.26	0.28	0.03	7.77	0.02	6.89	6.90	0.50	0.35	2.63	0.14	0.14			2.50
	MIN	20.20	6.65	1137.00	3.48	29.10	170.00	1.00	1.00	2.00	10.00	51.30	4.20	4.03	0.10	47.00	0.01	47.00	47.12	2.10	1.30	27.00	0.01	0.10	82.00	2.00	3.40
	MAX	27.80	6.98	1240.00	5.43	134.50	180.00	1.00	1.00	7.00	14.00	66.75	4.70	4.60	0.17	62.00	0.05	62.05	62.15	3.30	1.90	33.00	0.28	0.39	500.00	420.00	8.60
Stage 2a Ligno	n	4	4	4	4	4	3	4	3	4	4	4	4	4	4	3	3	4	4	4	3	4	4	4	4	4	4
	MEAN	25.43	6.69	1126.25	0.23	-96.70	266.67	2.25	2.67	4.00	17.00	34.73	2.60	2.58	0.02	31.00	0.18	32.13	32.16	2.13	1.26	27.50	0.22	0.35	55.04	12.82	6.83
	STD. DEV.	4.01		42.08	0.15	127.90	5.77	2.50	2.89	2.16	4.16	2.56	0.56	0.59	0.03	2.65	0.15	2.90	2.92	0.50	0.43	2.08	0.29	0.33			3.48
	MIN	19.60	6.44	1074.00	0.03	-209.30	260.00	1.00	1.00	2.00	12.00	32.00	1.80	1.73	0.01	29.00	0.01	29.30	29.31	1.60	0.78	25.00	0.01	0.10	43.00	2.00	4.60
	MAX	28.50	6.94	1166.00	0.38	63.10	270.00	6.00	6.00	7.00	22.00	37.03	3.10	3.09	0.07	34.00	0.30	35.00	35.07	2.80	1.60	30.00	0.63	0.79	70.00	56.00	12.00
Stage 2b Sulfur	n	4	4	4	4	4	3	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	MEAN	24.39	6.58	1288.50	0.12	-253.98	280.00	3.25	2.67	15.50	37.75	1.79	1.75	0.86	0.89	0.02	0.02	0.04	0.93	1.57	0.64	247.50	3.45	6.18	34.64	10.50	7.98
	STD. DEV.	3.76		26.59	0.07	41.72	85.44	1.50	1.15	12.87	9.98	0.35	0.34	0.17	0.49	0.01	0.01	0.01	0.50	0.68	0.60	71.36	3.27	2.84			3.48
	MIN	19.10	6.41	1249.00	0.05	-302.40	200.00	2.00	2.00	2.00	27.00	1.32	1.30	0.70	0.21	0.01	0.01	0.02	0.23	0.89	0.00	160.00	0.01	2.00	1.00	2.00	5.50
	MAX	28.00	6.77	1306.00	0.20	-208.90	370.00	5.00	4.00	33.00	50.00	2.15	2.10	1.09	1.30	0.04	0.03	0.05	1.35	2.50	1.40	330.00	6.30	8.20	300.00	74.00	13.00

Notes:

¹Total Nitrogen (TN) is a calculated value equal to the sum of TKN and NO_x.²Organic Nitrogen (ON) is a calculated value equal to the difference of TKN and NH₃.³Total Inorganic Nitrogen (TIN) is a calculated value equal to the sum of NH₃ and NO_x.⁴Fecal coliform and pH values are reported as geometric mean.

Table 9
Comparison of Water Quality

Sample ID	Statistical Parameter	Total Alkalinity (mg/L)		TSS (mg/L)		CBOD5 (mg/L)		TN (mg/L N)		TKN (mg/L N)		Organic N (mg/L N)		NH3-N (mg/L N)		NOx (mg/L N)		TIN (mg/L N)		TP (mg/L)		Sulfate (mg/L)	
		Single Pass	Recirc to Sprayers	Single Pass	Recirc to Sprayers	Single Pass	Recirc to Sprayers	Single Pass	Recirc to Sprayers	Single Pass	Recirc to Sprayers	Single Pass	Recirc to Sprayers	Single Pass	Recirc to Sprayers	Single Pass	Recirc to Sprayers	Single Pass	Recirc to Sprayers	Single Pass	Recirc to Sprayers	Single Pass	Recirc to Sprayers
Septic tank effluent (STE)	n	8	3	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4
	MEAN	406.3	426.7	38.3	33.8	70.9	108.5	70.2	75.0	70.1	75.0	7.8	21.7	62.4	53.3	0.03	0.05	62.4	53.4	7.5	5.6	3.9	12.5
	STD. DEV.	20.7	15.3	14.4	6.8	21.8	42.4	8.1	11.5	8.1	11.5	4.2	26.7	4.9	36.6	0.02	0.03	4.9	36.6	2.0	3.6	4.2	7.4
	MIN	370.0	410.0	22.0	27.0	32.0	74.0	62.1	61.0	62.0	61.0	2.0	1.0	56.0	0.3	0.02	0.02	56.0	0.3	5.9	0.6	1.3	3.3
	MAX	430.0	440.0	60.0	43.0	110.0	170.0	87.0	89.0	87.0	89.0	16.0	60.7	71.0	79.0	0.08	0.07	71.0	79.0	12.0	8.5	14.0	19.0
Stage 1 effluent	n	8	3	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	6	4
	MEAN	212.5	176.7	2.3	1.0	10.3	4.0	48.5	61.5	6.0	4.5	2.9	4.3	3.0	0.1	42.5	57.0	45.5	57.2	2.5	2.6	29.3	29.3
	STD. DEV.	8.9	5.8	1.0	0.0	5.1	2.2	6.3	7.1	2.5	0.3	1.6	0.3	2.4	0.0	5.5	6.9	6.6	6.9	0.5	0.5	6.5	2.6
	MIN	200.0	170.0	1.0	1.0	2.0	2.0	37.6	51.3	3.6	4.2	1.6	4.0	0.4	0.1	34.0	47.0	34.4	47.1	2.0	2.1	21.0	27.0
	MAX	230.0	180.0	4.0	1.0	18.0	7.0	57.4	66.8	10.0	4.7	6.5	4.6	7.5	0.2	49.5	62.1	54.6	62.2	3.1	3.3	37.0	33.0
Stage 2 lignocellulosic effluent	n	8	3	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	7	4
	MEAN	373.8	266.7	3.3	2.3	11.4	4.0	6.7	34.7	2.2	2.6	1.8	2.6	0.4	0.0	4.5	32.1	4.8	32.2	1.1	2.1	24.1	27.5
	STD. DEV.	30.7	5.8	1.6	2.5	5.0	2.2	3.9	2.6	1.3	0.6	1.3	0.6	0.5	0.0	3.7	2.9	3.6	2.9	0.4	0.5	3.3	2.1
	MIN	310.0	260.0	2.0	1.0	2.0	2.0	2.7	32.0	0.9	1.8	0.0	1.7	0.0	0.0	0.0	29.3	0.4	29.3	0.5	1.6	18.0	25.0
	MAX	410.0	270.0	6.0	6.0	17.0	7.0	15.3	37.0	4.7	3.1	4.3	3.1	1.4	0.1	12.0	35.0	12.5	35.1	1.6	2.8	27.0	30.0
Stage 2 sulfur effluent	n	8	3	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4
	MEAN	381.3	280.0	2.3	3.3	9.4	15.5	1.7	1.8	1.7	1.8	1.0	0.9	0.6	0.9	0.05	0.04	0.7	0.9	1.1	1.6	67.1	247.5
	STD. DEV.	43.9	85.4	1.4	1.5	6.1	12.9	0.7	0.4	0.7	0.3	0.3	0.2	0.7	0.5	0.06	0.01	0.7	0.5	0.3	0.7	20.6	71.4
	MIN	350.0	200.0	1.0	2.0	2.0	2.0	1.1	1.3	1.0	1.3	0.7	0.7	0.2	0.2	0.02	0.02	0.2	0.2	0.4	0.9	29.0	160.0
	MAX	480.0	370.0	5.0	5.0	19.0	33.0	3.3	2.2	3.3	2.1	1.5	1.1	2.4	1.3	0.18	0.05	2.4	1.4	1.5	2.5	98.0	330.0

Note: Nitrification and denitrification was still being established during the first two preliminary sample events; therefore the start-up period results were not included in the single pass data set.

5.0 B-HS5 Sample Event No. 8: Summary and Recommendations

5.1 Summary

The eighth and final sampling results indicate that:

- Septic tank effluent (STE) quality is characteristic of typical household STE quality. The total nitrogen concentration of 73 mg/L is within the high end of the range of values typically reported for Florida single family residence STE.
- The Stage 1 biofilter converted most of the ammonia N to oxidized nitrogen; effluent contained 4.7 mg/L TKN, of which 0.1 mg/L was ammonia.
- The Stage 2 biofilter effluent NO_x-N was 0.05 mg N/L.
- The total nitrogen concentration in the final effluent from the total treatment system was 2.15 mg/L, an approximately 97% reduction from STE.

5.2 Conclusions

Sample Event 8 was the last funded sample event for the B-HS5 treatment system. Sections 4.4 and 4.5 summarized the water quality data collected over the 1.4 year monitoring period for this system. These results indicate that:

- The septic tank effluent average total nitrogen concentration of 72.4 mg/L is in the upper range of values typically reported for Florida single family residence STE.
- Stage 1 recirculation mode of operation resulted in generally overall similar treatment performance as single pass mode.
- Both modes of operation showed that the Stage 1 biofilter provided significant nitrification with an average NH₃-N concentration of 3.0 and 0.1 mg/L and average TKN of 6.0 and 4.5 mg/L for single pass and recirculation, respectively. The Stage 1 biofilter effluent average NO_x-N was 42.5 and 57.0 mg/L for single pass and recirculation, respectively. These results indicate denitrification (approximately 31% and 18% total nitrogen reduction, respectively) was occurring.
- The time series plot (Figure 12) shows a trend in increasing total nitrogen in the lignocellulosic effluent with time which indicates less NO_x-N removal. The cause

for the reduction in $\text{NO}_x\text{-N}$ removal effectiveness in the lignocellulosic chamber is unclear; it could be related to the change in operation to recirculation, loss in reactivity of the media, or other factors.

- However, the Stage 2 biofilter sulfur media was effective in producing a reducing environment and achieving the $\text{NO}_x\text{-N}$ reduction goals throughout the study period (average $\text{NO}_x\text{-N}$ concentration of 0.04 mg/L). The average final total nitrogen (TN) in the treatment system effluent was 2.68 mg/L, primarily TKN (average TKN concentration of 2.64 mg/L), representing a 96 percent average reduction in total nitrogen from this PNRs.

Further analysis of the results obtained at this site will occur as Task B results are compiled and summarized. The results of the data collected to date have provided insights into the performance of a full-scale passive nitrogen reduction system monitored over an extended timeframe (524 experimental days) under actual onsite conditions.



Appendix A: Laboratory Report

PRELIMINARY

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Hazen and Sawyer
10002 Princess Palm Ave, Suite 200
Tampa, FL 33619

December 29, 2014
Work Order: 1412944

Laboratory Report

Project Name		B-HS5 SE#12						
Parameters	Units	Results *	Method	PQL	MDL	Prepared	Analyzed	Dilution
Sample Description		BHS5-STE						
Matrix		Wastewater						
SAL Sample Number		1412944-01						
Date/Time Collected		12/15/14 11:10						
Collected by		Josefin Hirst						
Date/Time Received		12/15/14 16:10						
<u>Inorganics</u>								
Hydrogen Sulfide (Unionized)	mg/L	0.01 U	SM 4550SF	0.04	0.01	12/24/14 10:01	12/24/14 10:06	1
Ammonia as N	mg/L	58	EPA 350.1	3.6	0.85		12/16/14 14:07	90
Carbonaceous BOD	mg/L	170	SM 5210B	2	2	12/17/14 09:06	12/22/14 13:12	1
Chemical Oxygen Demand	mg/L	240	EPA 410.4	25	10	12/22/14 10:37	12/22/14 12:39	1
Nitrate+Nitrite (N)	mg/L	0.04	EPA 353.2	0.04	0.01		12/16/14 11:49	1
Nitrite (as N)	mg/L	0.05 J5	SM 4500NO2-B	0.04	0.01		12/16/14 10:22	1
Phosphorous - Total as P	mg/L	0.63 I	SM 4500P-E	0.80	0.20	12/16/14 10:33	12/17/14 10:34	20
Sulfate	mg/L	19	EPA 300.0	0.60	0.20		12/24/14 01:42	1
Sulfide	mg/L	5.6	SM 4500SF	0.40	0.10		12/16/14 14:52	1
Total Kjeldahl Nitrogen	mg/L	73	EPA 351.2	4.0	1.0	12/16/14 10:33	12/17/14 10:34	20
Total Organic Carbon	mg/L	28	SM 5310B	10	0.60		12/18/14 11:26	10
Total Suspended Solids	mg/L	31	SM 2540D	1	1	12/17/14 08:19	12/18/14 15:43	1
Nitrate (as N)	mg/L	0.02 U	EPA 353.2	0.08	0.02		12/16/14 11:49	1
<u>Microbiology</u>								
E. Coli	MPN/100 mL	100,000	SM 9223B	2.0	2.0	12/15/14 16:49	12/16/14 11:06	1
Fecal Coliforms	CFU/100 ml	105,000	SM 9222D	1	1	12/15/14 16:41	12/16/14 15:07	1
Sample Description		BHS5-ST1						
Matrix		Wastewater						
SAL Sample Number		1412944-02						
Date/Time Collected		12/15/14 10:55						
Collected by		Josefin Hirst						
Date/Time Received		12/15/14 16:10						
<u>Inorganics</u>								
Hydrogen Sulfide (Unionized)	mg/L	0.01 U	SM 4550SF	0.04	0.01	12/24/14 10:01	12/24/14 10:06	1
Ammonia as N	mg/L	0.10	EPA 350.1	0.040	0.009		12/16/14 12:38	1
Carbonaceous BOD	mg/L	3	SM 5210B	2	2	12/17/14 09:06	12/22/14 13:12	1
Chemical Oxygen Demand	mg/L	10 I	EPA 410.4	25	10	12/22/14 10:37	12/22/14 12:39	1
Nitrate+Nitrite (N)	mg/L	62	EPA 353.2	0.96	0.24		12/16/14 13:38	24
Nitrite (as N)	mg/L	0.05	SM 4500NO2-B	0.04	0.01		12/16/14 10:22	1
Phosphorous - Total as P	mg/L	3.3	SM 4500P-E	0.20	0.050	12/16/14 10:33	12/17/14 10:34	5
Sulfate	mg/L	27	EPA 300.0	0.60	0.20		12/24/14 01:53	1
Sulfide	mg/L	0.20 I	SM 4500SF	0.40	0.10		12/16/14 14:52	1
Total Kjeldahl Nitrogen	mg/L	4.7	EPA 351.2	1.0	0.25	12/16/14 10:33	12/17/14 10:34	5
Total Organic Carbon	mg/L	3.4	SM 5310B	1.0	0.060		12/18/14 11:26	1

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December 29, 2014
Work Order: 1412944

Laboratory Report

Project Name		B-HS5 SE#12						
Parameters	Units	Results *	Method	PQL	MDL	Prepared	Analyzed	Dilution
Sample Description		BHS5-ST1						
Matrix		Wastewater						
SAL Sample Number		1412944-02						
Date/Time Collected		12/15/14 10:55						
Collected by		Josefin Hirst						
Date/Time Received		12/15/14 16:10						
Total Suspended Solids	mg/L	1 U	SM 2540D	1	1	12/17/14 08:19	12/18/14 15:43	1
Nitrate (as N)	mg/L	62	EPA 353.2	1.0	0.25		12/16/14 13:38	24
<u>Microbiology</u>								
E. Coli	MPN/100 mL	420	SM 9223B	2.0	2.0	12/15/14 16:49	12/16/14 11:06	1
Fecal Coliforms	CFU/100 ml	500	SM 9222D	1	1	12/15/14 16:41	12/16/14 15:07	1
Sample Description		BHS5-LIGNO-36						
Matrix		Wastewater						
SAL Sample Number		1412944-03						
Date/Time Collected		12/15/14 10:35						
Collected by		Josefin Hirst						
Date/Time Received		12/15/14 16:10						
<u>Inorganics</u>								
Ammonia as N	mg/L	0.054	EPA 350.1	0.040	0.009		12/16/14 12:40	1
Carbonaceous BOD	mg/L	2 U	SM 5210B	2	2	12/17/14 09:06	12/22/14 13:12	1
Nitrate+Nitrite (N)	mg/L	41	EPA 353.2	0.96	0.24		12/16/14 13:39	24
Nitrite (as N)	mg/L	0.05	SM 4500NO2-B	0.04	0.01		12/16/14 10:23	1
Sulfate	mg/L	26	EPA 300.0	0.60	0.20		12/24/14 02:04	1
Total Kjeldahl Nitrogen	mg/L	5.1	EPA 351.2	1.0	0.25	12/17/14 11:17	12/18/14 11:14	5
Nitrate (as N)	mg/L	41	EPA 353.2	1.0	0.25		12/16/14 13:39	24
Sample Description		BHS5-LIGNO-24						
Matrix		Wastewater						
SAL Sample Number		1412944-04						
Date/Time Collected		12/15/14 10:25						
Collected by		Josefin Hirst						
Date/Time Received		12/15/14 16:10						
<u>Inorganics</u>								
Ammonia as N	mg/L	0.009 U	EPA 350.1	0.040	0.009		12/16/14 12:42	1
Carbonaceous BOD	mg/L	2 U	SM 5210B	2	2	12/17/14 09:06	12/22/14 13:12	1
Nitrate+Nitrite (N)	mg/L	32	EPA 353.2	0.96	0.24		12/16/14 13:40	24
Nitrite (as N)	mg/L	0.05	SM 4500NO2-B	0.04	0.01		12/16/14 10:23	1
Sulfate	mg/L	25	EPA 300.0	0.60	0.20		12/24/14 02:15	1
Total Kjeldahl Nitrogen	mg/L	4.1	EPA 351.2	1.0	0.25	12/17/14 11:17	12/18/14 11:14	5
Nitrate (as N)	mg/L	32	EPA 353.2	1.0	0.25		12/16/14 13:40	24

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December 29, 2014
Work Order: 1412944

Laboratory Report

Project Name		B-HS5 SE#12						
Parameters	Units	Results *	Method	PQL	MDL	Prepared	Analyzed	Dilution
Sample Description		BHS5-LIGNO-12						
Matrix		Wastewater						
SAL Sample Number		1412944-05						
Date/Time Collected		12/15/14 10:20						
Collected by		Josefin Hirst						
Date/Time Received		12/15/14 16:10						
<u>Inorganics</u>								
Ammonia as N	mg/L	0.009 U	EPA 350.1	0.040	0.009		12/16/14 12:44	1
Carbonaceous BOD	mg/L	5	SM 5210B	2	2	12/17/14 09:06	12/22/14 13:12	1
Nitrate+Nitrite (N)	mg/L	33	EPA 353.2	0.96	0.24		12/16/14 13:41	24
Nitrite (as N)	mg/L	0.04	SM 4500NO2-B	0.04	0.01		12/16/14 10:24	1
Sulfate	mg/L	26	EPA 300.0	0.60	0.20		12/24/14 02:27	1
Total Kjeldahl Nitrogen	mg/L	3.3	EPA 351.2	1.0	0.25	12/17/14 11:17	12/18/14 11:14	5
Nitrate (as N)	mg/L	33	EPA 353.2	1.0	0.25		12/16/14 13:41	24
Sample Description		BHS5-LIGNO-0						
Matrix		Wastewater						
SAL Sample Number		1412944-06						
Date/Time Collected		12/15/14 10:05						
Collected by		Josefin Hirst						
Date/Time Received		12/15/14 16:10						
<u>Inorganics</u>								
Hydrogen Sulfide (Unionized)	mg/L	0.01 U	SM 4550SF	0.04	0.01	12/24/14 10:01	12/24/14 10:06	1
Ammonia as N	mg/L	0.009 U	EPA 350.1	0.040	0.009		12/16/14 12:46	1
Carbonaceous BOD	mg/L	2 U	SM 5210B	2	2	12/17/14 09:06	12/22/14 13:12	1
Chemical Oxygen Demand	mg/L	12 I	EPA 410.4	25	10	12/22/14 10:37	12/22/14 12:39	1
Nitrate+Nitrite (N)	mg/L	34	EPA 353.2	0.96	0.24		12/16/14 13:42	24
Nitrite (as N)	mg/L	0.23 I	SM 4500NO2-B	0.40	0.10		12/16/14 10:44	10
Phosphorous - Total as P	mg/L	2.8	SM 4500P-E	0.20	0.050	12/16/14 10:33	12/17/14 10:34	5
Sulfate	mg/L	25	EPA 300.0	0.60	0.20		12/24/14 02:38	1
Sulfide	mg/L	0.10 U	SM 4500SF	0.40	0.10		12/16/14 14:52	1
Total Kjeldahl Nitrogen	mg/L	2.8	EPA 351.2	1.0	0.25	12/16/14 10:33	12/17/14 10:34	5
Total Organic Carbon	mg/L	4.6	SM 5310B	1.0	0.060		12/18/14 11:26	1
Total Suspended Solids	mg/L	1 U	SM 2540D	1	1	12/17/14 08:19	12/18/14 15:43	1
Nitrate (as N)	mg/L	34	EPA 353.2	1.4	0.34		12/16/14 13:42	24
<u>Microbiology</u>								
E. Coli	MPN/100 mL	56	SM 9223B	2.0	2.0	12/15/14 16:49	12/16/14 11:06	1
Fecal Coliforms	CFU/100 ml	70	SM 9222D	1	1	12/15/14 16:41	12/16/14 15:07	1

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Laboratory Report

Project Name		B-HS5 SE#12						
Parameters	Units	Results *	Method	PQL	MDL	Prepared	Analyzed	Dilution
Sample Description		BHS5-SULFUR-6						
Matrix		Wastewater						
SAL Sample Number		1412944-07						
Date/Time Collected		12/15/14 09:55						
Collected by		Josefin Hirst						
Date/Time Received		12/15/14 16:10						
Inorganics								
Ammonia as N	mg/L	1.2	EPA 350.1	0.040	0.009		12/16/14 12:48	1
Carbonaceous BOD	mg/L	19	SM 5210B	2	2	12/17/14 09:06	12/22/14 13:12	1
Nitrate+Nitrite (N)	mg/L	0.02 I	EPA 353.2	0.04	0.01		12/16/14 12:02	1
Nitrite (as N)	mg/L	0.01 U	SM	0.04	0.01		12/16/14 10:25	1
			4500NO2-B					
Sulfate	mg/L	240	EPA 300.0	6.0	2.0		12/26/14 10:55	10
Total Kjeldahl Nitrogen	mg/L	2.3	EPA 351.2	1.0	0.25	12/17/14 11:17	12/18/14 11:14	5
Nitrate (as N)	mg/L	0.02 I	EPA 353.2	0.08	0.02		12/16/14 12:02	1
Sample Description		BHS5-SULFUR-12						
Matrix		Wastewater						
SAL Sample Number		1412944-08						
Date/Time Collected		12/15/14 09:50						
Collected by		Josefin Hirst						
Date/Time Received		12/15/14 16:10						
Inorganics								
Ammonia as N	mg/L	0.98	EPA 350.1	0.040	0.009		12/16/14 12:50	1
Carbonaceous BOD	mg/L	28	SM 5210B	2	2	12/17/14 09:06	12/22/14 13:12	1
Nitrate+Nitrite (N)	mg/L	0.01 U	EPA 353.2	0.04	0.01		12/16/14 12:04	1
Nitrite (as N)	mg/L	0.01 U	SM	0.04	0.01		12/16/14 10:25	1
			4500NO2-B					
Sulfate	mg/L	260	EPA 300.0	6.0	2.0		12/26/14 11:12	10
Total Kjeldahl Nitrogen	mg/L	1.9	EPA 351.2	1.0	0.25	12/17/14 11:17	12/18/14 11:14	5
Nitrate (as N)	mg/L	0.02 U	EPA 353.2	0.08	0.02		12/16/14 12:04	1
Sample Description		BHS5-ST2						
Matrix		Wastewater						
SAL Sample Number		1412944-09						
Date/Time Collected		12/15/14 09:50						
Collected by		Josefin Hirst						
Date/Time Received		12/15/14 16:10						
Inorganics								
Hydrogen Sulfide (Unionized)	mg/L	0.01 U	SM 4550SF	0.04	0.01	12/24/14 10:01	12/24/14 10:06	1
Ammonia as N	mg/L	1.3	EPA 350.1	0.040	0.009		12/16/14 13:01	1
Carbonaceous BOD	mg/L	14	SM 5210B	2	2	12/17/14 09:06	12/22/14 13:12	1
Chemical Oxygen Demand	mg/L	41	EPA 410.4	25	10	12/22/14 10:37	12/22/14 12:39	1

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Laboratory Report

Project Name		B-HS5 SE#12						
Parameters	Units	Results *	Method	PQL	MDL	Prepared	Analyzed	Dilution
Sample Description		BHS5-ST2						
Matrix		Wastewater						
SAL Sample Number		1412944-09						
Date/Time Collected		12/15/14 09:50						
Collected by		Josefin Hirst						
Date/Time Received		12/15/14 16:10						
Nitrate+Nitrite (N)	mg/L	0.03 I	EPA 353.2	0.04	0.01		12/16/14 12:14	1
Nitrite (as N)	mg/L	0.03 I	SM	0.04	0.01		12/16/14 10:28	1
			4500NO2-B					
Phosphorous - Total as P	mg/L	2.5	SM 4500P-E	0.20	0.050	12/16/14 10:33	12/17/14 10:34	5
Sulfate	mg/L	270	EPA 300.0	6.0	2.0		12/26/14 11:21	10
Sulfide	mg/L	6.8	SM 4500SF	0.40	0.10		12/16/14 14:52	1
Total Kjeldahl Nitrogen	mg/L	2.1	EPA 351.2	1.0	0.25	12/16/14 10:33	12/17/14 10:34	5
Total Organic Carbon	mg/L	5.5	SM 5310B	1.0	0.060		12/18/14 11:26	1
Total Suspended Solids	mg/L	5	SM 2540D	1	1	12/17/14 08:19	12/18/14 15:43	1
Nitrate (as N)	mg/L	0.02 U	EPA 353.2	0.08	0.02		12/16/14 12:14	1
Microbiology								
E. Coli	MPN/100 mL	41	SM 9223B	2.0	2.0	12/15/14 16:49	12/16/14 11:06	1
Fecal Coliforms	CFU/100 ml	60	SM 9222D	1	1	12/15/14 16:41	12/16/14 15:07	1
Sample Description		BHS5-ST2-DUP						
Matrix		Wastewater						
SAL Sample Number		1412944-10						
Date/Time Collected		12/15/14 09:30						
Collected by		Josefin Hirst						
Date/Time Received		12/15/14 16:10						
Inorganics								
Hydrogen Sulfide (Unionized)	mg/L	0.01 U	SM 4550SF	0.04	0.01	12/24/14 10:01	12/24/14 10:06	1
Ammonia as N	mg/L	1.4 J5	EPA 350.1	0.040	0.009		12/16/14 13:03	1
Carbonaceous BOD	mg/L	13	SM 5210B	2	2	12/17/14 09:06	12/22/14 13:12	1
Chemical Oxygen Demand	mg/L	37	EPA 410.4	25	10	12/22/14 10:37	12/22/14 12:39	1
Nitrate+Nitrite (N)	mg/L	0.03 I	EPA 353.2	0.04	0.01		12/16/14 12:16	1
Nitrite (as N)	mg/L	0.03 I	SM	0.04	0.01		12/16/14 10:28	1
			4500NO2-B					
Phosphorous - Total as P	mg/L	2.5	SM 4500P-E	0.20	0.050	12/16/14 10:33	12/17/14 10:34	5
Sulfate	mg/L	310	EPA 300.0	6.0	2.0		12/26/14 11:31	10
Sulfide	mg/L	6.6	SM 4500SF	0.40	0.10		12/16/14 14:52	1
Total Kjeldahl Nitrogen	mg/L	2.0	EPA 351.2	1.0	0.25	12/16/14 10:33	12/17/14 10:34	5
Total Organic Carbon	mg/L	5.5	SM 5310B	1.0	0.060		12/18/14 11:26	1
Total Suspended Solids	mg/L	1 U	SM 2540D	1	1	12/17/14 08:19	12/18/14 15:43	1
Nitrate (as N)	mg/L	0.02 U	EPA 353.2	0.08	0.02		12/16/14 12:16	1
Microbiology								
E. Coli	MPN/100 mL	37	SM 9223B	2.0	2.0	12/15/14 16:49	12/16/14 11:06	1
Fecal Coliforms	CFU/100 ml	60	SM 9222D	1	1	12/15/14 16:41	12/16/14 15:07	1

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Laboratory Report

Project Name		B-HS5 SE#12						
Parameters	Units	Results *	Method	PQL	MDL	Prepared	Analyzed	Dilution
Sample Description		BHS5-FB						
Matrix		Reagent Water						
SAL Sample Number		1412944-11						
Date/Time Collected		12/15/14 11:35						
Collected by		Josefin Hirst						
Date/Time Received		12/15/14 16:10						
<u>Inorganics</u>								
Hydrogen Sulfide (Unionized)	mg/L	0.01 U	SM 4550SF	0.04	0.01	12/24/14 10:01	12/24/14 10:06	1
Ammonia as N	mg/L	0.009 U	EPA 350.1	0.040	0.009		12/16/14 13:05	1
Carbonaceous BOD	mg/L	2 U	SM 5210B	2	2	12/17/14 09:06	12/22/14 13:12	1
Chemical Oxygen Demand	mg/L	10 U	EPA 410.4	25	10	12/22/14 10:37	12/22/14 12:39	1
Nitrate+Nitrite (N)	mg/L	0.02 I	EPA 353.2	0.04	0.01		12/16/14 12:19	1
Nitrite (as N)	mg/L	0.01 U	SM 4500NO2-B	0.04	0.01		12/16/14 10:29	1
Phosphorous - Total as P	mg/L	0.48	SM 4500P-E	0.040	0.010	12/16/14 10:33	12/17/14 10:34	1
Sulfate	mg/L	0.20 U	EPA 300.0	0.60	0.20		12/24/14 04:07	1
Sulfide	mg/L	0.10 U	SM 4500SF	0.40	0.10		12/16/14 14:52	1
Total Kjeldahl Nitrogen	mg/L	0.10 I	EPA 351.2	0.20	0.05	12/16/14 10:33	12/17/14 10:34	1
Total Organic Carbon	mg/L	0.060 U	SM 5310B	1.0	0.060		12/18/14 11:26	1
Total Suspended Solids	mg/L	1 U	SM 2540D	1	1	12/17/14 08:19	12/18/14 15:43	1
Nitrate (as N)	mg/L	0.02 I	EPA 353.2	0.08	0.02		12/16/14 12:19	1
<u>Microbiology</u>								
E. Coli	MPN/100 mL	2.0 U	SM 9223B	2.0	2.0	12/15/14 16:49	12/16/14 11:06	1
Fecal Coliforms	CFU/100 ml	1 U	SM 9222D	1	1	12/15/14 16:41	12/16/14 15:07	1

Sample Description **BHS5-EB**
 Matrix **Reagent Water**
 SAL Sample Number **1412944-12**
 Date/Time Collected **12/15/14 11:45**
 Collected by **Josefin Hirst**
 Date/Time Received **12/15/14 16:10**

<u>Inorganics</u>								
Hydrogen Sulfide (Unionized)	mg/L	0.01 U	SM 4550SF	0.04	0.01	12/24/14 10:01	12/24/14 10:06	1
Ammonia as N	mg/L	0.009 U	EPA 350.1	0.040	0.009		12/16/14 13:07	1
Carbonaceous BOD	mg/L	2 U	SM 5210B	2	2	12/17/14 09:06	12/22/14 13:12	1
Chemical Oxygen Demand	mg/L	10 U	EPA 410.4	25	10	12/22/14 10:37	12/22/14 12:39	1
Nitrate+Nitrite (N)	mg/L	0.01 I	EPA 353.2	0.04	0.01		12/16/14 12:21	1
Nitrite (as N)	mg/L	0.01 U	SM 4500NO2-B	0.04	0.01		12/16/14 10:29	1
Phosphorous - Total as P	mg/L	0.49	SM 4500P-E	0.040	0.010	12/16/14 10:33	12/17/14 10:34	1
Sulfate	mg/L	0.20 U	EPA 300.0	0.60	0.20		12/26/14 10:00	1
Sulfide	mg/L	0.10 U	SM 4500SF	0.40	0.10		12/16/14 14:52	1
Total Kjeldahl Nitrogen	mg/L	0.08 I	EPA 351.2	0.20	0.05	12/16/14 10:33	12/17/14 10:34	1

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Laboratory Report

Project Name		B-HS5 SE#12						
Parameters	Units	Results *	Method	PQL	MDL	Prepared	Analyzed	Dilution
Sample Description		BHS5-EB						
Matrix		Reagent Water						
SAL Sample Number		1412944-12						
Date/Time Collected		12/15/14 11:45						
Collected by		Josefin Hirst						
Date/Time Received		12/15/14 16:10						
Total Organic Carbon	mg/L	0.060 U	SM 5310B	1.0	0.060		12/18/14 11:26	1
Total Suspended Solids	mg/L	1 U	SM 2540D	1	1	12/17/14 08:19	12/18/14 15:43	1
Nitrate (as N)	mg/L	0.02 U	EPA 353.2	0.08	0.02		12/16/14 12:21	1
Microbiology								
E. Coli	MPN/100 mL	2.0 U	SM 9223B	2.0	2.0	12/15/14 16:49	12/16/14 11:06	1
Fecal Coliforms	CFU/100 ml	1 U	SM 9222D	1	1	12/15/14 16:41	12/16/14 15:07	1

SOUTHERN ANALYTICAL LABORATORIES, INC.

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Inorganics - Quality Control

Analyte	Result	PQL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch BL41605 - Nitrite SM 4500NO2-B by seal										
Blank (BL41605-BLK1)					Prepared & Analyzed: 12/16/14 10:20					
Nitrite (as N)	0.01 U	0.04	0.01	mg/L						
LCS (BL41605-BS1)					Prepared & Analyzed: 12/16/14 10:20					
Nitrite (as N)	0.0764	0.04	0.01	mg/L	0.080		96	90-110		
Matrix Spike (BL41605-MS1)					Source: 1412944-01 Prepared & Analyzed: 12/16/14 10:21					
Nitrite (as N)	0.0657 J2	0.04	0.01	mg/L	0.10	0.0462	20	77-119		
Matrix Spike (BL41605-MS2)					Source: 1413190-02 Prepared & Analyzed: 12/16/14 10:27					
Nitrite (as N)	0.01 U,J2	0.04	0.01	mg/L	0.10	ND		77-119		
Matrix Spike Dup (BL41605-MSD1)					Source: 1412944-01 Prepared & Analyzed: 12/16/14 10:21					
Nitrite (as N)	0.0678 J2	0.04	0.01	mg/L	0.10	0.0462	22	77-119	3	20
Matrix Spike Dup (BL41605-MSD2)					Source: 1413190-02 Prepared & Analyzed: 12/16/14 10:27					
Nitrite (as N)	0.01 U,J2	0.04	0.01	mg/L	0.10	ND		77-119		20
Batch BL41610 - Nitrate 353.2 by seal										
Blank (BL41610-BLK1)					Prepared & Analyzed: 12/16/14 11:40					
Nitrate+Nitrite (N)	0.0150 I	0.04	0.01	mg/L						
Blank (BL41610-BLK2)					Prepared & Analyzed: 12/16/14 12:50					
Nitrate+Nitrite (N)	0.01 U	0.04	0.01	mg/L						
LCS (BL41610-BS1)					Prepared & Analyzed: 12/16/14 11:42					
Nitrate+Nitrite (N)	0.780	0.04	0.01	mg/L	0.80		97	90-110		

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Inorganics - Quality Control

Analyte	Result	PQL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch BL41610 - Nitrate 353.2 by seal										
LCS (BL41610-BS2)					Prepared & Analyzed: 12/16/14 12:51					
Nitrate+Nitrite (N)	0.788	0.04	0.01	mg/L	0.80		98	90-110		
Matrix Spike (BL41610-MS1)					Source: 1412944-01 Prepared & Analyzed: 12/16/14 11:45					
Nitrate+Nitrite (N)	0.994	0.04	0.01	mg/L	1.0	0.0410	95	90-110		
Matrix Spike (BL41610-MS2)					Source: 1412944-10 Prepared & Analyzed: 12/16/14 12:10					
Nitrate+Nitrite (N)	1.04	0.04	0.01	mg/L	1.0	0.0280	101	90-110		
Matrix Spike (BL41610-MS3)					Source: 1413196-01 Prepared & Analyzed: 12/16/14 12:52					
Nitrate+Nitrite (N)	1.04	0.04	0.01	mg/L	1.0	0.0860	96	90-110		
Matrix Spike Dup (BL41610-MSD1)					Source: 1412944-01 Prepared & Analyzed: 12/16/14 11:47					
Nitrate+Nitrite (N)	1.01	0.04	0.01	mg/L	1.0	0.0410	97	90-110	2	20
Matrix Spike Dup (BL41610-MSD2)					Source: 1412944-10 Prepared & Analyzed: 12/16/14 12:12					
Nitrate+Nitrite (N)	1.03	0.04	0.01	mg/L	1.0	0.0280	100	90-110	0.6	20
Matrix Spike Dup (BL41610-MSD3)					Source: 1413196-01 Prepared & Analyzed: 12/16/14 12:53					
Nitrate+Nitrite (N)	0.991	0.04	0.01	mg/L	1.0	0.0860	90	90-110	5	20
Batch BL41612 - Digestion for TP and TKN										
Blank (BL41612-BLK1)					Prepared: 12/16/14 Analyzed: 12/17/14 10:34					
Phosphorous - Total as P	0.0120 I	0.040	0.010	mg/L						
Total Kjeldahl Nitrogen	0.05 U	0.20	0.05	mg/L						
Blank (BL41612-BLK2)					Prepared: 12/16/14 Analyzed: 12/17/14 10:34					
Total Kjeldahl Nitrogen	0.05 U	0.20	0.05	mg/L						
Phosphorous - Total as P	0.0170 I	0.040	0.010	mg/L						

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Inorganics - Quality Control

Analyte	Result	PQL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch BL41612 - Digestion for TP and TKN										
LCS (BL41612-BS1)					Prepared: 12/16/14 Analyzed: 12/17/14 10:34					
Total Kjeldahl Nitrogen	1.02	0.20	0.05	mg/L	1.0		102	90-110		
Phosphorous - Total as P	1.04	0.040	0.010	mg/L	1.0		104	90-110		
LCS (BL41612-BS2)					Prepared: 12/16/14 Analyzed: 12/17/14 10:34					
Phosphorous - Total as P	1.04	0.040	0.010	mg/L	1.0		104	90-110		
Total Kjeldahl Nitrogen	0.925	0.20	0.05	mg/L	1.0		92	90-110		
Matrix Spike (BL41612-MS1)					Source: 1413178-07		Prepared: 12/16/14 Analyzed: 12/17/14 10:34			
Phosphorous - Total as P	0.940	0.040	0.010	mg/L	1.0	0.578	36	90-110		
Total Kjeldahl Nitrogen	1.06 J2	0.20	0.05	mg/L	1.0	0.597	46	90-110		
Matrix Spike (BL41612-MS2)					Source: 1413196-02		Prepared: 12/16/14 Analyzed: 12/17/14 10:34			
Total Kjeldahl Nitrogen	0.900	0.20	0.05	mg/L	1.0	ND	90	90-110		
Phosphorous - Total as P	1.06	0.040	0.010	mg/L	1.0	0.568	49	90-110		
Matrix Spike (BL41612-MS3)					Source: 1412944-12		Prepared: 12/16/14 Analyzed: 12/17/14 10:34			
Total Kjeldahl Nitrogen	1.03	0.20	0.05	mg/L	1.0	0.0820	95	90-110		
Phosphorous - Total as P	1.12	0.040	0.010	mg/L	1.0	0.492	63	90-110		
Matrix Spike Dup (BL41612-MSD1)					Source: 1413178-07		Prepared: 12/16/14 Analyzed: 12/17/14 10:34			
Phosphorous - Total as P	1.08	0.040	0.010	mg/L	1.0	0.578	50	90-110	14	25
Total Kjeldahl Nitrogen	1.01 J2	0.20	0.05	mg/L	1.0	0.597	41	90-110	5	20
Matrix Spike Dup (BL41612-MSD2)					Source: 1413196-02		Prepared: 12/16/14 Analyzed: 12/17/14 10:34			
Total Kjeldahl Nitrogen	1.09	0.20	0.05	mg/L	1.0	ND	109	90-110	19	20
Phosphorous - Total as P	0.925	0.040	0.010	mg/L	1.0	0.568	36	90-110	14	25
Matrix Spike Dup (BL41612-MSD3)					Source: 1412944-12		Prepared: 12/16/14 Analyzed: 12/17/14 10:34			
Phosphorous - Total as P	1.05	0.040	0.010	mg/L	1.0	0.492	56	90-110	6	25
Total Kjeldahl Nitrogen	1.03	0.20	0.05	mg/L	1.0	0.0820	95	90-110	0	20

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Inorganics - Quality Control

Analyte	Result	PQL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch BL41614 - Ammonia by SEAL										
Blank (BL41614-BLK1)					Prepared & Analyzed: 12/16/14 12:28					
Ammonia as N	0.009 U	0.040	0.009	mg/L						
LCS (BL41614-BS1)					Prepared & Analyzed: 12/16/14 12:30					
Ammonia as N	0.52	0.040	0.009	mg/L	0.50		105	90-110		
Matrix Spike (BL41614-MS1)					Source: 1412944-01 Prepared & Analyzed: 12/16/14 14:04					
Ammonia as N	54 L2	3.6	0.85	mg/L	0.50	58	NR	90-110		
Matrix Spike (BL41614-MS2)					Source: 1412944-10 Prepared & Analyzed: 12/16/14 12:57					
Ammonia as N	1.8 J2	0.040	0.009	mg/L	0.50	1.4	80	90-110		
Matrix Spike Dup (BL41614-MSD1)					Source: 1412944-01 Prepared & Analyzed: 12/16/14 14:06					
Ammonia as N	54 L2	3.6	0.85	mg/L	0.50	58	NR	90-110	0.6	10
Matrix Spike Dup (BL41614-MSD2)					Source: 1412944-10 Prepared & Analyzed: 12/16/14 12:59					
Ammonia as N	1.8 J2	0.040	0.009	mg/L	0.50	1.4	86	90-110	2	10
Batch BL41618 - Sulfide prep										
Blank (BL41618-BLK1)					Prepared & Analyzed: 12/16/14 14:52					
Sulfide	0.10 U	0.40	0.10	mg/L						
LCS (BL41618-BS1)					Prepared & Analyzed: 12/16/14 14:52					
Sulfide	4.84	0.40	0.10	mg/L	5.0		97	85-115		
Matrix Spike (BL41618-MS1)					Source: 1412944-11 Prepared & Analyzed: 12/16/14 14:52					
Sulfide	4.84	0.40	0.10	mg/L	5.0	ND	97	85-115		

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Inorganics - Quality Control

Analyte	Result	PQL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch BL41618 - Sulfide prep										
Matrix Spike Dup (BL41618-MSD1)		Source: 1412944-11			Prepared & Analyzed: 12/16/14 14:52					
Sulfide	5.04	0.40	0.10	mg/L	5.0	ND	101	85-115	4	14
Batch BL41625 - TOC prep										
Blank (BL41625-BLK1)				Prepared & Analyzed: 12/18/14 11:26						
Total Organic Carbon	0.060 U	1.0	0.060	mg/L						
LCS (BL41625-BS1)				Prepared & Analyzed: 12/18/14 11:26						
Total Organic Carbon	9.80	1.0	0.060	mg/L	10		98	90-110		
Matrix Spike (BL41625-MS1)		Source: 1412944-02			Prepared & Analyzed: 12/18/14 11:26					
Total Organic Carbon	12.6	1.0	0.060	mg/L	10	3.38	92	85-115		
Matrix Spike Dup (BL41625-MSD1)		Source: 1412944-02			Prepared & Analyzed: 12/18/14 11:26					
Total Organic Carbon	12.9	1.0	0.060	mg/L	10	3.38	95	85-115	2	10
Batch BL41703 - TSS prep										
Blank (BL41703-BLK1)				Prepared: 12/17/14 Analyzed: 12/18/14 15:43						
Total Suspended Solids	1 U	1	1	mg/L						
Blank (BL41703-BLK2)				Prepared: 12/17/14 Analyzed: 12/18/14 15:43						
Total Suspended Solids	1 U	1	1	mg/L						
LCS (BL41703-BS1)				Prepared: 12/17/14 Analyzed: 12/18/14 15:43						
Total Suspended Solids	53.5	1	1	mg/L	50		107	85-115		

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Inorganics - Quality Control

Analyte	Result	PQL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch BL41703 - TSS prep										
LCS (BL41703-BS2)					Prepared: 12/17/14 Analyzed: 12/18/14 15:43					
Total Suspended Solids	47.0	1	1	mg/L	50		94	85-115		
Duplicate (BL41703-DUP1)					Source: 1413204-01 Prepared: 12/17/14 Analyzed: 12/18/14 15:43					
Total Suspended Solids	115	1	1	mg/L		115			0	30
Duplicate (BL41703-DUP2)					Source: 1413217-01 Prepared: 12/17/14 Analyzed: 12/18/14 15:43					
Total Suspended Solids	181	1	1	mg/L		179			1	30
Batch BL41706 - BOD										
Blank (BL41706-BLK1)					Prepared: 12/17/14 Analyzed: 12/22/14 13:12					
Carbonaceous BOD	2 U	2	2	mg/L						
Blank (BL41706-BLK2)					Prepared: 12/17/14 Analyzed: 12/22/14 13:12					
Carbonaceous BOD	2 U	2	2	mg/L						
LCS (BL41706-BS1)					Prepared: 12/17/14 Analyzed: 12/22/14 13:12					
Carbonaceous BOD	172	2	2	mg/L	200		86	85-115		
LCS (BL41706-BS2)					Prepared: 12/17/14 Analyzed: 12/22/14 13:12					
Carbonaceous BOD	177	2	2	mg/L	200		88	85-115		
LCS Dup (BL41706-BSD1)					Prepared: 12/17/14 Analyzed: 12/22/14 13:12					
Carbonaceous BOD	188	2	2	mg/L	200		94	85-115	9	200
LCS Dup (BL41706-BSD2)					Prepared: 12/17/14 Analyzed: 12/22/14 13:12					
Carbonaceous BOD	189	2	2	mg/L	200		94	85-115	7	200

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Inorganics - Quality Control

Analyte	Result	PQL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch BL41706 - BOD										
Duplicate (BL41706-DUP1)		Source: 1412943-01			Prepared: 12/17/14 Analyzed: 12/22/14 13:12					
Carbonaceous BOD	170	2	2	mg/L		170			3	25
Duplicate (BL41706-DUP2)		Source: 1413217-01			Prepared: 12/17/14 Analyzed: 12/22/14 13:12					
Carbonaceous BOD	310	2	2	mg/L		300			4	25
Batch BL41712 - Digestion for TP and TKN										
Blank (BL41712-BLK1)					Prepared: 12/17/14 Analyzed: 12/18/14 11:14					
Total Kjeldahl Nitrogen	0.0500 I	0.20	0.05	mg/L						
Blank (BL41712-BLK2)					Prepared: 12/17/14 Analyzed: 12/18/14 11:14					
Total Kjeldahl Nitrogen	0.05 U	0.20	0.05	mg/L						
LCS (BL41712-BS1)					Prepared: 12/17/14 Analyzed: 12/18/14 11:14					
Total Kjeldahl Nitrogen	0.944	0.20	0.05	mg/L	1.0		94	90-110		
LCS (BL41712-BS2)					Prepared: 12/17/14 Analyzed: 12/18/14 11:14					
Total Kjeldahl Nitrogen	1.09	0.20	0.05	mg/L	1.0		109	90-110		
Matrix Spike (BL41712-MS1)		Source: 1412943-10			Prepared: 12/17/14 Analyzed: 12/18/14 11:14					
Total Kjeldahl Nitrogen	6.10	0.20	0.05	mg/L	1.0	5.02	108	90-110		
Matrix Spike (BL41712-MS2)		Source: 1412943-12			Prepared: 12/17/14 Analyzed: 12/18/14 11:14					
Total Kjeldahl Nitrogen	1.17	0.20	0.05	mg/L	1.0	0.198	97	90-110		
Matrix Spike (BL41712-MS3)		Source: 1413212-07			Prepared: 12/17/14 Analyzed: 12/18/14 11:14					
Total Kjeldahl Nitrogen	1.10	0.20	0.05	mg/L	1.0	ND	110	90-110		

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Inorganics - Quality Control

Analyte	Result	PQL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch BL41712 - Digestion for TP and TKN										
Matrix Spike (BL41712-MS4)		Source: 1413217-07			Prepared: 12/17/14 Analyzed: 12/18/14 11:14					
Total Kjeldahl Nitrogen	2.10	0.20	0.05	mg/L	1.0	1.09	101	90-110		
Matrix Spike Dup (BL41712-MSD1)		Source: 1412943-10			Prepared: 12/17/14 Analyzed: 12/18/14 11:14					
Total Kjeldahl Nitrogen	6.00	0.20	0.05	mg/L	1.0	5.02	99	90-110	2	20
Matrix Spike Dup (BL41712-MSD2)		Source: 1412943-12			Prepared: 12/17/14 Analyzed: 12/18/14 11:14					
Total Kjeldahl Nitrogen	1.10	0.20	0.05	mg/L	1.0	0.198	90	90-110	6	20
Matrix Spike Dup (BL41712-MSD3)		Source: 1413212-07			Prepared: 12/17/14 Analyzed: 12/18/14 11:14					
Total Kjeldahl Nitrogen	1.03	0.20	0.05	mg/L	1.0	ND	103	90-110	7	20
Matrix Spike Dup (BL41712-MSD4)		Source: 1413217-07			Prepared: 12/17/14 Analyzed: 12/18/14 11:14					
Total Kjeldahl Nitrogen	2.15	0.20	0.05	mg/L	1.0	1.09	106	90-110	2	20
Batch BL42212 - COD prep										
Blank (BL42212-BLK1)		Prepared & Analyzed: 12/22/14 12:39								
Chemical Oxygen Demand	10 U	25	10	mg/L						
Blank (BL42212-BLK2)		Prepared & Analyzed: 12/22/14 12:39								
Chemical Oxygen Demand	10 U	25	10	mg/L						
Blank (BL42212-BLK3)		Prepared & Analyzed: 12/22/14 12:39								
Chemical Oxygen Demand	10 U	25	10	mg/L						
LCS (BL42212-BS1)		Prepared & Analyzed: 12/22/14 12:39								
Chemical Oxygen Demand	49	25	10	mg/L	50		98	90-110		

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Inorganics - Quality Control

Analyte	Result	PQL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch BL42212 - COD prep										
LCS (BL42212-BS2)					Prepared & Analyzed: 12/22/14 12:39					
Chemical Oxygen Demand	47	25	10	mg/L	50		94	90-110		
LCS (BL42212-BS3)					Prepared & Analyzed: 12/22/14 12:39					
Chemical Oxygen Demand	45	25	10	mg/L	50		90	90-110		
Matrix Spike (BL42212-MS1)					Source: 1412942-19 Prepared & Analyzed: 12/22/14 12:39					
Chemical Oxygen Demand	45	25	10	mg/L	50	ND	90	85-115		
Matrix Spike (BL42212-MS2)					Source: 1412944-11 Prepared & Analyzed: 12/22/14 12:39					
Chemical Oxygen Demand	47	25	10	mg/L	50	ND	94	85-115		
Matrix Spike (BL42212-MS3)					Source: 1412946-21 Prepared & Analyzed: 12/22/14 12:39					
Chemical Oxygen Demand	45	25	10	mg/L	50	ND	90	85-115		
Matrix Spike Dup (BL42212-MSD1)					Source: 1412942-19 Prepared & Analyzed: 12/22/14 12:39					
Chemical Oxygen Demand	45	25	10	mg/L	50	ND	90	85-115	0	32
Matrix Spike Dup (BL42212-MSD2)					Source: 1412944-11 Prepared & Analyzed: 12/22/14 12:39					
Chemical Oxygen Demand	45	25	10	mg/L	50	ND	90	85-115	4	32
Matrix Spike Dup (BL42212-MSD3)					Source: 1412946-21 Prepared & Analyzed: 12/22/14 12:39					
Chemical Oxygen Demand	43	25	10	mg/L	50	ND	86	85-115	5	32
Batch BL42316 - Ion Chromatography 300.0 Prep										
Blank (BL42316-BLK1)					Prepared & Analyzed: 12/24/14 00:46					
Sulfate	0.20 U	0.60	0.20	mg/L						
Surrogate: Dichloroacetate	0.840			mg/L	1.0		84	78-120		

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Inorganics - Quality Control

Analyte	Result	PQL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch BL42316 - Ion Chromatography 300.0 Prep										
LCS (BL42316-BS1)					Prepared & Analyzed: 12/24/14 00:57					
Sulfate	9.54	0.60	0.20	mg/L	9.0		106	85-115		
Surrogate: Dichloroacetate	1.04			mg/L	1.0		104	78-120		
LCS Dup (BL42316-BSD1)					Prepared & Analyzed: 12/24/14 01:08					
Sulfate	9.24	0.60	0.20	mg/L	9.0		103	85-115	3	200
Surrogate: Dichloroacetate	0.987			mg/L	1.0		99	78-120		
Matrix Spike (BL42316-MS1)					Source: 1412944-08		Prepared & Analyzed: 12/24/14 03:11			
Sulfate	298 L	0.60	0.20	mg/L	9.0	262	405	85-115		
Surrogate: Dichloroacetate	0.826			mg/L	1.0		83	78-120		
Matrix Spike (BL42316-MS2)					Source: 1412943-08		Prepared & Analyzed: 12/24/14 05:37			
Sulfate	82.7	0.60	0.20	mg/L	9.0	72.7	111	85-115		
Surrogate: Dichloroacetate	0.868			mg/L	1.0		87	78-120		
Batch BL42414 - Ion Chromatography 300.0 Prep										
Blank (BL42414-BLK1)					Prepared & Analyzed: 12/24/14 17:26					
Sulfate	0.20 U	0.60	0.20	mg/L						
Surrogate: Dichloroacetate	0.966			mg/L	1.0		97	78-120		
LCS (BL42414-BS1)					Prepared & Analyzed: 12/24/14 17:35					
Sulfate	8.76	0.60	0.20	mg/L	9.0		97	85-115		
Surrogate: Dichloroacetate	1.05			mg/L	1.0		105	78-120		
LCS Dup (BL42414-BSD1)					Prepared & Analyzed: 12/24/14 17:53					
Sulfate	9.16	0.60	0.20	mg/L	9.0		102	85-115	4	200
Surrogate: Dichloroacetate	1.04			mg/L	1.0		104	78-120		

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Inorganics - Quality Control

Analyte	Result	PQL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch BL42414 - Ion Chromatography 300.0 Prep										
Matrix Spike (BL42414-MS1)		Source: 1413401-01			Prepared & Analyzed: 12/24/14 19:37					
Sulfate	453	6.0	2.0	mg/L	90	372	90	85-115		
Surrogate: Dichloroacetate	1.10			mg/L	1.0		110	78-120		
Matrix Spike (BL42414-MS2)		Source: 1412944-10			Prepared & Analyzed: 12/26/14 11:40					
Sulfate	395	6.0	2.0	mg/L	90	314	90	85-115		
Surrogate: Dichloroacetate	1.07			mg/L	1.0		107	78-120		

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Microbiology - Quality Control

Analyte	Result	PQL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch BL41603 - FC-MF										
Blank (BL41603-BLK1)					Prepared: 12/15/14 Analyzed: 12/16/14 15:07					
Fecal Coliforms	1 U	1	1	CFU/100 ml						
Duplicate (BL41603-DUP1)					Source: 1412944-11 Prepared: 12/15/14 Analyzed: 12/16/14 15:07					
Fecal Coliforms	1 U	1	1	CFU/100 ml		ND				200

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*** Qualifiers, Notes and Definitions**

Results followed by a "U" indicate that the sample was analyzed but the compound was not detected. Results followed by "I" indicate that the reported value is between the laboratory method detection limits and the laboratory practical quantitation limit.

A statement of estimated uncertainty of test results is available upon request.

For methods marked with **, all QC criteria have been met for this method which is equivalent to a SAL certified method.

Test results in this report meet all the requirements of the NELAC standards. Any applicable qualifiers are shown below.

- L2 Analyte level in sample invalidated Matrix Spike.
L Off-scale high. Result exceeded highest calibration standard.
J5 Matrix spike of this sample was outside typical range. All other QC criteria were acceptable.
J2 Quality control value for accuracy was outside control limits.

Questions regarding this report should be directed to :

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Kathryn@southernanalyticalabs.com



Client Name Hazan and Sawyer										Contact / Phone: Josefin Hirst 813-630-4498									
Project Name / Location BHS5 SE#12																			
Samplers: (Signature) <i>Josefin Hirst</i>										PARAMETER / CONTAINER DESCRIPTION									
Matrix Codes: DW-Drinking Water WW-Wastewater SW-Surface Water SL-Sludge SO-Soil GW-Groundwater SA-Saline Water O-Other R-Reagent Water																			
SAL Use Only Sample No.																			
Sample Description										Date									
Time										Matrix									
Composite										Grab									
125mLP, Sterile, Na ₂ S ₂ O ₃ FC-MF, FC-QT										500mLP, Cool TSS, CBOD, NOx, SO ₄									
125mLP, H ₂ SO ₄ COD, TKN, NH ₃ , TP										500mLP, NaOH, Zn Acetate H ₂ S									
40mLaV, HCl TOC										500mLP, Cool CBOD, NOx, SO ₄									
125mLP, H ₂ SO ₄ TKN, NH ₃										pH									
Temperature										Conductivity									
DO																			
01 BHS5-STE										12/15/14 11:10 WW X 4 2 1 1 2 7.43 19.8 122 2 0.05									
02 BHS5-ST1										10:55 WW X 4 2 1 1 2 6.93 20.2 118 7 5.43									
03 BHS5-LIGNO-36										10:35 WW X 1 1 6.87 20.0 112 2 1.26									
04 BHS5-LIGNO-24										10:35 WW X 1 1 6.97 20.1 110 7 1.75									
05 BHS5-LIGNO-12										10:20 WW X 1 1 6.92 19.8 111 0 0.23									
06 BHS5-LIGNO-0										10:05 WW X 4 2 1 1 2 6.92 19.6 111 1 0.38									
07 BHS6-SULFUR-6										9:55 WW X 1 1 6.62 19.7 120 9 0.30									
08 BHS5-SULFUR-12										9:50 WW X 1 1 6.33 19.2 130 1 0.50									
09 BHS5-ST2										9:25 WW X 4 2 1 1 2 6.77 19.1 130 6 0.20									
10 BHS5-ST2-DUP										9:30 WW X 4 2 1 1 2 6.77 19.1 130 6 0.20									
11 BHS5-FB										11:35 R X 4 2 1 1 2 6.59 18.1 4.36 8.41									
12 BHS5-EB										11:45 R X 4 2 1 1 2 6.23 18.3 2.06 8.42									
Container Prepared/Relinquished										Date/Time: 13:00 Received: <i>Josefin Hirst</i> Date/Time: 13:00 Seal intact? <input checked="" type="checkbox"/> N NA									
Relinquished										Date/Time: 12:01 Samples intact upon arrival? <input checked="" type="checkbox"/> N NA									
Relinquished										Date/Time: 12:15 Received: <i>Josefin Hirst</i> Date/Time: 12:15 Received on ice? Temp _____ <input checked="" type="checkbox"/> N NA									
Relinquished										Date/Time: 12:15 Received: <i>Josefin Hirst</i> Date/Time: 12:15 Proper preservatives indicated? <input checked="" type="checkbox"/> N NA									
Relinquished										Date/Time: 12:15 Received: <i>Josefin Hirst</i> Date/Time: 12:15 Rec'd within holding time? <input checked="" type="checkbox"/> N NA									
Relinquished										Date/Time: Volatiles rec'd w/out headspace? <input checked="" type="checkbox"/> N NA									
Relinquished										Date/Time: Proper containers used? <input checked="" type="checkbox"/> N NA									
										Instructions / Remarks 1412944									



Appendix B: Operation & Maintenance Log

Table B.1
Operation and Maintenance Log

Date	Description
6/24/2013	Construction - Stage 1 and Stage 2 tanks installed
6/25/2013	Construction - Drainfield distribution box installed and all pipework
7/9/2013	System Start-up
	Bull run valve switched from drainfield to Stage 1 biofilter
7/17/2013	System check
7/23/2013	Construction - sod installation
7/29/2013	Preliminary sample event No. 1
8/6/2013	Site visit. System ok.
	Need to add soil around low side of pump tank riser
8/15/2013	Preliminary sample event No. 2
9/27/2013	Sample Event No. 1
11/8/2013	Site visit. System ok.
11/27/2013	Site visit. System ok.
12/4/2013	Sample Event No. 2
12/23/2013	Site visit. System ok.
1/23/2014	Site visit. System ok.
1/31/2014	Site visit. System ok.
2/3/2014	Sample Event No. 3
2/4/2014	Sample Event No. 4
2/5/2014	Sample Event No. 5
2/6/2014	Sample Event No. 6
2/7/2014	Sample Event No. 7
2/12/2014	Site visit. System ok.
3/14/2014	Site visit. System ok.
4/11/2014	Sample Event No. 8
4/25/2014	Site visit. System ok.
	Revised mode of operation to recirculation to the Stage 1 biofilter sprayers.
	Set recirc ratio to 3:1.
	Installed Stage 1 biofilter piezometer for water level monitoring.

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Table B.1 (con't)
Operation and Maintenance Log

4/29/2014	Site visit. System ok.
5/28/2014	Sample Event No. 9 (formal No. 5)
5/29/2014	Collected samples for product composition testing.
7/11/2014	Site visit. System ok.
	First and second sprayers in Stage 1 biofilter not spinning on dose. Fixed.
7/29/2014	Site visit. System ok.
	Cleaned STE effluent screen.
8/18/2014	Sample Event No. 10 (formal No. 6)
	Middle sprayer in Stage 1 biofilter not spinning on dose. Fixed.
9/19/2014	Site visit. System ok.
	Cleaned STE effluent screen.
10/21/2014	Sample Event No. 11 (formal No. 7)
	Cleaned STE effluent screen.
11/21/2014	Site visit. System ok.
12/15/2014	Sample Event No. 12 (formal No. 8)
	Cleaned STE effluent screen.



Appendix C: Vericomm PLC Data

Table C.1
Vericomm Data October 23, 2014 through December 15, 2014

System Status		12/15/14 12:22	11/21/14 8:55	10/23/14 3:10
Point	Description	Value	Value	Value
1	Alarm Status	OK	OK	OK
2	Alert Status	OK	OK	OK
3	System Mode	Normal	Normal	Normal
5	Timer Mode	Normal	Off	Off
6	Active Off Time	60.0 Minutes	60.0 Minutes	60.0 Minutes
7	Active On Time	2.1 Minutes	2.1 Minutes	2.1 Minutes
9	Pump Mode	OffCycl	Off	Off
10	Pump Status	Off	Off	Off
Settings				
Point	Description	Value	Value	Value
17	Off Cycle Time	60.0 Minutes	60.0 Minutes	60.0 Minutes
18	On Cycle Time	2.1 Minutes	2.1 Minutes	2.1 Minutes
19	Override Off Cycle Time	30.0 Minutes	30.0 Minutes	30.0 Minutes
20	Override On Cycle Time	2.1 Minutes	0.7 Minutes	0.7 Minutes
21	Minimum Override Cycles	3.0 Cycles	3.0 Cycles	3.0 Cycles
23	Override Cycle Limit per Day	7.0 Cycles	7.0 Cycles	7.0 Cycles
24	Time Limit per Day	26.0 Minutes	26.0 Minutes	26.0 Minutes
25	High Level Pump Test	2.0 Minutes	2.0 Minutes	2.0 Minutes
28	Alarm Update Interval	120.0 Minutes	120.0 Minutes	120.0 Minutes
29	Page Delay	960.0 Minutes	960.0 Minutes	960.0 Minutes
30	Page Interval	30.0 Minutes	30.0 Minutes	30.0 Minutes
31	Local Alarm Delay	1140.0 Minutes	1140.0 Minutes	1140.0 Minutes
32	Local Reactivate Delay	120.0 Minutes	120.0 Minutes	120.0 Minutes
Troubleshooting				
Point	Description	Value	Value	Value
33	Top Float Status	OK	OK	OK
34	Middle Float Status	OK	OK	OK
35	Bottom Float Status	OK	OK	OK
37	Contactors Status	OK	OK	OK
38	Pump Status	OK	OK	OK
40	Filter Status	OK	OK	OK
41	Tank Status	OK	OK	OK
43	Power Status	OK	OK	OK
Flow Data (at the time of Vericomm call-in)				
Point	Description	Value	Value	Value
49	Pump Run Time Today	5.8 Minutes	4.7 Minutes	0.9 Minutes
50	Override Cycles Today	0	0	0
51	Pump Cycles Today	6.0 Cycles	5.0 Cycles	1.0 Cycles
52	Average Run Time per Cycle Today	1.0 Minutes	0.9 Minutes	0.9 Minutes
54	Brownouts Today	0	0	0

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Table C.1 (continued)
Vericomm Data August 23, 2014 through October 21, 2014

		12/15/14 12:22	11/21/14 8:55	10/23/14 3:10
30-Day History Data				
Point	Description	Value	Value	Value
65	30 Day Average Run Time per Day	20.9 Minutes	13.9 Minutes	15.8 Minutes
66	30 Day Average Override Cycles per Day	2.2 Cycles	0.0 Cycles	0.2 Cycles
67	30 Day Average Cycles per Day	17.2 Cycles	13.3 Cycles	14.4 Cycles
68	30 Day Average Run Time per Cycle	1.2 Minutes	1.0 Minutes	1.1 Minutes
71	30 Day Total Pump Run Time	626.9 Minutes	417.8 Minutes	472.8 Minutes
72	30 Day Total Override Cycles	65.0 Cycles	0.0 Cycles	7.0 Cycles
73	30 Day Total Cycles	516.0 Cycles	398.0 Cycles	431.0 Cycles
76	30 Day Total Brownouts	0	0	0
Totalized Pump Data				
Point	Description	Value	Value	Value
82	Pump Total Run Time	85.6 Hours	76.8 Hours	70.0 Hours
83	Pump Total Cycles	5281.0 Cycles	4852.0 Cycles	4462.0 Cycles
Miscellaneous				
Point	Description	Value	Value	Value
145	Pump On Auto	Off	Off	Off
147	Pump Test Today	Off	Off	Off
148	Pump Check Enable	Off	Off	Off
149	Total Override Cycles	0	0	0
150	High Level Condition	Off	Off	Off
151	Leak Check Enable	On	Off	Off
152	Brownout State	Off	Off	Off
153	Test Mode	Off	Off	Off
Alarm Points				
Point	Description	Value	Value	Value
161	General Alarm	Off	Off	Off
162	New Alarm	Off	Off	Off
163	Update Central Enable	On	On	On
167	Page Alarm Start	Off	Off	Off
168	Pager Signal	Off	Off	Off
169	Local Alarm Start	Off	Off	Off
170	Local Alarm Silence	Off	Off	Off
Inputs & Outputs				
Point	Description	Value	Value	Value
177	High Level/Override Timer Float Input	Off	Off	Off
178	Timer Float Input	On	Off	Off
179	Redundant Off Float & Low Level Alarm Input	On	On	On
181	Push To Silence Input	Off	Off	Off
182	Auxiliary Contact Input	Off	Off	Off
186	Pump Output	Off	Off	Off
188	Alarm Light Output	Off	Off	Off
189	Audible Alarm Output	Off	Off	Off

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