APPENDIX A SYSTEM INSTALLATION REPORTS

Florida Department of Health
Onsite Nitrogen Reduction Strategies Study

Contract CORCL

TASK B.6

Installation Report for Passive Nitrogen Reduction System B-HS1

June 30, 2011

Task B of the Florida Onsite 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. To meet this objective, full scale treatment systems will be installed at various residential sites in Florida, operated on septic tank effluent under actual onsite conditions, and monitored over an extended timeframe. 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 installation of a passive nitrogen reduction system at a home site in Wakulla County, Florida (B-HS1).

System Overview

The system installed in Wakulla County, Florida (B-HS1) in June 2011 consists of a 1,500 gallon two chamber concrete tank with 1,000 gallon primary treatment tank (1st chamber) and 500 gallon pump chamber (2nd chamber); an Aerocell unsaturated media filter chamber, and a 1,500 gallon single chamber upflow tank containing Nitrex media. Figure 1 is a site schematic showing the system components and layout of the installation. A complete as-built system diagram is included in the Operation and Maintenance manual which is attached as Appendix A. A few of the details in Figure 1 were revised during the installation and are detailed in the next section of this report.

Household wastewater enters the 1st (i.e. septic) chamber of the primary tank and exits as septic tank effluent through a “filter” into the 2nd chamber. A Quanics pump vault within the 2nd chamber serves as another “filter” and contains the pump, float switches, and a post pump filter. The 2nd chamber contents are pumped to the top of the unsaturated Aerocell chamber, after which all wastewater flow is by gravity. Wastewater proceeds downward through the Aerocell media where nitrification occurs. Aerocell effluent then flows into an adjustable split recirculation device which allows for a portion of the Aerocell chamber effluent to be sent back to the 2nd chamber of the primary tank (recirculation) with the rest proceeding to the Nitrex tank. Recirculation back to the 2nd chamber increases the hydraulic loading on the Aerocell unit. Following the Aerocell unit, the nitrified effluent flows into the Nitrex tank where denitrification occurs. The denitrified treated effluent is discharged into the soil via Infiltrator chambers.

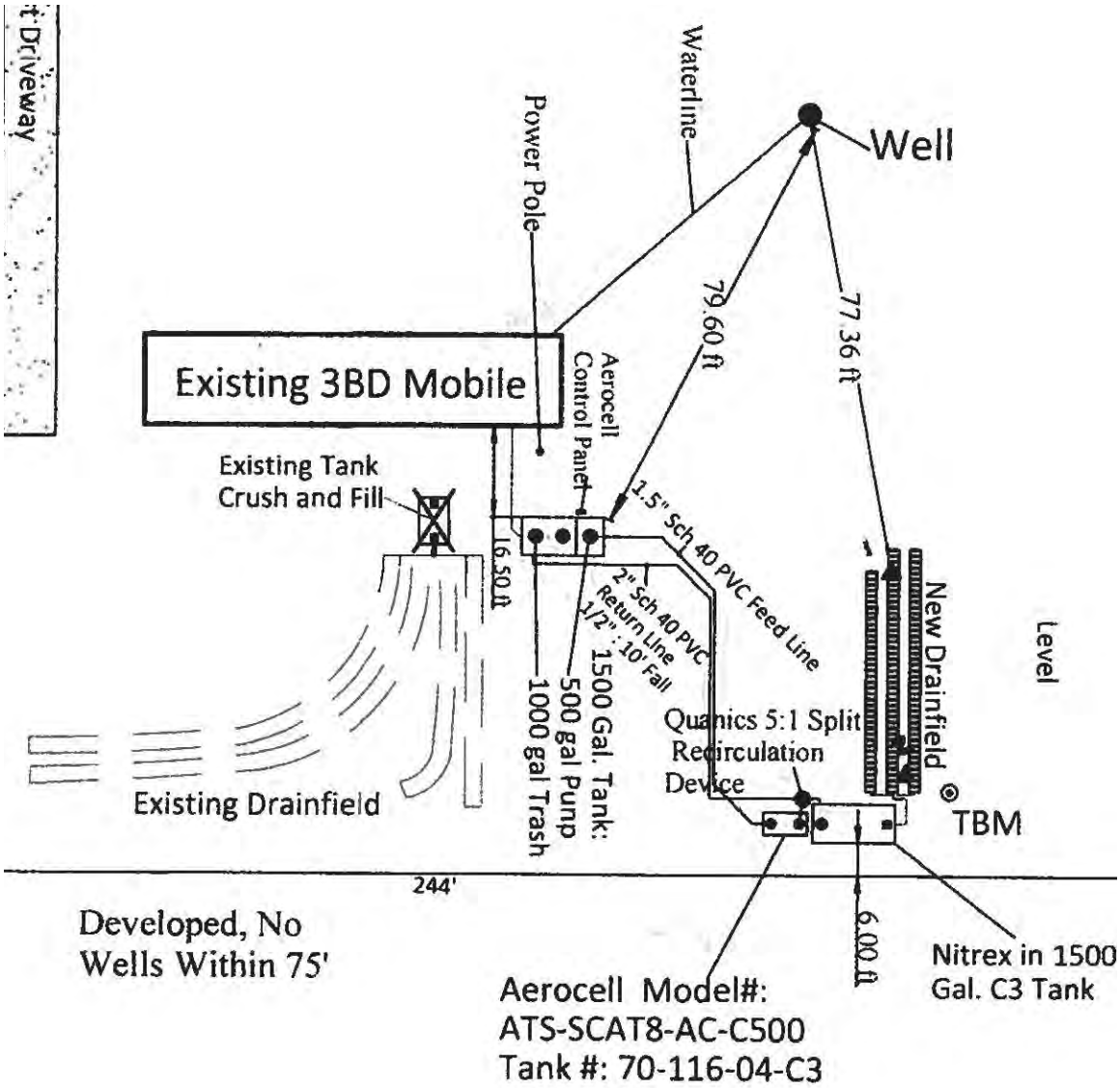

Figure 1
Schematic of PNRS Installed in Wakulla County

Installation

Installation of the system commenced June 7, 2011 and was completed on June 10, 2011. The installation began with a pump out and abandonment of the existing conventional septic system. After the pump out was completed, the old septic tank was crushed and filled with a backhoe (Figure 2).

Figure 2
Old Septic Tank Crushed and Filled

A 1,500 gallon, two compartment tank was installed next to the abandoned tank. The first larger chamber (1,000 gallon) serves as a primary receiving tank, receiving the raw sewage from the household. The second smaller (500 gallon) chamber serves as the pump chamber (Figure 3). Care was taken to assure the tank was installed level. The sewer pipe from the house was plumbed into the side hole at the bottom of Figure 3.

Figure 3
1,500 Gallon Two Chamber Primary Tank

A single chamber (1,500 gallon) concrete tank was then installed towards the back of the property near the planned area of the future drainfield. The purpose of this tank was to hold the Nitrex media. The tank manufacturer delivered a two chamber tank by mistake; therefore the baffle wall was removed using a concrete saw to create a one chamber tank (Figure 4).

Figure 4
1,500 Gallon Single Chamber Nitrex Tank

The Aerocell chamber and the split recirculation device were installed adjacent to the Nitrex tank and leveled. Copper sulfate was applied to the soil underneath these two components to prevent root growth from causing the Aerocell and split recirculation device to become unleveled. Once the Nitrex tank, Aerocell chamber, and the split recirculation device were installed and leveled, plumbing connections were installed (Figure 5). An inline flow meter was installed prior to the Aerocell chamber to record the cumulative flow in gallons pumped from the 2nd chamber of the primary tank (Figure 6). At this location, the flowmeter measurement includes the forward wastewater flow and the recirculation flow. Figure 5 shows the line leading into the Aerocell chamber with water meter, the line coming out of the Aerocell chamber into the split recirculation device, the line from the split recirculation device to the Nitrex tank, and the line from the split recirculation device back to the 2nd chamber of the two chambered primary tank. Flow from the split recirculation device is by gravity to both the Nitrex tank and the 2nd chamber of the primary tank.

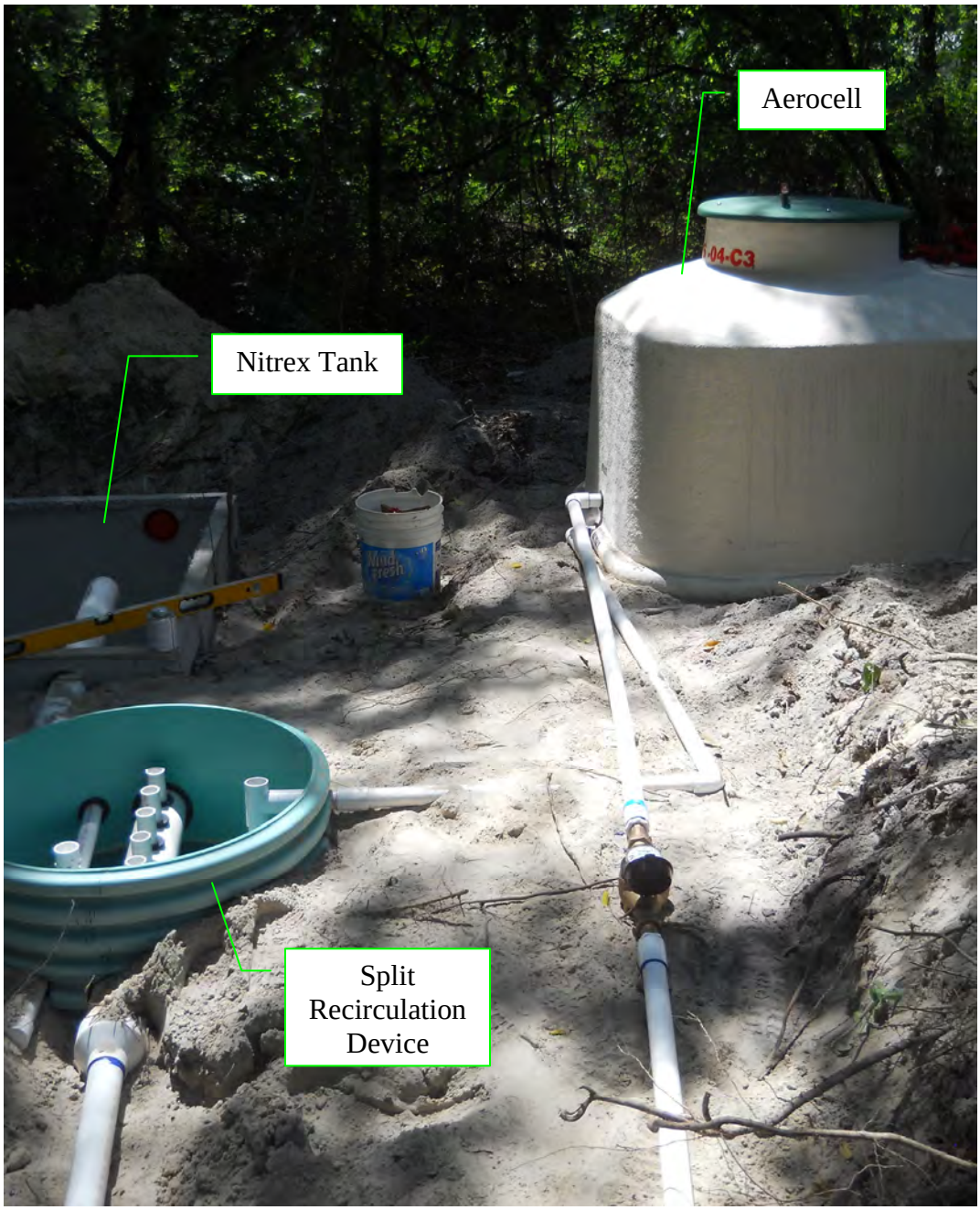

Figure 5
Layout and Plumbing of the Nitrex Tank, Aerocell Chamber and Split Recirculation Device

Figure 6
Aerocell Flow Meter

The Aerocell chamber is a single chamber filled with high density foam cubes. Effluent is applied to the top of the Aerocell high density foam cubes (Figure 7) by four spray nozzles located above the cubes. Not shown are the pressure gauge and the ball valve which allows the pressure of the pumped effluent to be adjusted. The target pressure is between 5 and 10 PSI, with 7 PSI being optimal. The spray nozzles are removable for cleaning in the event clogging occurs despite the filter in the STE tank, the pump tank filter, and the filter installed following the pump (Figure 8).

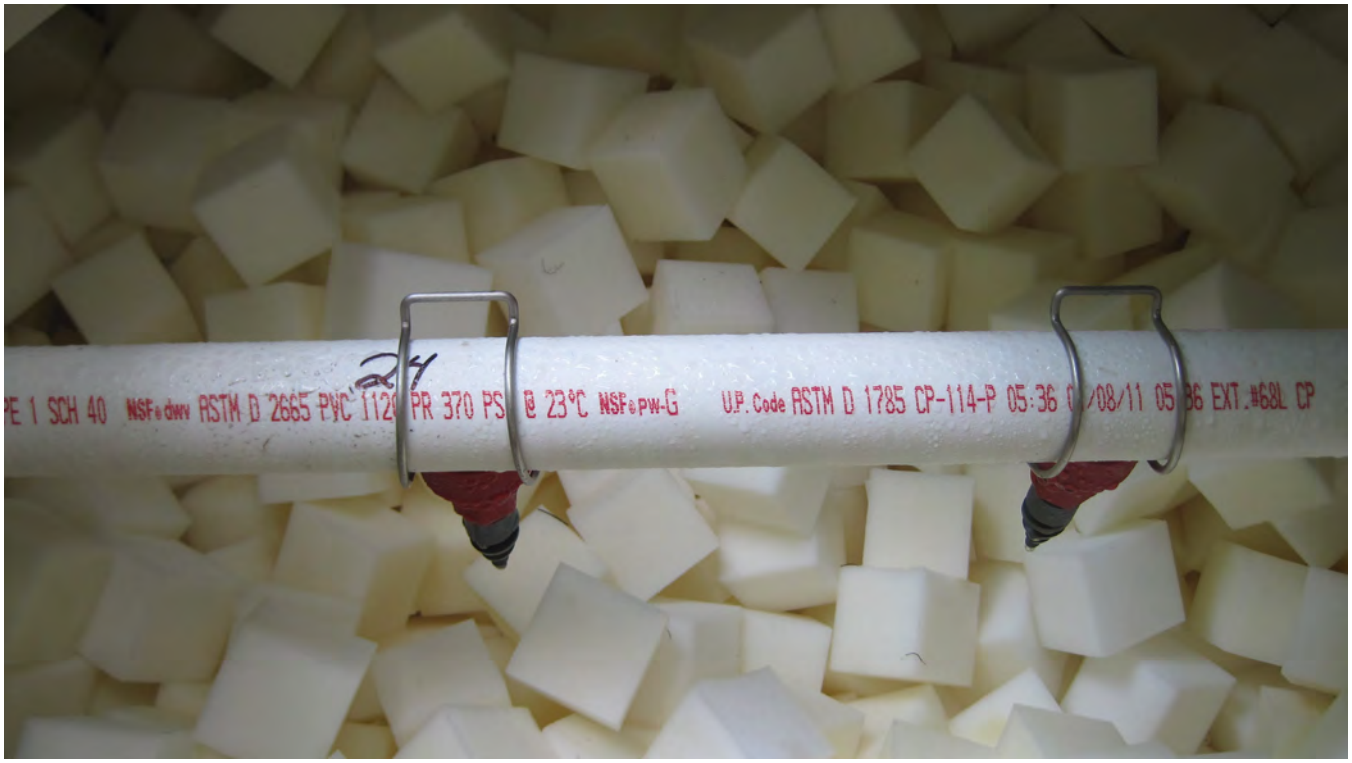

Figure 7
Spray Nozzles and High Density Foam Cubes Inside One Side of Aerocell Chamber

Figure 8
Removable Nozzle from Aerocell Chamber

Although Figure 1 indicates a 5 to 1 split recirculation device, the device installed is capable of a 7 to 1 split. The amount of recirculation is adjustable from 7 parts recirculation back to the 2nd chamber of the primary tank and 1 part going to the Nitrex tank, down to no recirculation to the 2nd chamber. The split recirculation device consists of 7 adjustable PVC pipes that deliver effluent back to the two chamber tank and one fixed PVC pipe that delivers effluent to the Nitrex tank. To reduce the amount of effluent recirculated back to the two chamber tank, one or more of the 7 PVC pipes are simply raised above the water line. The inlet pipe from the Aerocell chamber is shown with a PVC tee. This piece was left unglued so that it can be removed to gather an effluent sample from the Aerocell chamber (Figure 9).

Figure 9
Split Recirculation Device

Figure 1 shows the recirculating effluent flowing back to the 1st chamber of the primary tank via a 2 inch pipe, however the design was modified. As installed, the 2 inch PVC pipe was increased to 4 inch PVC pipe which was fitted with a "Y" and a "bull run" valve (Figure 10 and 11). This gives the option of having the recirculation effluent flow to either the 2nd chamber or the 1st chamber of the primary tank. A riser pipe was installed to grade over the valve, so that the valve can be turned after installation is complete. The valve is turned with a wrench on a rod which is long enough to reach with the riser installed (Figure 11). The valve was initially set so the recirculation goes to the 2nd chamber. Not shown in Figure 10 is the screw cap covering the riser pipe. Shown in the lower left corner of Figure 10, is the sewer pipe from the home.

Figure 10
Split of Recirculation Pipe back towards the Two Chamber Tank

Figure 11
Valve being turned with Tool

The 1st chamber filter was installed in the hole in the baffle separating the first and second chambers (Figure 12). Concrete was used to seal the pipe in the baffle wall. Effluent enters the filter from a 4 inch PVC tee located at the midpoint of the tank depth. The pipe shown extending from the tee downwards is to provide support for the filter. A 4 inch PVC tee was also installed on the recirculation line in the 1st chamber. The down leg of pipe was cut to the midpoint of the tank.

Figure 12
Filter between 1st Chamber and 2nd Chamber of Primary Tank

The tank lid has three risers as shown in Figure 13. The riser to the right allows access to the 1st chamber, which provides the ability to pump out as needed. The middle riser allows the 1st chamber filter to be serviced. STE samples will also be taken from this riser. The riser to the left gives access to the 2nd chamber. The blue cylinder shown in Figure 13 is the pump vault. Figure 14 shows the installed pump vault, the valve for sample access, and the final filter on the pipe leading to the Aerocell chamber. Samples taken from the pump vault represent the water quality characteristics of Aerocell

influent. The hose shown in Figure 14 was used to fill the 2nd chamber with potable water prior to testing the system.

Figure 13
Primary Tank Lid and Pump Vault

Figure 14
Plumbing and Filter installed in Pump Vault inside of 2nd Chamber

Four float switches were installed to maintain the effluent level in the 2nd chamber of the primary tank and are attached to a "float tree" installed in the pump vault and connected to the control panel. The height of the floats is adjustable and once the proper heights were established, screws were used to secure the floats to the float tree. Figure 15 shows the float tree being placed into the pump vault after adjustment.

Figure 15
Placing Float Tree into the Pump Vault

A power meter was installed between the main power box of the house and the control panel to record cumulative power usage of the pump in kilowatts. The equipment connected to the power meter are the recirculation pump and the control panel. Figure 16 shows the power meter located above the control panel.

Figure 16
Control Panel and Power Meter

The system control panel (Figure 17) allows for a timed pump cycle which can be overridden if the effluent levels are too low or too high in the 2nd chamber of the primary tank. If the floats indicate a low effluent level in the tank, the timed cycle is turned off to protect the pump. If the floats indicate a high effluent tank level, then the pump cycles faster (off cycle reduced) until the water level reaches the optimal range. An alarm will indicate if the water level goes above a critical level.

Figure 17
Control Panel

The inlet pipe into the Nitrex tank was routed down to the bottom of the tank and a 90 degree bend was used to attach a 4 inch pipe with a row of drilled holes. This allows for the tank to be filled from the bottom in a uniform manner (Figure 18). The pipe shown across the top of the tank is the outlet pipe to be connected at the top.

Figure 18
Inlet Pipe installed in the Nitrex Tank

After the inlet pipe was in place, the tank was filled with the Nitrex media (Figure 19). This media consisted of pine wood chips and pine sawdust. The pipe extending upwards from the inlet tee was used temporarily during media filling to prevent media from entering the inlet pipe.

Figure 19
Filling the Nitrex Tank with Media

After the media was installed to the desired height, the outlet pipe for the tank was installed (Figure 20). The outlet pipe which has two rows of drilled holes on the top and is wrapped with a plastic mesh to prevent wood chips from entering the pipe collects the wastewater for discharge to the drainfield. The PVC pipe underneath the outlet pipe shown in Figure 20 was used to level the pipe above the media.

Figure 20
Outlet Pipe in the Nitrex Tank

Following the outlet pipe install, additional media was used to fill the tank to the level of the influent pipe (Figure 21), and the lid was installed (Figure 22).

Figure 21
Nitrex Tank filled with Media

Figure 22
Nitrex Tank with Lid Installed

Two Risers were cemented over the tank openings and the drainfield was installed (Figure 23). The drainfield consists of Infiltrator chambers in 4 trenches spaced two feet apart. Three rows are 40 feet in length, and the fourth is 36 feet long. The original design shown in Figure 1 only showed three rows, two 44 feet long and the third shorter row being 40 feet long. However, in some areas of the drainfield, the clay layer was shallower than anticipated from the original soil borings, and the drainfield area was therefore enlarged. The chambers were covered in protective fabric to prevent sand from washing into and filling the chambers.

Figure 23
Four Rows of Infiltrator Drainfield Chamber

On the pipe between the Nitrex tank and the drainfield, a catch basin was installed so that the final effluent discharged to the drainfield can be sampled (Figure 24). The black piece extends into the ground approximately three inches. The riser pipe shown was cut at the final grade and capped with a screw cap.

Figure 24
Sampling Port for the Effluent being discharged to the Drainfield

During final testing of the system, leaks were discovered from the split recirculation device around the grommets. The grommets were sealed with PVC glue (Figure 25). The drainfield trenches were filled and all disturbed areas on the property were graded. Sod will be laid after consulting the homeowner concerning placement of the sod.

Figure 25
Sealing Leaks around Grommets

A water meter was installed on the water line from the household well. The water line for the one hose bib on the home was re-plumbed so that the junction came before the water meter. This allows for the measurement of the household water use independent of water use outside the home (Figure 26). So we will assume this represents flow to the treatment system.

Figure 26
Water Meter on line leading into the home, installed after junction for hose bib

Operation and Verification

On June 9, 2011, the 2nd chamber of the primary tank was filled with potable water for system operational testing. The pump was tested and found to deliver approximately 26 gallons of water to the Aerocell unit per minute. It was also found that there is a six second delay between pushing the manual pump button (labeled "Hand") on the control panel and water arriving to the Aerocell chamber. At the end of the day, the split recirculation device was set to a 7 to 1 recycle split, with 7 parts going back to the 2nd chamber of the primary tank and 1 part going to the tank with the Nitrex media. The on and off cycles were set, and the data from the control panel and two water meters were read and recorded (Table 1). The next morning, it was decided that the recirculation was too great as it took approximately 50 cycles to decrease the level of the 2nd chamber of the primary tank to the level when the time dose is turned off. (At this time the 1st chamber had less than 160 gallons, so no other water was added to the 2nd chamber). The split recirculation device was then set so that 5 parts went back to the 2nd chamber and 1 part went to the Nitrex tank by the vendor. At the control panel, the on and off cycles were set for longer times with the decreased recirculation (Table 1). Before leaving the site, the settings and readings on the control panel, the electric meter, and two water meters were read and recorded.

Table 1
Initial Settings and Readings Recorded

	6/9/11 18:15	6/10/11 12:35	Notes
Recirculation Ratio	7:1	5:1	
Control Panel Settings			
Pump Run Time (hr:min)	0:05	1:48	
Pump Activations	9	61	Some from testing floats
Alarm Counter	0	3	From testing alarm
Float Error	0	0	
Timer Override	0	0	
On time cycle (min:sec)	1:36	2:06	
Off time cycle (min:sec)	13:48	18:24	
Electric Meter	1 KW	2KW	Installed with 1 KW on dial
House Water Meter	87.3 (17:10)	148.2 (12:25)	Installed 6/8/11 14:10
Septic Pump Water Meter	NR	629.2 (12:30)	Installed with reading 2.1 gal

Notes: The On Time Cycle and Off Time Cycle are settings. The rest of the parameters are cumulative readings. For both water meters, the actual time read on each date is given in parenthesis.

The Nitrex™ system inspection checklist from July 26th is provided in Appendix B. The system operating permit was issued June 24, 2011, and the construction inspection and final approval was issued August 31, 2011. Both these documents are included in Appendix C. The final construction costs for the installed system was $23,600 as detailed in Appendix D.

Florida Department of Health
Onsite Nitrogen Reduction Strategies Study

Contract CORCL

TASK B.6

Installation Report for Passive Nitrogen Reduction System B-HS2

September 2012

Task B of the Florida Onsite Nitrogen Reduction Strategies Study (FOSNRS) includes performing field experiments to critically evaluate the performance of nitrogen removal technologies that were identified and pilot tested in FOSNRS Task A. To meet this objective, full scale treatment systems will be installed at various residential sites in Florida, operated on septic tank effluent under actual onsite conditions, and monitored over an extended timeframe. 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 installation of a passive nitrogen reduction system at a home site in Hillsborough County, Florida (B-HS2).

System Overview

The B-HS2 system was installed in Hillsborough County, Florida in September 2012. It consists of a replacement 1,050 gallon two chamber concrete primary tank; 300 gallon concrete recirculation tank; 900 gallon concrete Stage 1 unsaturated media filter; 300 gallon concrete pump tank; and 1,500 gallon two chamber concrete Stage 2 saturated media biofilter. Figure 1 is a site schematic showing the system components and layout of the installation. The complete as-built system drawings are included in the attached Appendix A.

Household wastewater enters the 1st chamber of the primary tank and exits the second chamber as septic tank effluent through an effluent screen into the recirculation tank. The recirculation tank contents are discharged by gravity to a distribution box, located inside the Stage 1 biofilter, which splits the flow between two perforated distribution pipes along the top of the unsaturated Stage 1 biofilter media. The Stage 1 biofilter contains 10 inches of coarse expanded clay media (Riverlite^{TM} 1/4; 1.1 to 4.8 mm) above 20 inches of finer expanded clay media (Riverlite^{TM} 3/16; 0.6 to 2.4 mm). Wastewater proceeds downward through the expanded clay media where nitrification occurs. Stage 1 biofilter effluent then flows into the pump tank (which contains the pump and float switches). The pump tank discharge is split via two throttling globe valves which allow for a portion of the Stage 1 biofilter effluent to be sent back for recirculation with the rest proceeding to the Stage 2 biofilter. The system was designed with two recirculation modes of operation. The first option (which will initially be tested) is to have the recirculated effluent return to the recirculation tank for mixing with incoming septic tank effluent. The second option is to have the recirculated effluent return to the top of the Stage 1 biofilter,

dispersed by three spray nozzles. Recirculation back to either the recirculation tank or Stage 1 biofilter increases the hydraulic loading on the Stage 1 biofilter. Effluent form the unsaturated (Stage 1) media tank enters the denitrification (Stage 2) biofilter into a standing water column lying above 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 Stage 2 biofilter contains 42-inches of lignocellulosic media in the first chamber. A collection pipe along the bottom transfers the effluent to the second chamber which contains 24-inches of elemental sulfur mixed with oyster shell media. The Stage 2 biofilter effluent discharges near the top of the tank; therefore denitrification occurs in the saturated environment. The denitrified treated effluent is discharged into the soil via the existing mounded drainfield (P.T.I.™ bundles). A flow schematic of the system is shown on Figure 2.

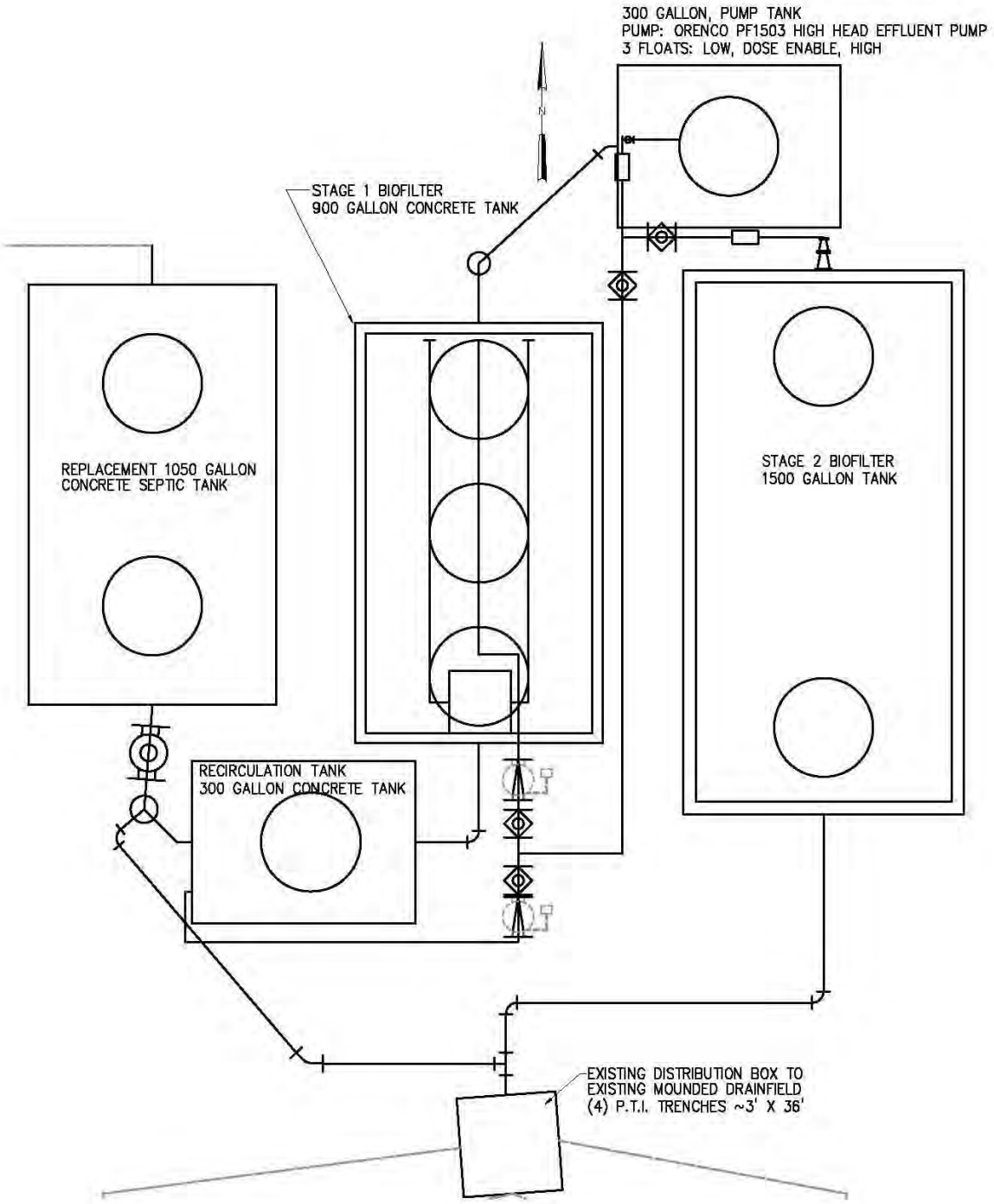

Figure 1
Schematic of B-HS2 PNRS installed in Hillsborough county

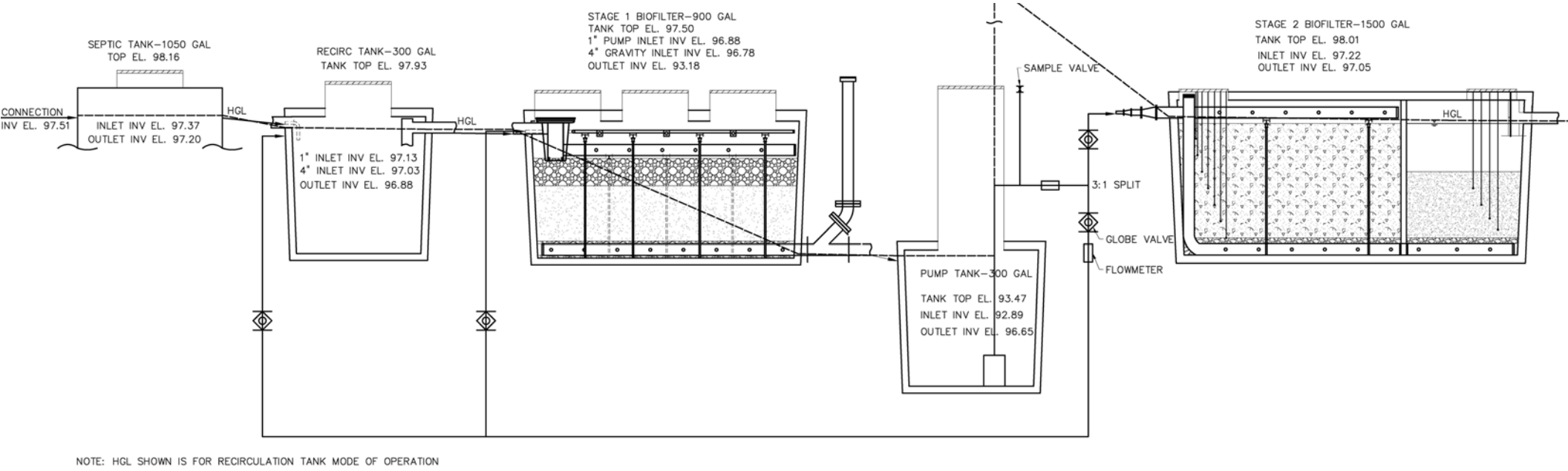

Figure 2
Flow Schematic of B-HS2 PNRS installed in Hillsborough county

Installation

Installation of the system commenced September 10, 2012 and was completed on September 12, 2012. The installation began with a pump out and removal of the existing 1,050 gallon septic tank, which was found to be cracked during the system evaluation. After the pump out was completed, the old septic tank was removed (Figure 3).

Figure 3
Old septic tank removed

A 1,050 gallon, two compartment replacement concrete primary tank was installed. The first larger chamber serves as a primary receiving tank, receiving the raw sewage from the household. The sewer pipe from the house was plumbed into the 4"D (diameter) inlet hole shown in Figure 4. An effluent screen (Polylok™, PL-68) was installed in the outlet tee of the second chamber (Figure 5).

Figure 4
1,050 gallon, two chamber, primary Tank

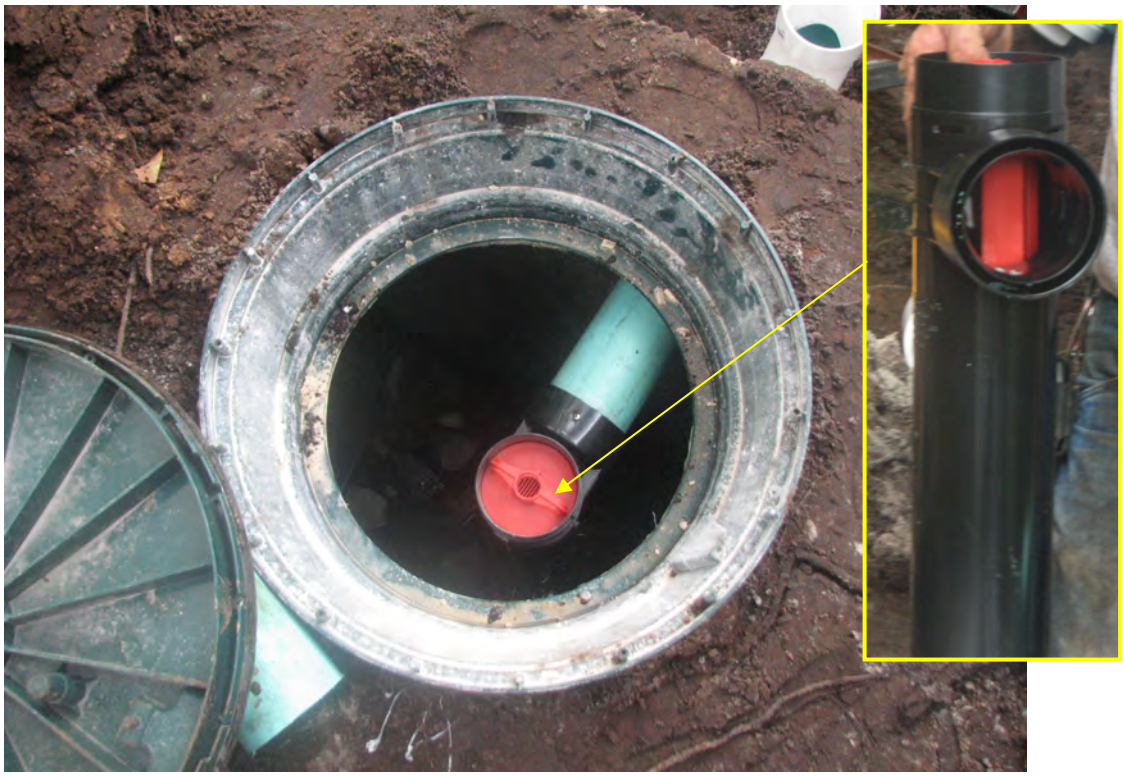

Figure 5
Primary tank effluent screen

Following the primary tank installation, the remaining passive nitrogen reduction system components were installed (Table 1). A single chamber (900 gallon) concrete tank was installed beside the primary tank (Figure 6). The purpose of this tank is to hold the Stage 1 expanded clay media. The 4"D inlet of the tank is connected (gravity flow) to the recirculation tank discharge. The 2"D inlet is connected (pressurized flow) to the recirculation pipe from the pump tank. The 4"D outlet (Figure 7) of the pipe is located near the bottom of the tank to allow for unsaturated operation. The 4"D underdrain pipe (perforated) with gravel surrounding was installed along the centerline of the bottom of the tank for effluent collection (Figure 8). Following gravel installation and leveling, 20-inches of fine (3/16 Riverlite™) expanded clay media was installed (Figure 9). Above the fine media, 10-inches of coarse (1/4 Riverlite™) expanded clay media was installed (Figure 10). Following media installation and leveling, the influent distribution network was installed. The 4"D influent pipe, connected to the recirculation tank discharge, discharges into a distribution box which flows to two 4"D perforated pipes across the top of the media (Figure 11). The distribution box includes two Polylok equalizer™ weirs to allow for the adjustment of the flow split (Figure 12). The 2"D influent pipe is reduced to a 1"D pipe along the centerline with three spray nozzles attached to distribute the recirculated effluent. The spray nozzles are removable for cleaning in the event clogging occurs (Figure 13).

Table 1
Passive Nitrogen Reduction System Components

	Tank Volume (gal)	Surface Area (ft^2)	Media
Primary Tank	1,050	37	none
Recirculation Tank	300	12	none
Stage 1 Biofilter	900	37	• 10" Riverlite 1/4 • 20" Riverlite 3/16
Pump Tank	300	12	none
Stage 2a Biofilter, downflow	1,000 (1,500 total)	36 (54 total)	42" lignocellulosic (Southern yellow pine)
Stage 2b Biofilter, upflow	500 (1,500 total)	18 (54 total)	24" Elemental sulfur (90%) & oyster shell mixture (10%)

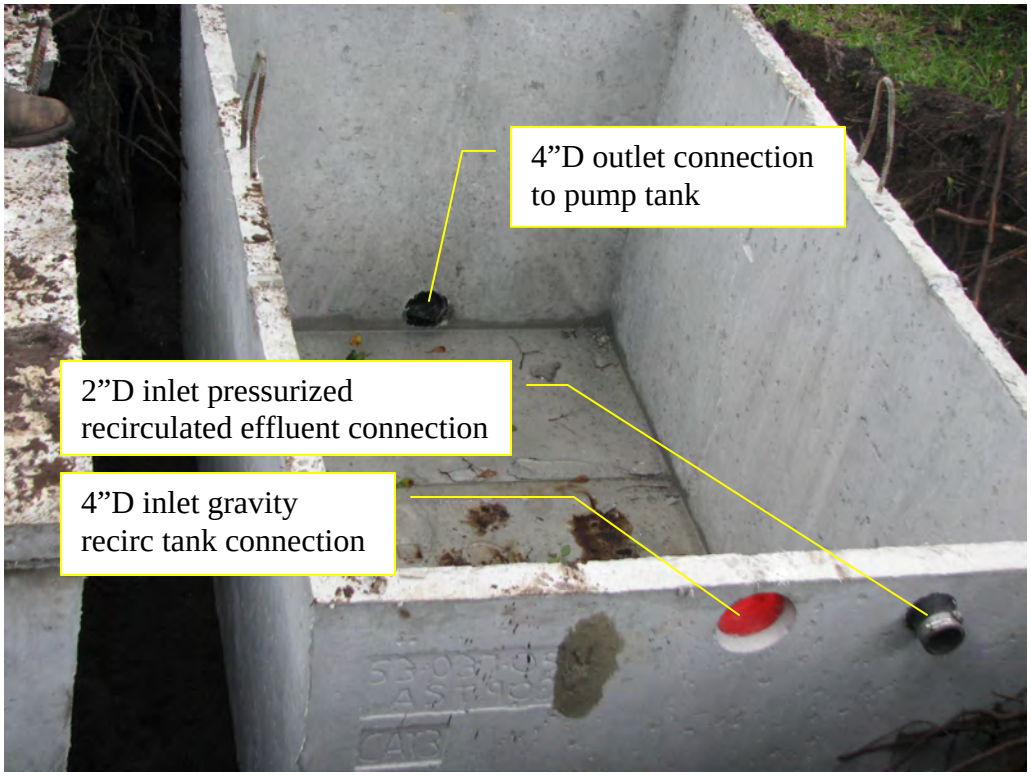

Figure 6
900 gallon, single chamber, stage 1 biofilter tank

Figure 7
Stage 1 biofilter 4”D outlet pipe, with cleanout

Figure 8
Stage 1 biofilter gravel underdrain

Figure 9
Stage 1 biofilter 20-inches of fine media (3/16 Riverlite™)

Figure 10
Stage 1 biofilter 10-inches of coarse media (1/4 Riverlite™)

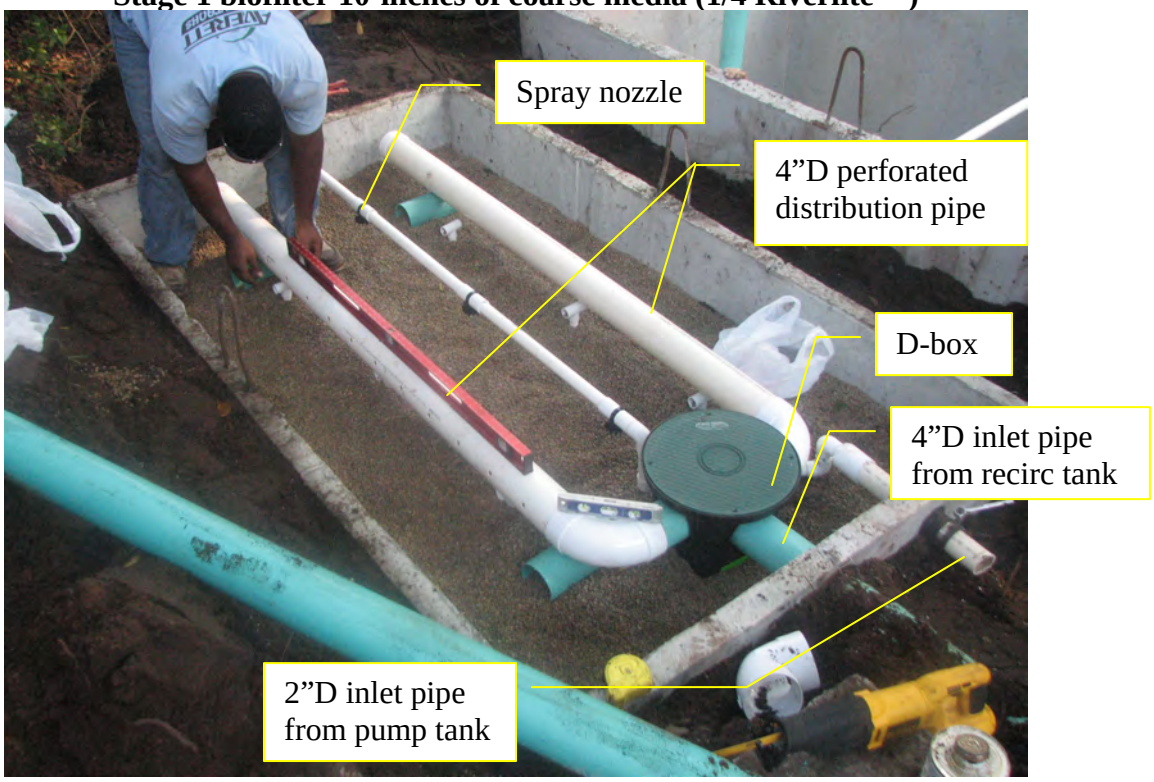

Figure 11
Stage 1 biofilter influent distribution system

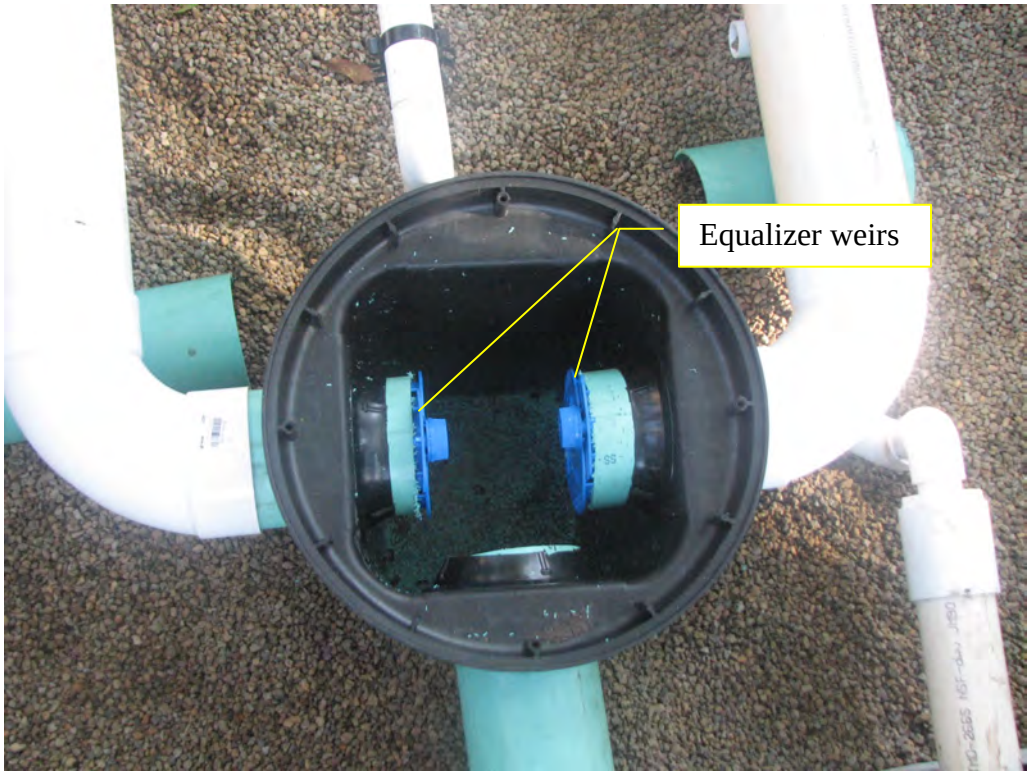

Figure 12
Stage 1 biofilter d-box

Figure 13
Removable spray nozzle

The 300 gallon concrete recirculation tank was then installed (Figure 14). The 4”D inlet is connected to the septic tank effluent discharge, and the 2” D inlet is connected to the recirculation pipe from the pump tank. A bull run valve™ (Figure 15) was installed following the septic tank outlet to allow the flow to either be completely directed to the new passive system (to the recirculation tank) or to the existing distribution box (to the existing drainfield). A riser pipe was installed to grade over the valve, so that the valve can be turned after installation is complete. The valve is turned with a wrench on a rod which is long enough to reach with the riser installed (Figure 15).

Figure 14
300 gallon recirculation tank

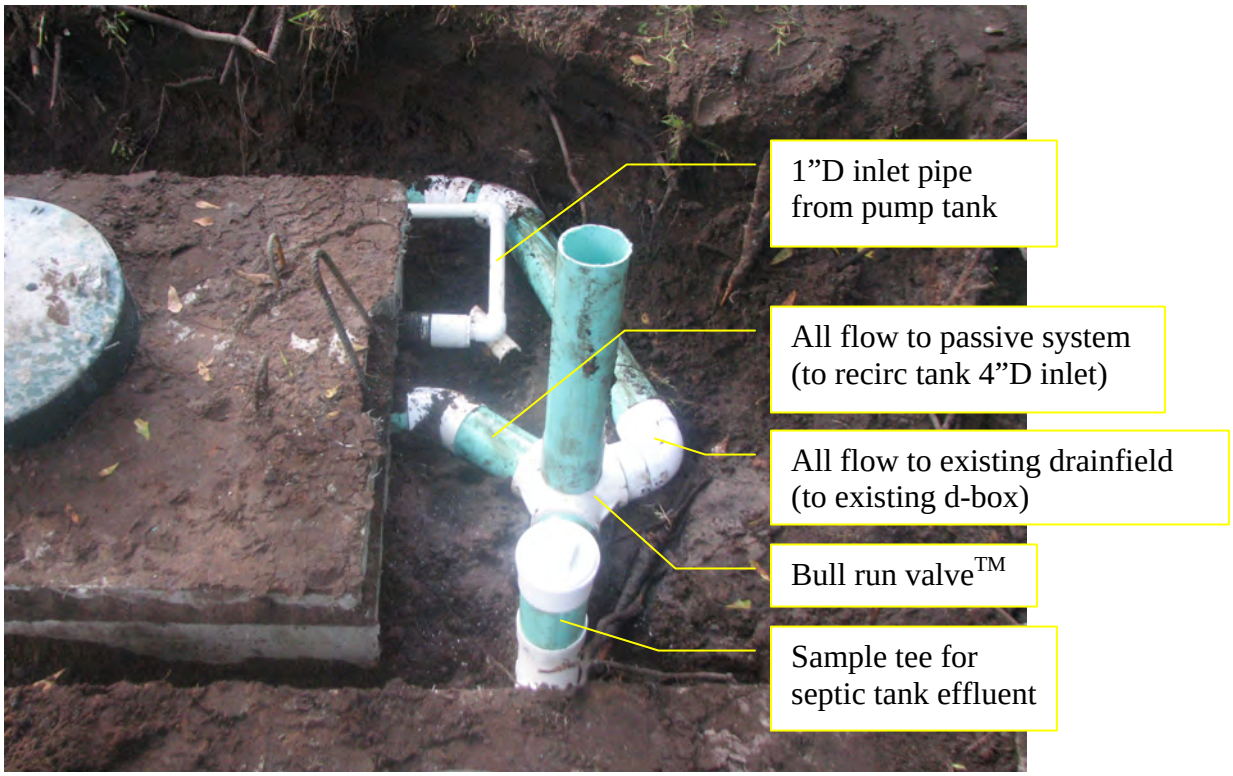

Figure 15
Bull run valve™

Next, the 300 gallon concrete pump tank was installed downgradient of the Stage 1 biofilter (Figure 16). The outlet pipe connection was plugged since the pump discharge pipe is installed through the riser. The pump was installed within a holding bracket which also supports the float tree (Figure 17). Three float switches were installed to maintain the effluent level in the pump tank and are attached to a float tree installed in the pump tank and connected to the control panel. The height of the floats is adjustable and once the proper heights were established, screws were used to secure the floats to the float tree.

Two inline flow meters were installed following the pump discharge. The first inline flow meter was installed prior to the recirculation flow split, to record the cumulative flow in gallons pumped from the pump tank (Figure 18). At this location, the flowmeter measurement includes the forward wastewater flow (F) and the recirculation flow (R). Two throttling globe valves were installed to allow for the adjustment of F and R flow to achieve the target recirculation ratio (initially set at approximately 3:1). The second flowmeter installed downstream of the F globe valve measures the forward wastewater flow to the Stage 2 biofilter (Figure 18). As previously discussed, the design includes two modes of operation for the recirculation of Stage 1 effluent: 1) to the recirculation tank or 2) to the Stage 1 biofilter spray nozzles. Two ball valves were installed (Figure 19) which either shut on or off the recirculation mode desired (initially set so that all the recirculation flow returns to the recirculation tank).

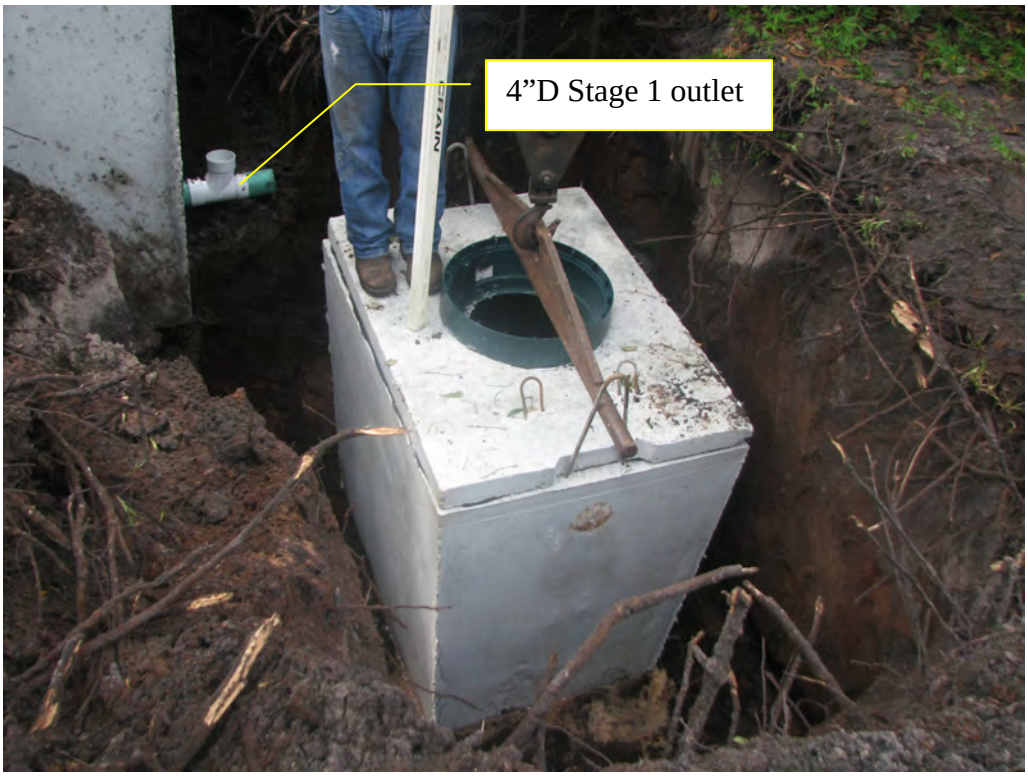

Figure 16
300 gallon pump tank

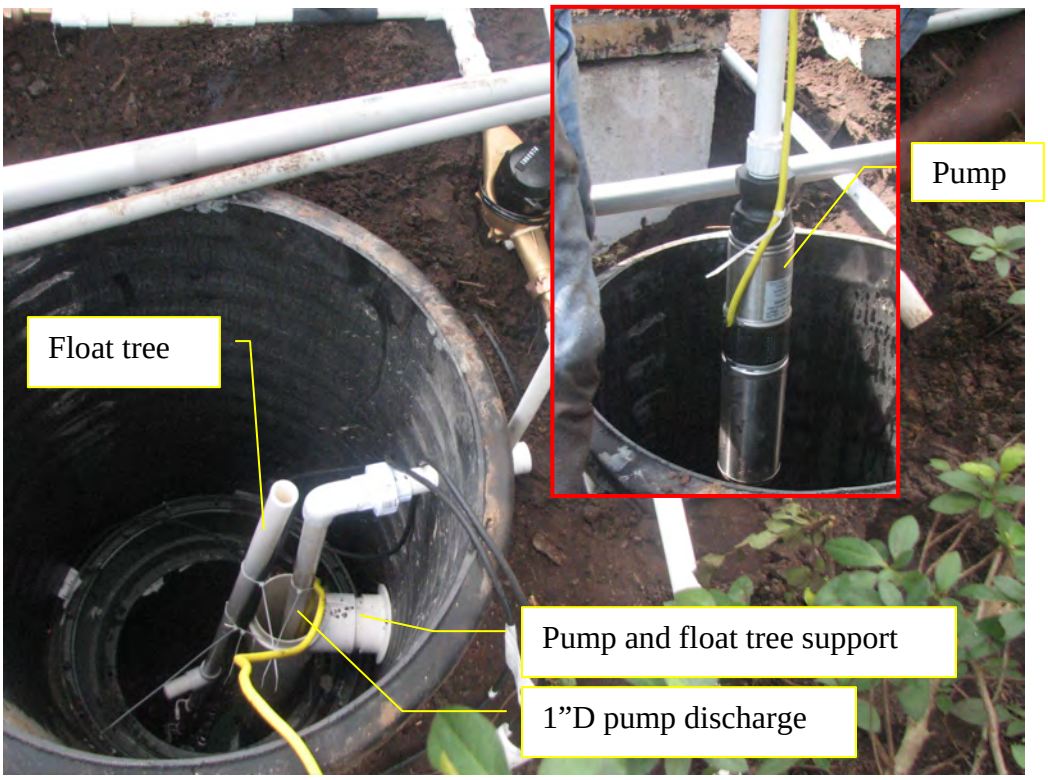

Figure 17
300 gallon pump tank (pump and float tree)

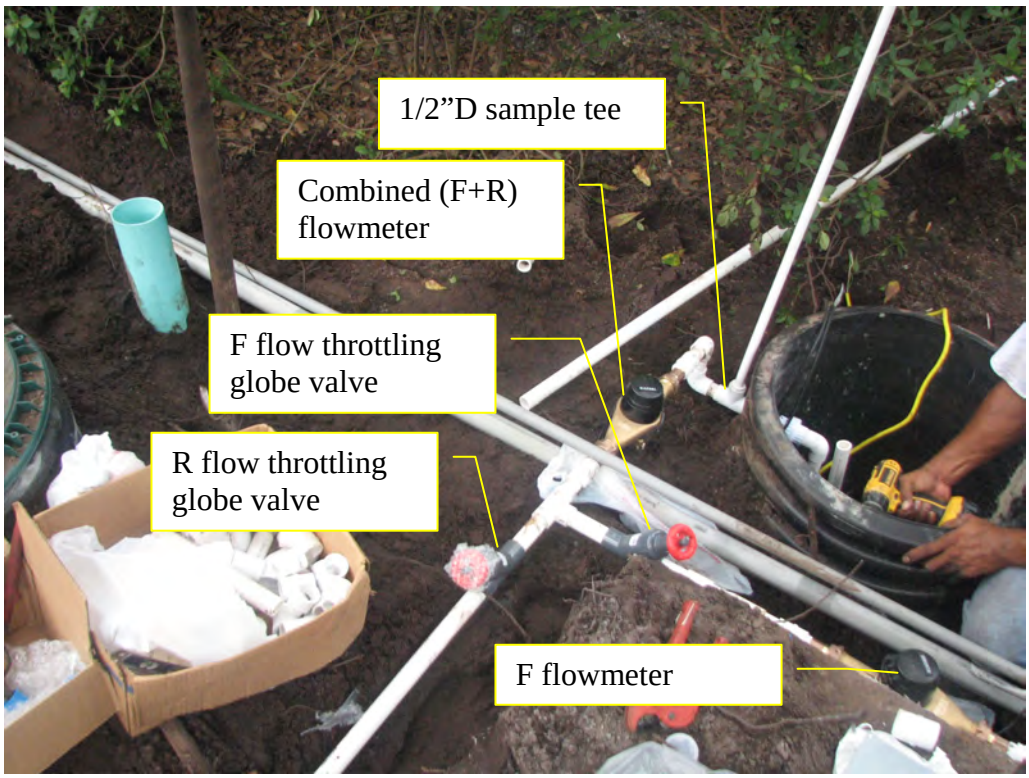

Figure 18
Recirculation flow split and monitoring

Figure 19
Recirculation mode of operation flow split

The last tank installed was a two chamber (1,500 gallon) concrete tank (Figure 20). The purpose of this tank is to hold the Stage 2 lignocellulosic and sulfur media. The 1”D pipe downstream of the F flowmeter is expanded to 4”D and connects to a perforated pipe which distributes nitrified effluent over the lignocellulosic media within the first chamber of the Stage 2 biofilter. The nitrified effluent flows downward through the lignocellulosic media (within first chamber) and upward through the sulfur media mixture (within second chamber).

A 4”D underdrain pipe (perforated) with gravel surrounding was installed along the centerline of the bottom of the tank for transfer from the first chamber to the second chamber (Figure 21). The tank arrived with a coupling cast into the baffle wall near the bottom to connect both chambers of the tank. Following the underdrain gravel installation (Figure 22) and leveling, 24-inches of elemental sulfur and oyster shell media was installed and mixed (Figure 23) within the second chamber. A stainless steel drivepoint sampler tree (Figure 24) was installed for sampling at 3, 7, 12, and 18-inches above the bottom of the sulfur media mixture (Figure 23).

Above the gravel underdrain within the first chamber of the tank, 42-inches of lignocellulosic media was installed (Figure 25). A stainless steel drivepoint sampler tree was installed for sampling at 0, 6, 12, 18, 24, 30, and 36-inches above the bottom of the lignocellulosic media. A 4”D perforated pipe was connected to the inlet of the tank for effluent dispersal above the lignocellulosic media. A 4”D tee was installed at the outlet of the tank which allows for saturated operating conditions across the biofilter (Figure 26). The 4”D outlet is connected to the distribution box to the existing drainfield.

Figure 20
1,500 gallon stage 2 biofilter tank

Figure 21
Stage 2 biofilter tank perforated pipe along bottom (lignocellulosic chamber)

Figure 22
Stage 2 biofilter tank gravel underdrain (sulfur chamber)

Figure 23
Stage 2 biofilter tank (sulfur mixed with oyster shell)

Figure 24
Stage 2 biofilter tank SST drivepoint sampler tree (sulfur chamber)

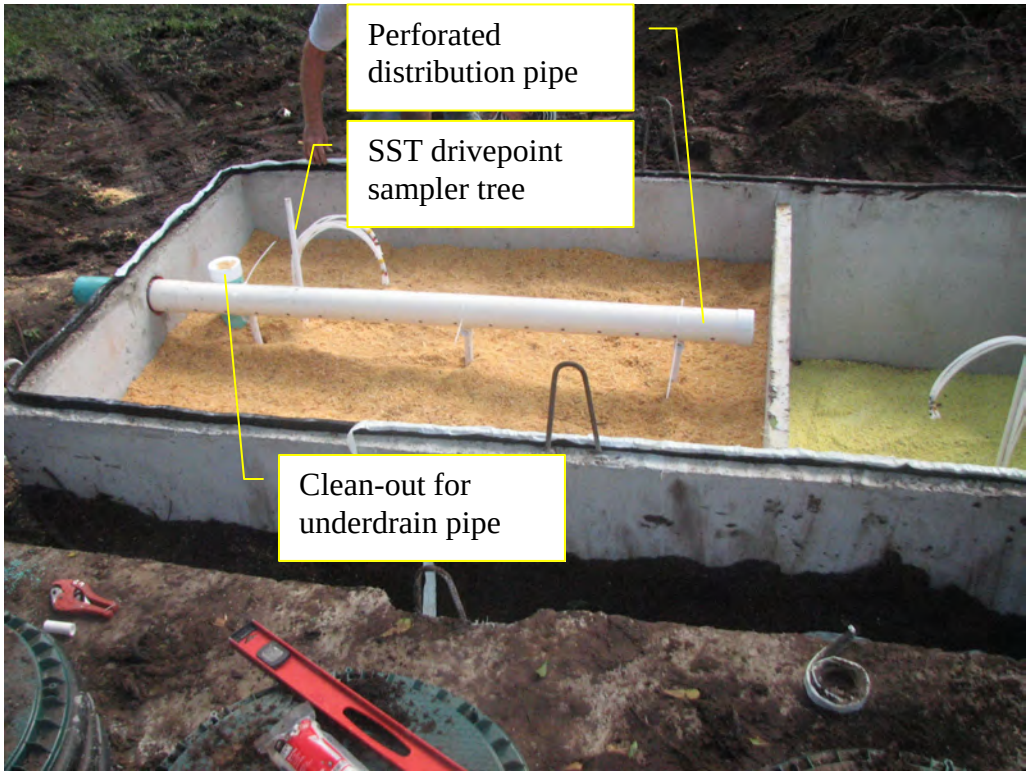

Figure 25
Stage 2 biofilter tank (lignocellulosic media)

Figure 26
Stage 2 biofilter tank outlet tee

A power meter was installed between the main power box of the house and the control panel to record cumulative power usage of the system in kilowatts. The equipment connected to the power meter are the recirculation pump and the control panel. Figure 27 shows the power meter installed inside the control panel.

The system control panel (Figure 27) allows for a timed pump cycle which can be overridden if the effluent levels are too low or too high in the pump tank. If the floats indicate a low effluent level in the tank, the timed cycle is turned off to protect the pump. If the floats indicate a high effluent tank level, then the pump cycles faster (off cycle reduced) until the water level reaches the optimal range. An alarm will indicate if the water level goes above a critical level. The control panel is connected to a phone line which transmits data to Vericomm for monitoring.

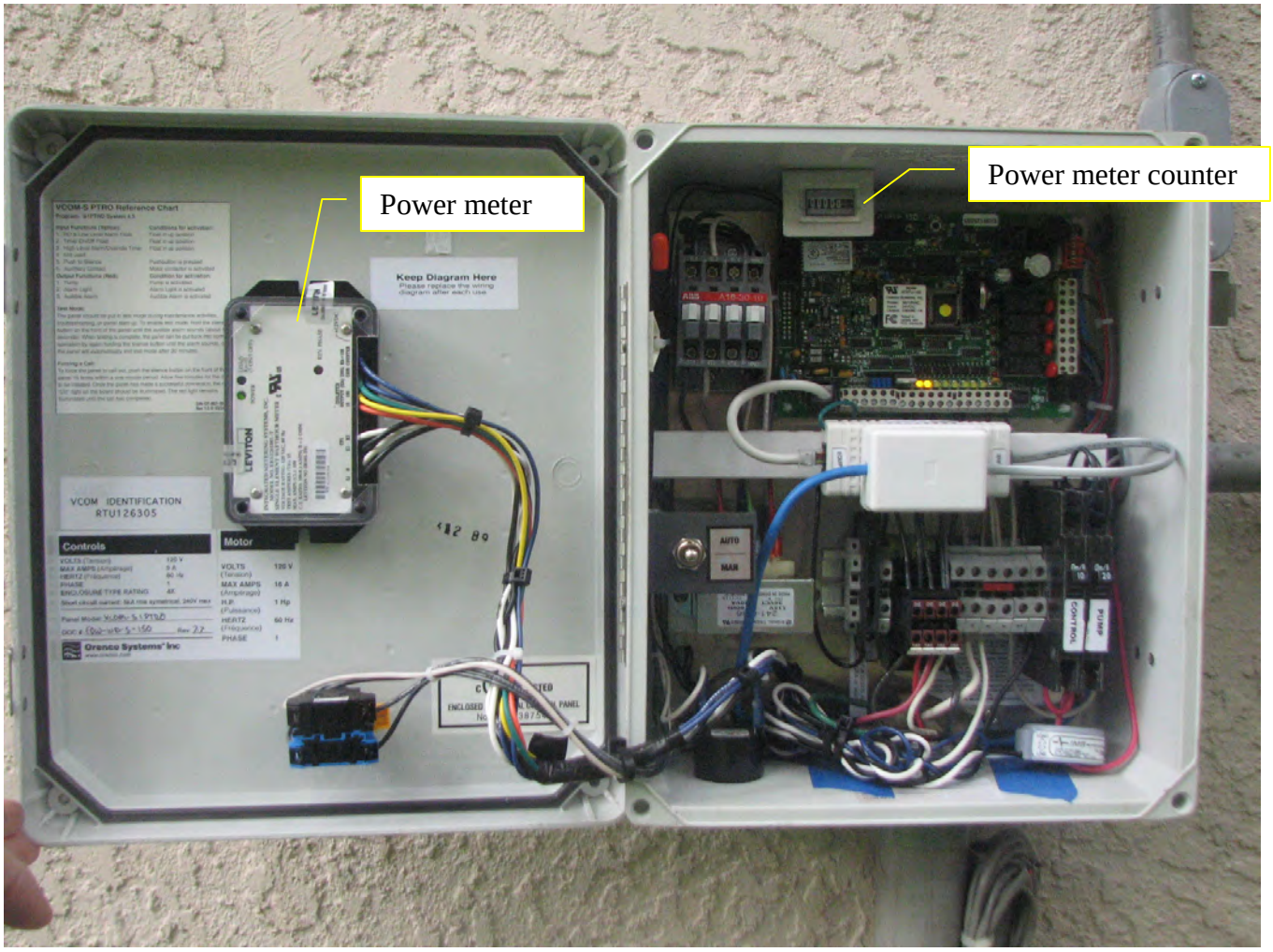

Figure 27
Control Panel

During final testing of the system, the system operated with no visible signs of leaks, etc. The system area was filled and all disturbed areas on the property were graded (Figure 28) and covered with sod (Figure 29).

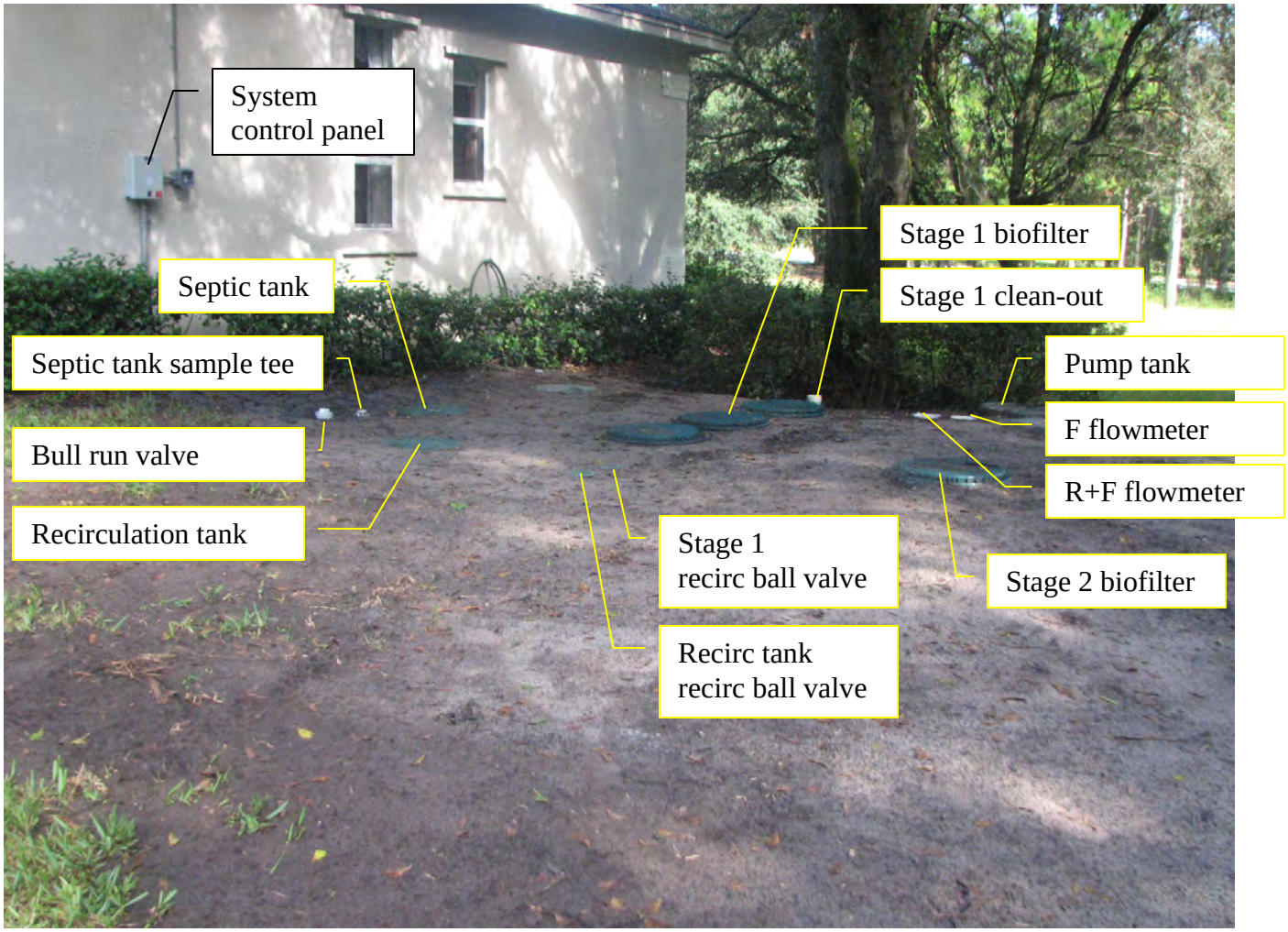

Figure 28
Overall PNRS system installed

Figure 29
Sod cover over PNRS system

Operation and Verification

On September 25, 2012, the pump tank was filled with potable water for system operational testing. The pump was tested, and the globe valves were set to an approximate 3 to 1 recirculation split, with 3 parts going back to the recirculation tank and 1 part going to the Stage 2 biofilter tank. Through the Vericomm system, the on and off pump cycles were set. A call to Vericomm was initiated from the control panel to transmit the data following the testing. In addition, the two flowmeters and electric meter were read and recorded (Table 1).

Table 1
Initial Settings and Readings Recorded

	September 25, 2012 11:45am
Recirculation Ratio	3:1
Control Panel Settings	
Pump Run Time (hr:min)	0:07
Pump Cycles Today	5
Override Cycles Today	1
On time cycle (min:sec)	01:12
Off time cycle (min:sec)	60:00
Electric Meter Reading	
Electric Meter (kWh)	2
Flowmeter Readings	
Household use flowmeter (gal)	32660
Combined flowmeter (R+F) (gal)	00000351.9
Stage 2 flowmeter (F) (gal)	00000102.2

Estimated Cost

The final construction cost for the installed system was $19,142.18 as detailed in Appendix B.

System Start-up

The system was started up September 25, 2012, when all flow was diverted to the new passive system. Routine checks of the system were made for the first two weeks to ensure the system was functioning as intended. Tanks were noted to be full on October 5, 2012. Preliminary sampling will begin in October to monitor nitrification.

Florida Department of Health
Onsite Nitrogen Reduction Strategies Study

Contract CORCL

TASK B.6

Installation Report for Passive Nitrogen Reduction System B-HS3

June 2013

Task B of the Florida Onsite Nitrogen Reduction Strategies Study (FOSNRS) includes performing field experiments to critically evaluate the performance of nitrogen removal technologies that were identified and pilot tested in FOSNRS Task A. To meet this objective, full scale treatment systems will be installed at various residential sites in Florida, operated on septic tank effluent under actual onsite conditions, and monitored over an extended timeframe. 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 installation of a passive nitrogen reduction system at a home site in Seminole County, Florida (B-HS3).

System Overview

The B-HS3 system was installed in Seminole County, Florida in June 2013. It consists of a replacement septic tank which was upgraded to a 1,500 gallon two chamber concrete primary tank; 600 gallon concrete STE dose tank; a two zone drip system, a Stage 1 lined drip zone and a reclaimed water dispersal drip zone, and a 1,050 gallon concrete tank Stage 2 saturated media biofilter. Figure 1 is a site schematic showing the system components and layout of the installation. The complete as-built system drawings are included in the attached Appendix A.

Household wastewater enters the 1st chamber of the primary tank and exits the second chamber as septic tank effluent through an effluent screen into the STE dose tank. The STE dose tank contents are pumped through the drip system hydraulic unit and discharged to the Stage 1 drip system (Zone 1). Effluent is dispersed above an 18-inch layer of mound sand (slightly limited sand) and proceeds downward through the sand media where nitrification occurs. Underlying the sand is a 9-inch layer of lignocellulosic and sand media mixture above a 30-mil PVC liner where there is the potential for denitrification prior to the Stage 2 biofilter. The liner effluent is conveyed to the bottom of the Stage 2 biofilter (denitrification) tank containing elemental sulfur reactive media and flows upward through the media for additional treatment. The Stage 2 biofilter contains 12-inches of elemental sulfur mixed with oyster shell media. The outlet is above the media; therefore, denitrification occurs in the saturated environment. The denitrified effluent is pumped through the drip system hydraulic unit and discharged to the reclaimed water drip irrigation system (Zone 2). The denitrified effluent is discharged to the natural soil. A flow schematic of the system is shown on Figure 2.

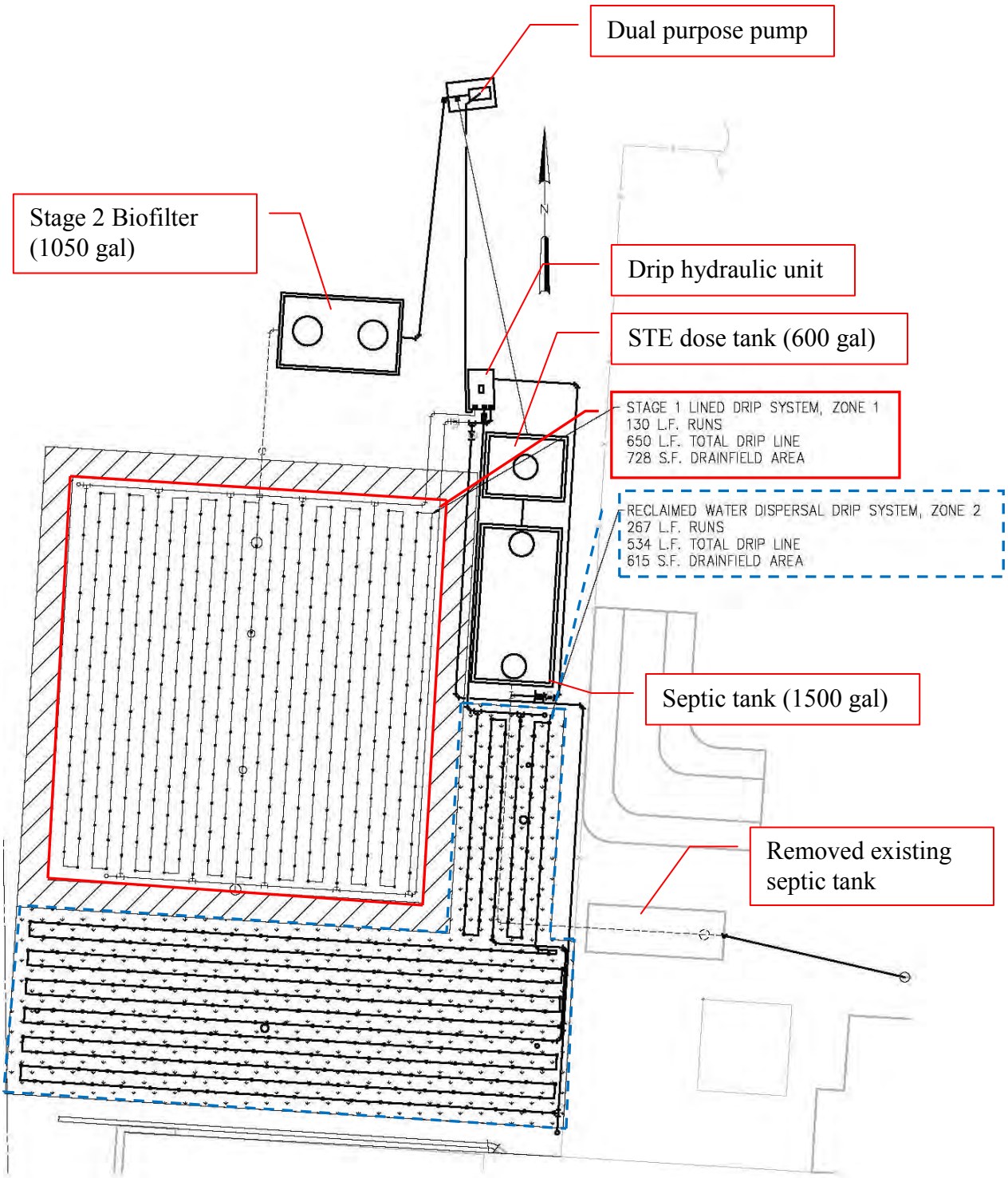

Figure 1
Schematic of B-HS3 PNRS installed in Seminole county

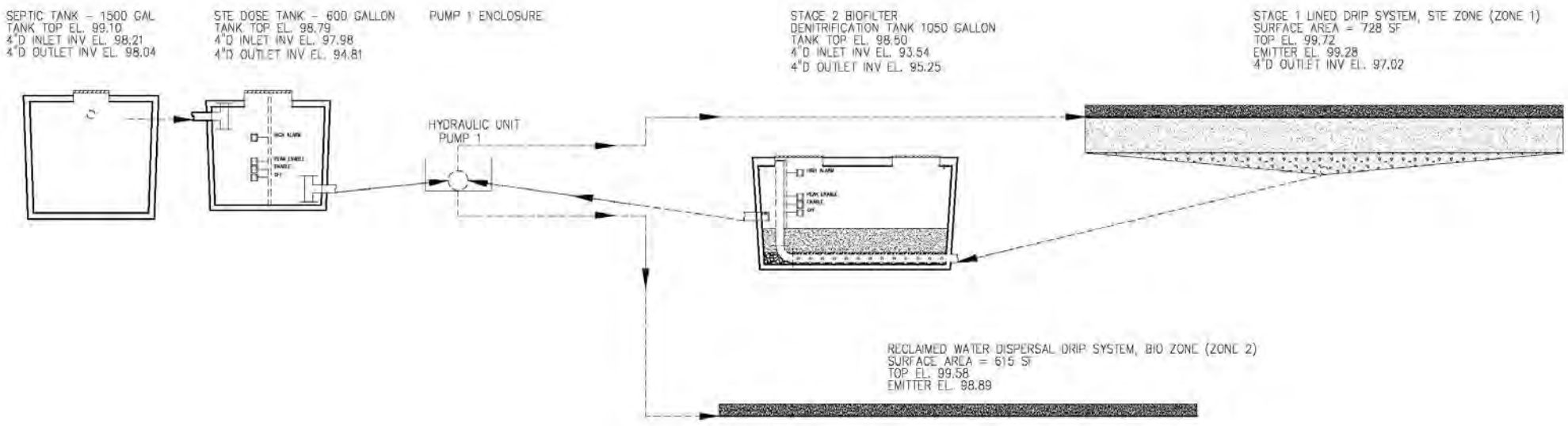

Figure 2
Flow Schematic of B-HS3 PNRS installed in Seminole county

Installation

Installation of the system commenced June 17, 2013 and was completed on June 28, 2013. The installation began with a pump out and removal of the existing 1,050 gallon fiberglass septic tank. After the pump out was completed, the old septic tank was removed (Figure 3).

Figure 3
Old septic tank pumped out and removed

A 1,500 gallon, two compartment replacement concrete primary tank was installed. The first larger chamber serves as a primary receiving tank, receiving the raw sewage from the household. The sewer

pipe from the house was plumbed into the 4”D (diameter) inlet hole shown in Figure 4. An effluent screen (Polylok™, PL-68) was installed in the outlet tee of the second chamber (Figure 5).

Figure 4
1,500 gallon, two chamber, primary Tank

Figure 5
Primary tank effluent screen

Following the primary tank installation, the remaining passive nitrogen reduction system components were installed (Table 1). A STE dose tank (600 gallon) concrete tank was installed beside the primary tank (Figure 6). The purpose of this tank is to hold the septic tank effluent to be pumped to the Stage 1 lined drip area. The 4”D inlet of the STE dose tank is connected (gravity flow) to the primary tank

discharge. The 2”D outlet is connected to the pump. The 2”D outlet (Figure 7) is located near the bottom of the tank.

Table 1
Passive Nitrogen Reduction System Components

	Tank Volume (gal)	Surface Area (ft^2)	Media
Primary Tank	1,500		none
STE Dose Tank	600		none
Stage 1 Biofilter, lined drip area	N/A	728	• 18” sand • 9” lignocellulosic and sand mixture
Stage 2 Biofilter, upflow	1,050	37	12” Elemental sulfur (90%) & oyster shell mixture (10%)

Figure 6
600 gallon, single chamber, STE Dose Tank

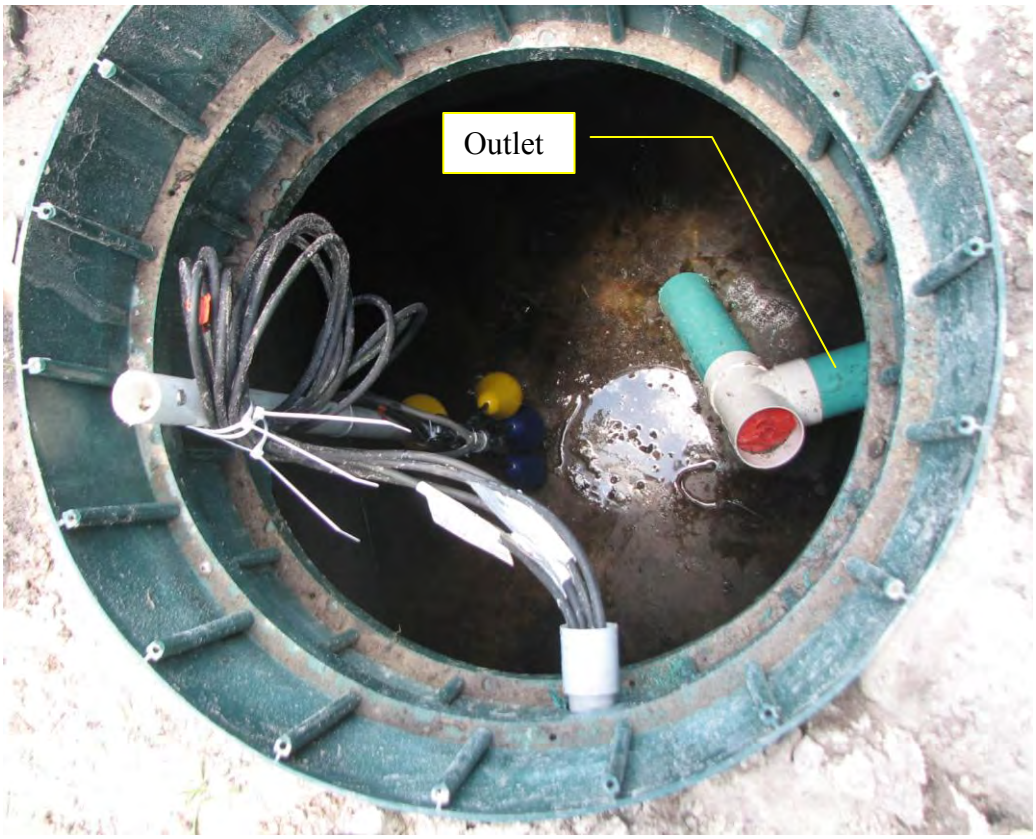

Figure 7
STE Dose Tank outlet pipe

The STE dose tank effluent is pumped (Figure 8) through the drip system hydraulic unit (Figure 9) and discharged to the Stage 1 drip system (Zone 1). The Stage 1 drip system area was prepared by grading a V-shape (Figure 10) so that effluent would collect on the liner (Figure 11) and flow to the center where a perforated pipe within a gravel underdrain conveys the nitrified effluent to the denitrification tank through a pipe boot within the liner (Figure 11). A 9-inch layer of lignocellulosic and sand media mixture was placed above the liner (Figure 12). Overlying the lignocellulosic media mixture is an 18-inch layer of mound sand (slightly limited sand) and the drip emitter lines (Figure 13). An additional 6-inch layer of mound sand was placed above the drip emitter lines (Figure 13).

Figure 8
Dual-purpose pump

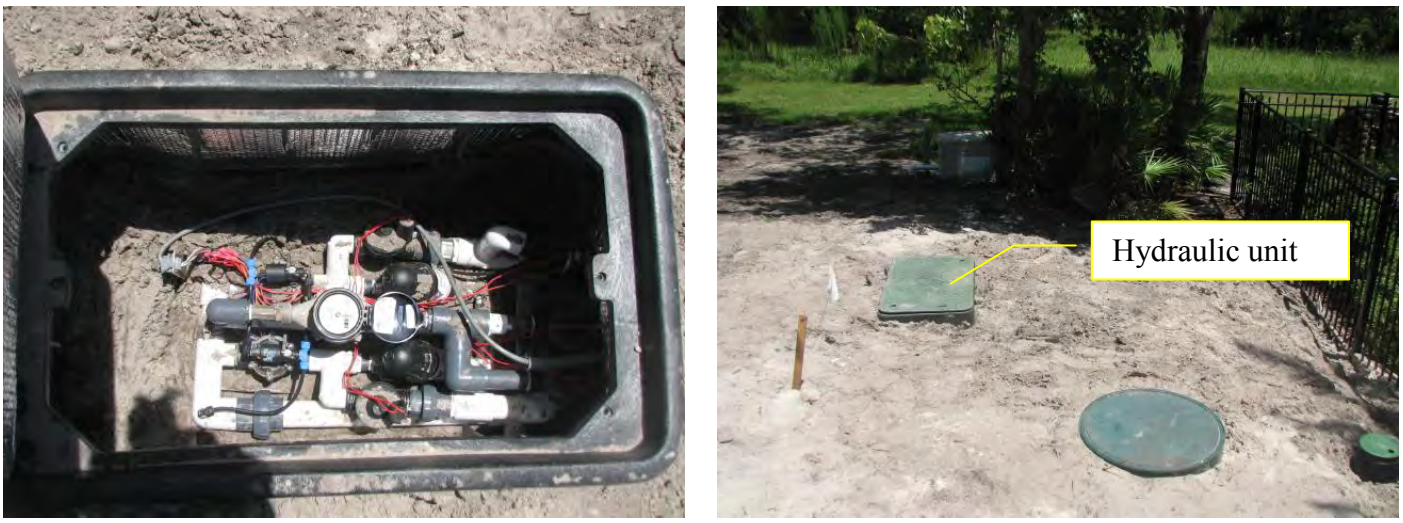

Figure 9
Drip system hydraulic unit

Figure 10
Stage 1 liner area preparation

Figure 11
Stage 1 Liner

Figure 12
Lignocellulosic and sand mixture above liner

Figure 13
Stage 1 drip emitter lines (Zone 1)

The liner effluent is conveyed to a Stage 2 biofilter (1,050 gallon) containing elemental sulfur reactive media (Figure 14) for additional treatment (denitrification). The denitrified effluent is pumped through the drip system hydraulic unit (Figure 9) and discharged to the reclaimed water drip system (Zone 2) (Figure 15). The denitrified effluent is discharged to the natural soil. A flow schematic of the system is shown on Figure 2.

Figure 14
Stage 2 Biofilter

Figure 15
Reclaimed Water Drip Area (Zone 2)

A power meter was installed between the main power box of the house and the control panel to record cumulative power usage of the system in kilowatts. The equipment connected to the power meter are the drip system dose pump and the control panel. Figure 16 shows the power meter installed inside the control panel.

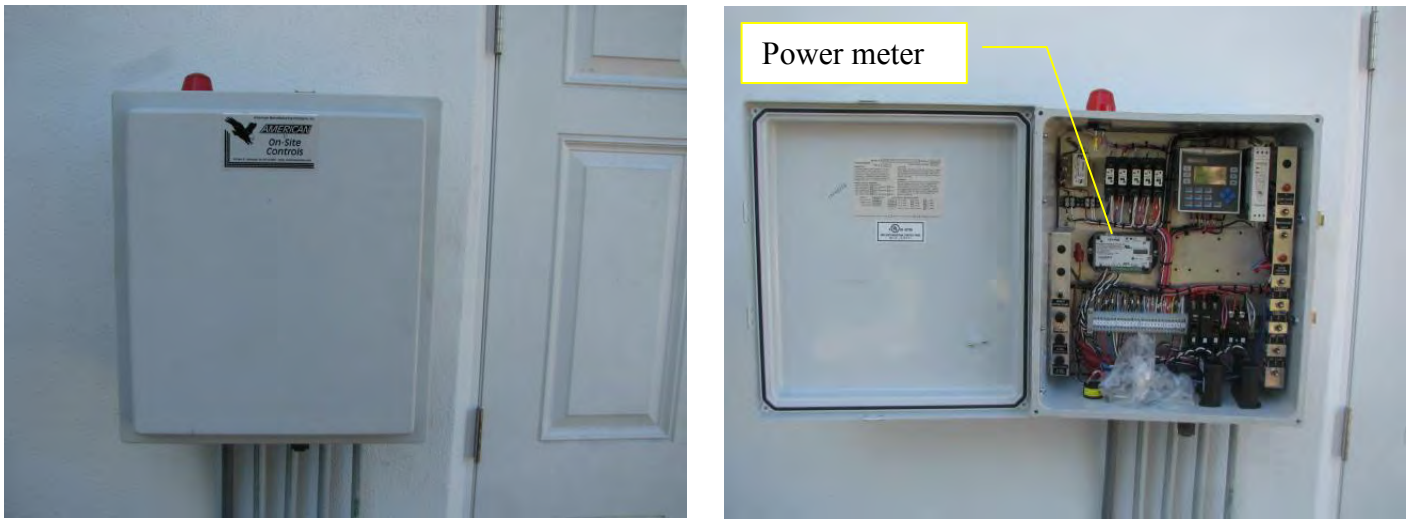

Figure 16
Control Panel

The system control panel (Figure 16) allows for a timed pump cycle which can be overridden if the effluent levels are too low or too high in the dose tanks (STE dose tank and Stage 2 Biofilter). If the floats indicate a low effluent level in the tank, the timed cycle is turned off to protect the pump. If the floats indicate a high effluent tank level, then the pump cycles faster (off cycle reduced) until the water

level reaches the optimal range. An alarm will indicate if the water level goes above a critical level. The control panel is connected to a phone line which transmits data for monitoring.

During final testing of the system, the system operated with no visible signs of leaks, etc. The system area was filled and all disturbed areas on the property were graded (Figure 17).

Figure 28
Overall PNRS system installed

Estimated Cost

The final construction cost for the installed system was $40,129.79 as detailed in Appendix B.

System Start-up

The system was started up July 11, 2013, when all flow was diverted to the new passive system. Routine checks of the system will be made, and preliminary sampling will begin in July to monitor nitrification.

Florida Department of Health
Onsite Nitrogen Reduction Strategies Study

Contract CORCL

TASK B.6

Installation Report for Passive Nitrogen Reduction System B-HS4

June 2013

Task B of the Florida Onsite Nitrogen Reduction Strategies Study (FOSNRS) includes performing field experiments to critically evaluate the performance of nitrogen removal technologies that were identified and pilot tested in FOSNRS Task A. To meet this objective, full scale treatment systems will be installed at various residential sites in Florida, operated on septic tank effluent under actual onsite conditions, and monitored over an extended timeframe. 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 installation of a passive nitrogen reduction system at a home site in Seminole County, Florida (B-HS4).

System Overview

The B-HS4 passive nitrogen reduction system (PNRS) was installed in Seminole County, Florida in June 2013. The property had two existing onsite sewage treatment and disposal systems. The existing 1,200 gallon concrete septic tank, located on the west side of the property, will continue to provide primary treatment for the PNRS system. The existing 800 gallon septic tank, located on the northeast side of the property, was converted to a lift station. The passive nitrogen reduction system consists of an addition of two tanks and a new drainfield to the existing permitted systems. A 2,800 gallon concrete Stage 1 unsaturated media biofilter and 1,500 gallon two chamber concrete Stage 2 saturated media biofilter were installed. Figure 1 is a site schematic showing the system components and layout of the installation. The complete as-built system drawings are included in the attached Appendix A.

The septic tank contents are discharged by gravity to a distribution box, located inside the Stage 1 biofilter, which splits the flow between two perforated distribution pipes along the top of the unsaturated Stage 1 biofilter media. The Stage 1 biofilter contains 10 inches of coarse expanded clay media (Riverlite™ 1/4; 1.1 to 4.8 mm) above 20 inches of finer expanded clay media (Riverlite™ 3/16; 0.6 to 2.4 mm). Wastewater proceeds downward through the expanded clay media where nitrification occurs. Stage 1 biofilter effluent then flows by gravity into the Stage 2 biofilter tank. Effluent from the unsaturated (Stage 1) media tank enters the denitrification (Stage 2) biofilter into a standing water column lying above 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 Stage 2 biofilter contains 42-inches of lignocellulosic media in the first chamber. A collection pipe along the bottom

transfers the effluent to the second chamber which contains 18-inches of elemental sulfur mixed with oyster shell media. The Stage 2 biofilter effluent discharges near the top of the tank; therefore denitrification occurs in the saturated environment. The denitrified treated effluent is discharged into the soil via a new drainfield. The effluent is split between four low-profile Infiltrator chamber trenches by a concrete distribution box. Three of the trenches have 11 chambers and one trench has 12 chambers as depicted in Figure 1. A flow schematic of the system is shown on Figure 2.

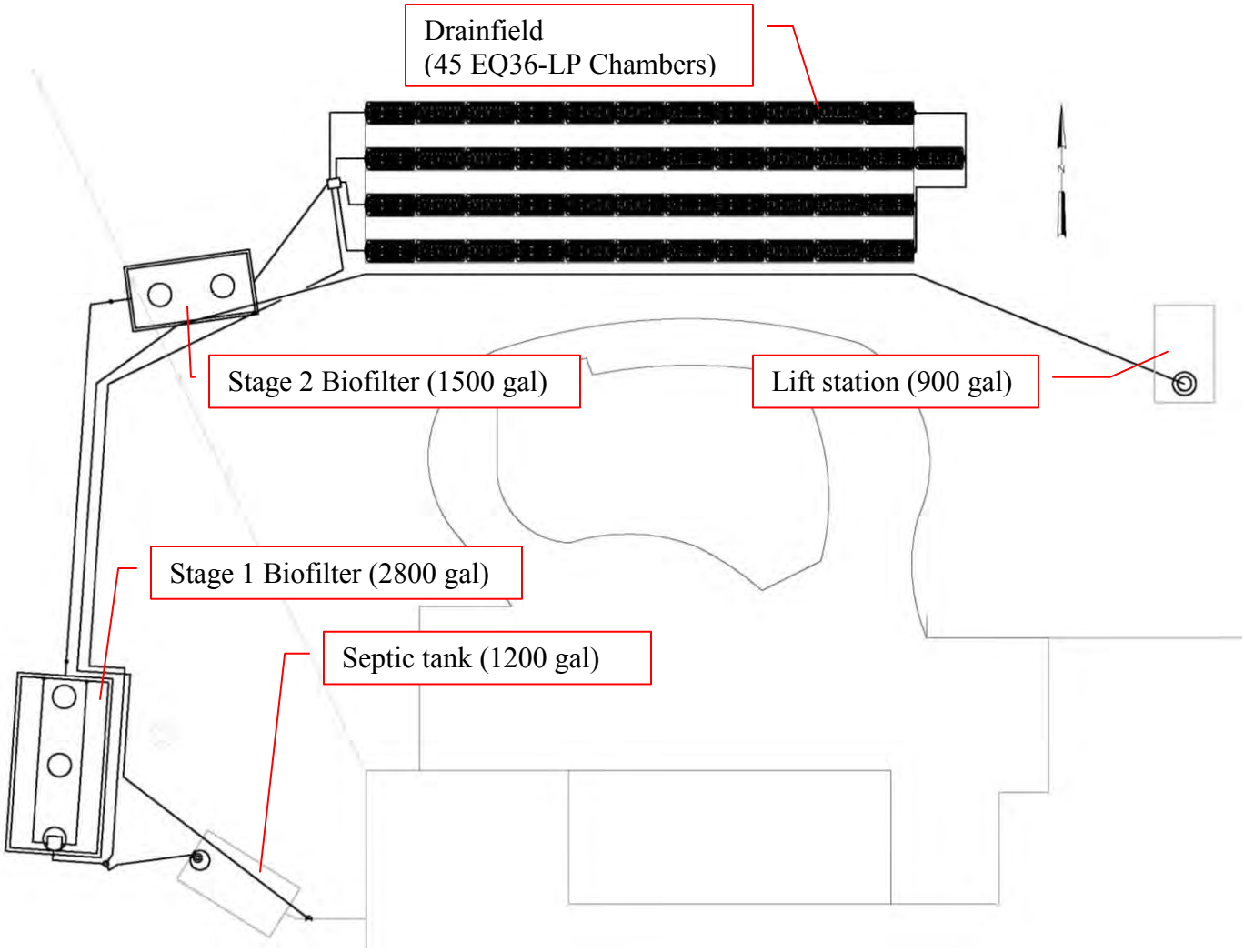

Figure 1
Schematic of B-HS4 PNRS installed in Seminole county

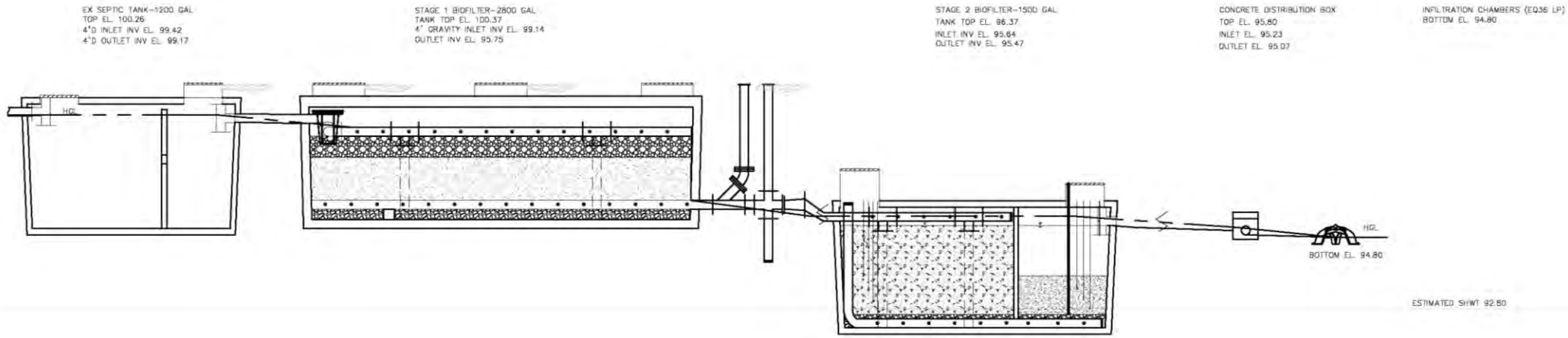

Figure 2
Flow Schematic of B-HS4 PNRS installed in Seminole county

Installation

Installation of the system commenced June 19, 2013 and was completed on June 28, 2013. As previously discussed, the existing 1,200 gallon septic tank will continue to provide primary treatment. Prior to the existing 1,200 gallon septic tank a 2-inch pipe connection was made into the sewer line from the house (Figure 3). The 2-inch diameter pipe conveys the wastewater from the converted 800 gallon lift station via a Liberty grinder pump model number PRG101A-2 (Figure 4) placed within the first chamber. Within the 1,200 gallon septic tank a new effluent filter (Polylok™, PL-68) was installed in the outlet tee (Figure 5). A new lid with manhole (Figure 5) was installed to allow access to the filter for maintenance. Following the 1,200 gallon septic tank, a bull-run-valve (Figure 6) was installed to allow for a means to bypass the PNRS system and discharge septic tank effluent directly into the new drainfield (via the concrete distribution box). A riser pipe was installed to grade over the valve, so that the valve can be turned after installation is complete. The valve is turned with a wrench on a rod which is long enough to reach with the riser installed.

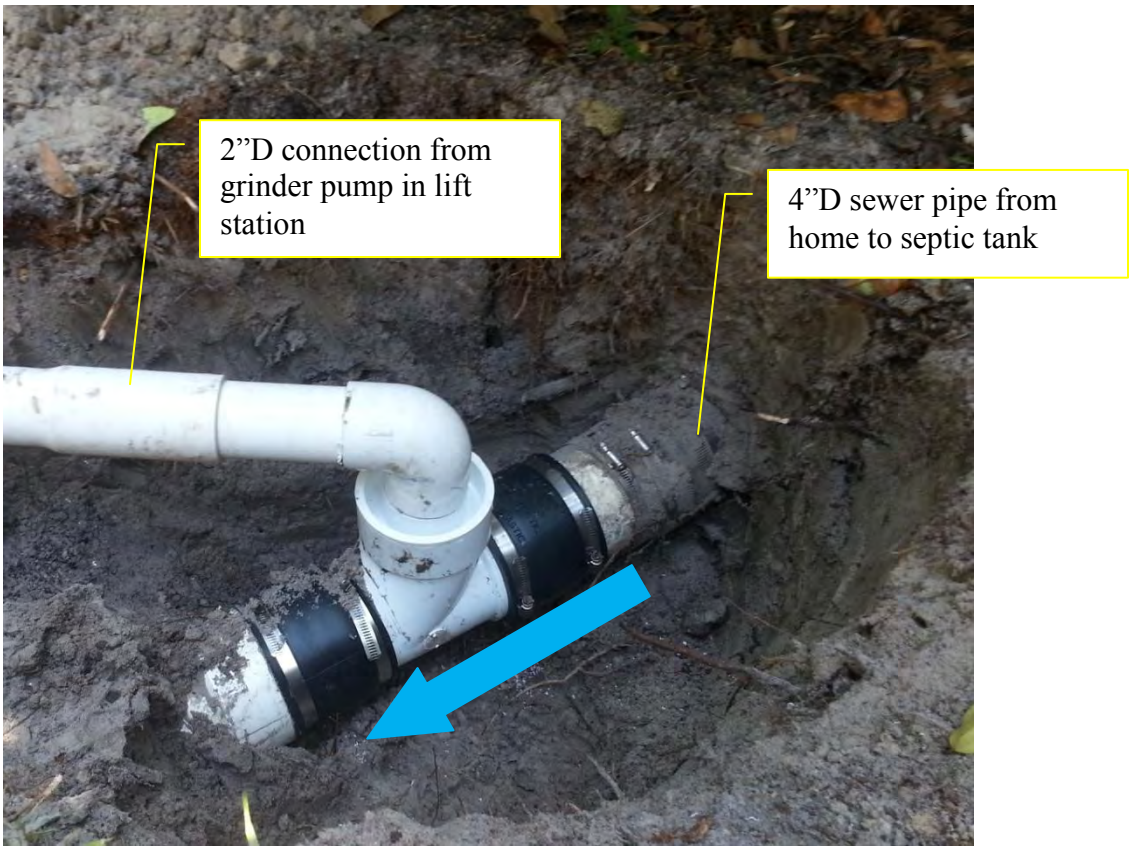

Figure 3
Pipe from Lift Station

Figure 4
Liberty pump within lift station

Figure 5
Septic tank filter and manhole

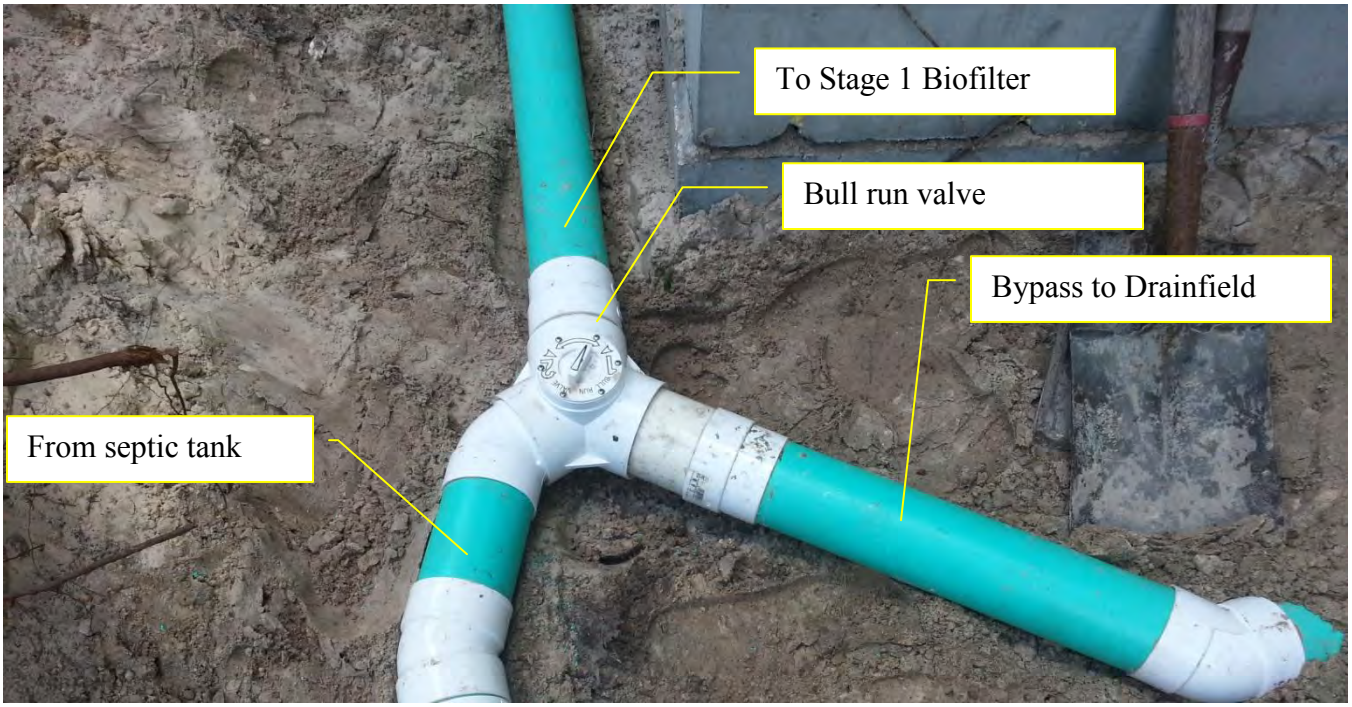

Figure 6
Bull run valve for PNRS bypass

The remaining passive nitrogen reduction system components were installed (Table 1). A single chamber (2,800 gallon) concrete tank was installed beside the primary tank (Figure 7). The purpose of this tank is to hold the Stage 1 expanded clay media. The 4"D inlet of the tank is connected (gravity flow) to the septic tank discharge. The 4"D outlet (Figure 7) of the pipe is located near the bottom of the tank to allow for unsaturated operation. The 4"D underdrain pipe (perforated) with gravel surrounding was installed along the centerline of the bottom of the tank for effluent collection (Figure 8). Following gravel installation and leveling, 20-inches of fine (3/16 Riverlite™) expanded clay media was installed (Figure 9). Above the fine media, 10-inches of coarse (1/4 Riverlite™) expanded clay media was installed (Figure 10). Following media installation and leveling, the influent distribution network was installed. The 4"D influent pipe, connected to the septic tank discharge, discharges into a distribution box which flows to two 4"D perforated pipes across the top of the media (Figure 10). The distribution box includes two Polylok equalizer™ weirs to allow for the adjustment of the flow split (Figure 11). The Stage 1 biofilter outlet pipe includes a clean-out (Figure 12).

Table 1
Passive Nitrogen Reduction System Components

	Tank Volume (gal)	Surface Area (ft^2)	Media
Primary Tank	1,200	47.5	none
Stage 1 Biofilter	2,800	113.3	• 10” Riverlite 1/4 • 20” Riverlite 3/16
Stage 2a Biofilter, downflow	1,000 (1,500 total)	36 (54 total)	42” lignocellulosic (Southern yellow pine)
Stage 2b Biofilter, upflow	500 (1,500 total)	18 (54 total)	18” Elemental sulfur (90%) & oyster shell mixture (10%)

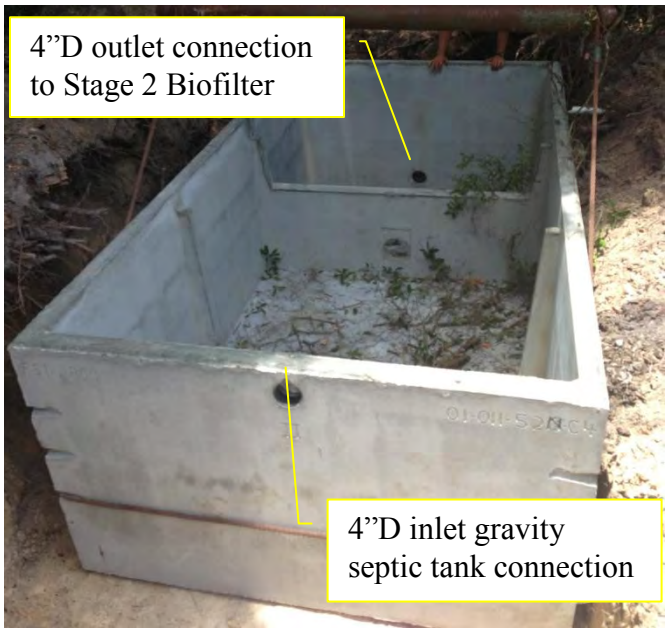

Figure 7
2,800 gallon, single chamber, stage 1 biofilter tank

Figure 8
Stage 1 biofilter gravel underdrain

Figure 9
Stage 1 biofilter 20-inches of fine media (3/16 Riverlite™)

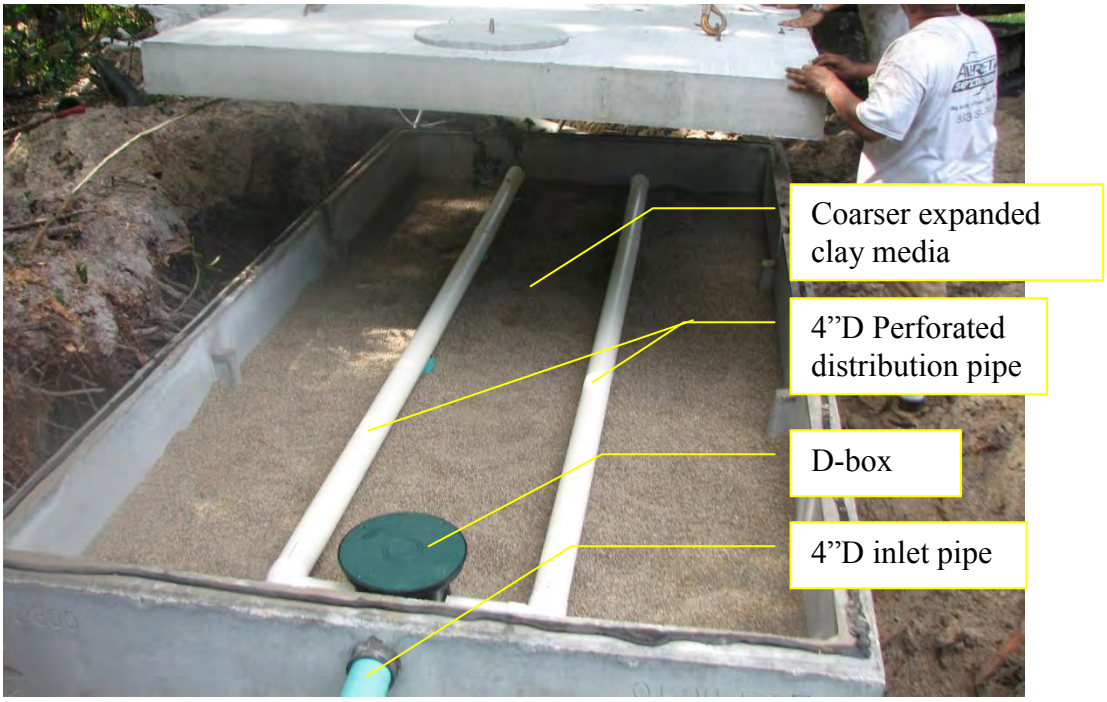

Figure 10
Stage 1 biofilter 10-inches of coarse media (1/4 Riverlite™)

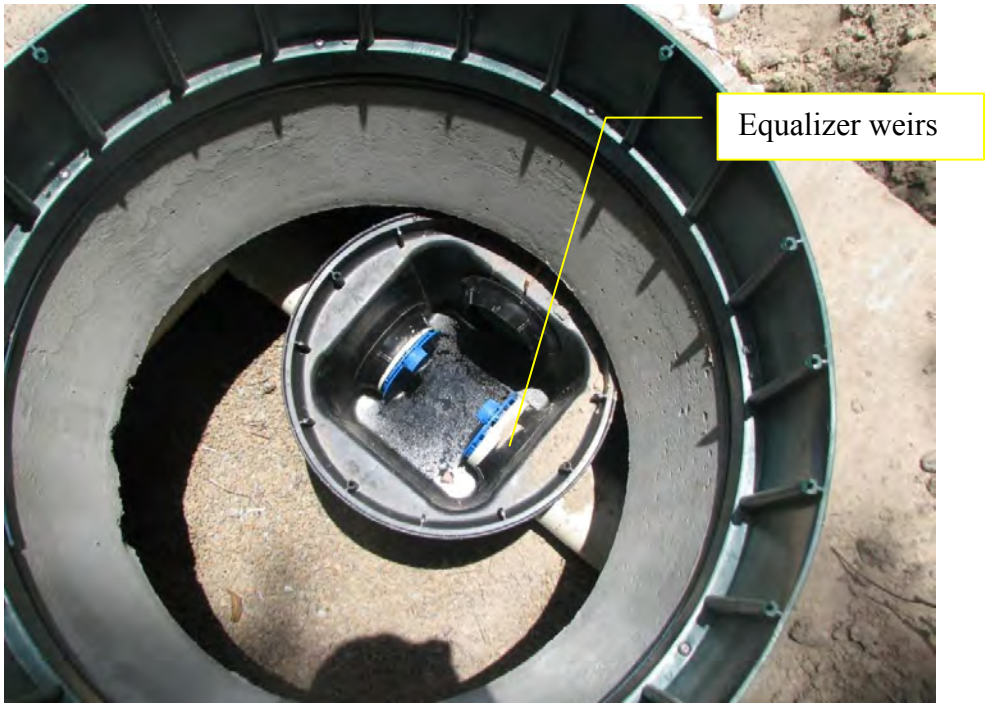

Figure 11
Stage 1 biofilter d-box

Figure 12
Stage 1 biofilter 4”D outlet pipe, with cleanout

The second tank installed was a two chamber (1,500 gallon) concrete tank (Figure 13). The purpose of this tank is to hold the Stage 2 lignocellulosic and sulfur media. The 4”D pipe from the Stage 1 biofilter connects to a perforated pipe which distributes nitrified effluent over the lignocellulosic media within the first chamber of the Stage 2 biofilter. The nitrified effluent flows downward through the lignocellulosic media (within first chamber) and upward through the sulfur media mixture (within second chamber).

A 4”D perforated underdrain pipe (Figure 13) with gravel surrounding (Figure 14) was installed along the centerline of the bottom of the tank for transfer from the first chamber to the second chamber. The tank arrived with a coupling cast into the baffle wall near the bottom to connect both chambers of the tank. Following the underdrain gravel installation (Figure 14) and leveling, 18-inches of elemental sulfur and oyster shell media was installed and mixed (Figure 15) within the second chamber. A stainless steel drivepoint sampler tree (Figure 15) was installed for sampling at 6 and 12-inches above the bottom of the sulfur media mixture.

Above the gravel underdrain within the first chamber of the tank, 42-inches of lignocellulosic media was installed (Figure 16). A stainless steel drivepoint sampler tree was installed for sampling at 0, 12, 24 and 36-inches above the bottom of the lignocellulosic media. A 4”D perforated pipe was connected to the inlet of the tank for effluent dispersal above the lignocellulosic media (Figure 16). A 4”D tee was installed at the outlet of the tank which allows for saturated operating conditions across the biofilter (Figure 17). The 4”D outlet is connected to the distribution box to the existing drainfield.

Figure 13
Stage 2 biofilter perforated pipe through wall

Figure 14
Stage 2 biofilter gravel underdrain

Figure 15
Stage 2 biofilter 18-inches of sulfur and oyster shell media

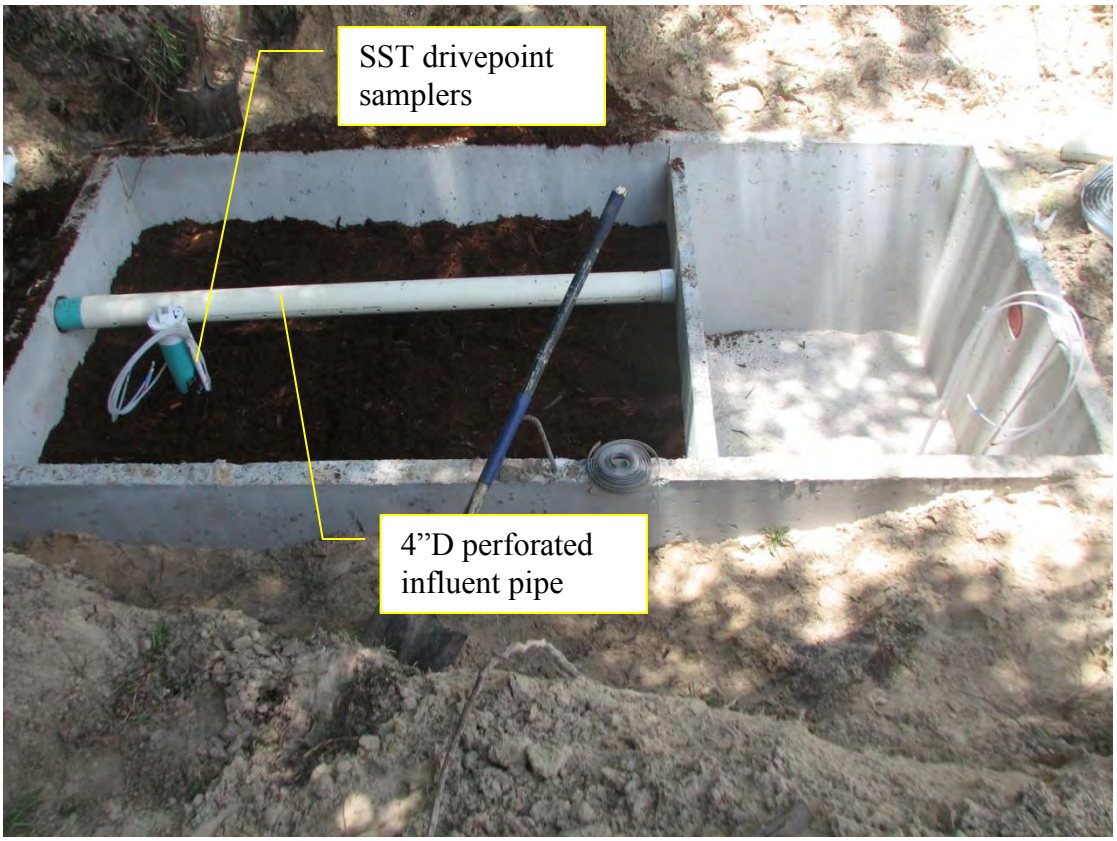

Figure 16
Stage 2 biofilter 42-inches of lignocellulosic media

Figure 17
Stage 2 biofilter outlet tee

The Stage 2 biofilter effluent is discharged into the soil via a new drainfield. The effluent is split between four low-profile Infiltrator chamber trenches by a concrete distribution box (Figure 18). Three of the trenches have 11 chambers and one trench has 12 chambers (Figure 19).

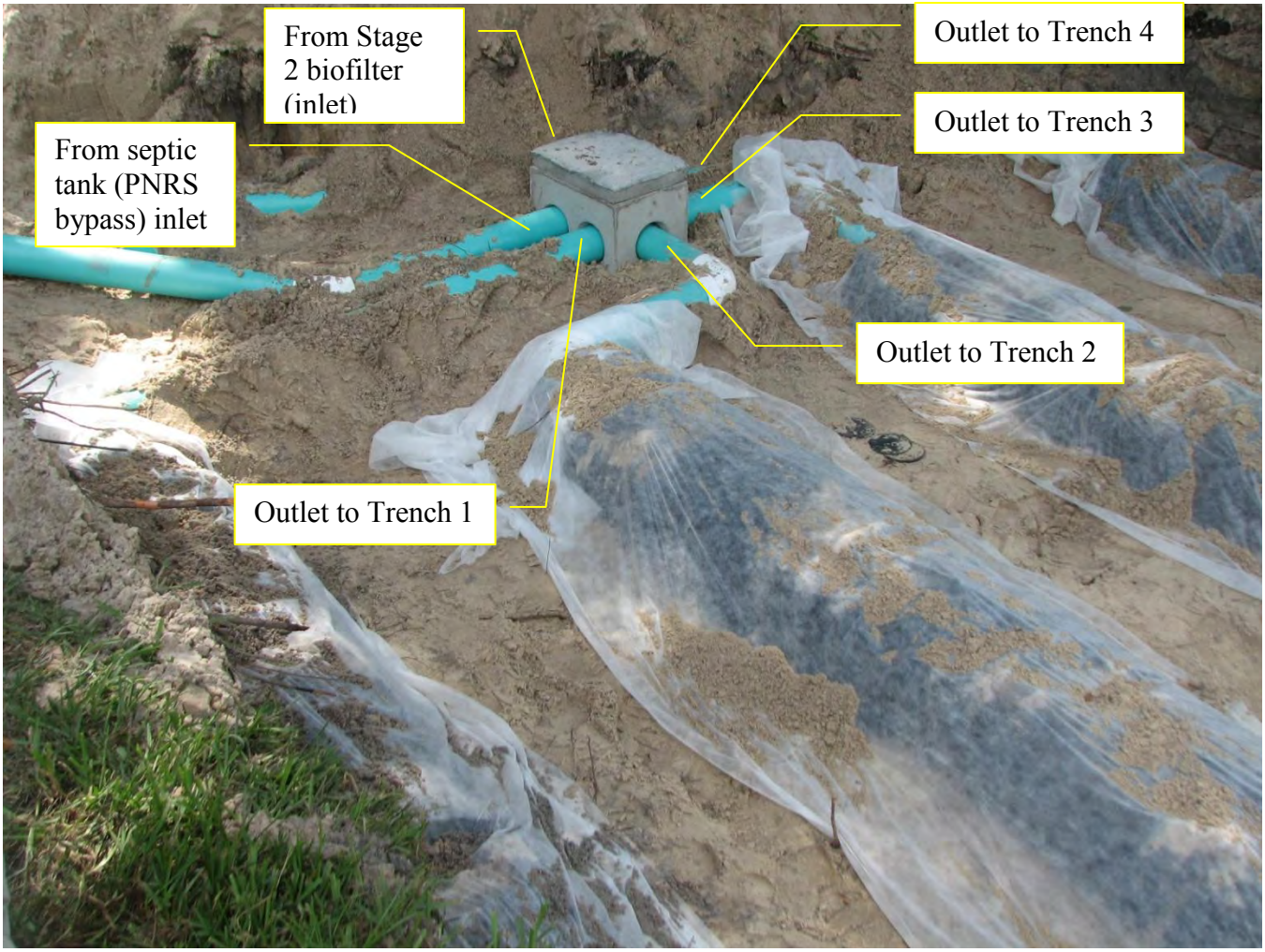

Figure 18
Drainfield distribution box

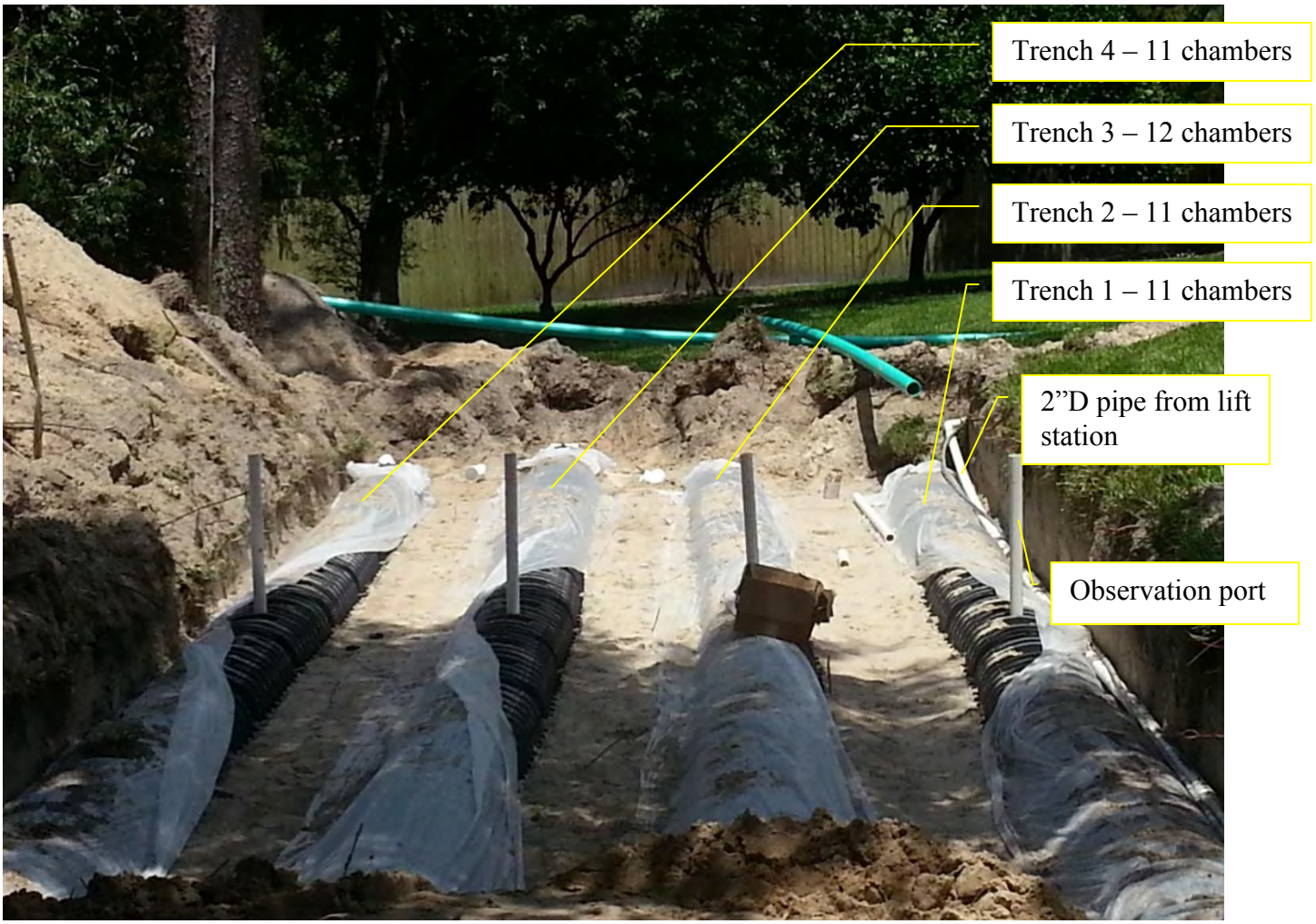

Figure 19
Drainfield trenches

A power meter was installed between the main power box of the house and the grinder pump to record cumulative power usage of the pump in kilowatts. Figure 20 shows the power meter installed inside an outdoor enclosure. Figure 21 shows the electrical outlet that was installed for the pump to plug into.

Figure 20
Power meter inside outdoor enclosure

Figure 21
Power outlet for grinder pump in lift station

During final testing of the system, the system operated with no visible signs of leaks, etc. The system area was filled and all disturbed areas on the property were graded (Figure 22).

Figure 22
Overall PNRS system installed

Estimated Cost

The final construction cost for the installed system was $19,842.84 as detailed in Appendix B.

System Start-up

The system was started up July 8, 2013, when all flow was diverted to the new passive system. Routine checks of the system were made for the first two weeks to ensure the system was functioning as intended. Preliminary sampling will begin in July to monitor nitrification.

Florida Department of Health
Onsite Nitrogen Reduction Strategies Study

Contract CORCL

TASK B.6

Installation Report for Passive Nitrogen Reduction System B-HS5

June 2013

Task B of the Florida Onsite Nitrogen Reduction Strategies Study (FOSNRS) includes performing field experiments to critically evaluate the performance of nitrogen removal technologies that were identified and pilot tested in FOSNRS Task A. To meet this objective, full scale treatment systems will be installed at various residential sites in Florida, operated on septic tank effluent under actual onsite conditions, and monitored over an extended timeframe. 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 installation of a passive nitrogen reduction system at a home site in Seminole County, Florida (B-HS5).

System Overview

The B-HS5 system was installed in Seminole County, Florida in June 2013. It consists of three additional tanks to the existing permitted system: 1500 gallon plastic Infiltrator Stage 1 unsaturated media filter; 300 gallon concrete pump tank; and 1,500 gallon two chamber concrete Stage 2 saturated media biofilter. Figure 1 is a site schematic showing the system components and layout of the installation. The complete as-built system drawings are included in the attached Appendix A.

Household wastewater enters the existing 1,350 gallon primary tank and exits as septic tank effluent through an effluent screen. The septic tank effluent contents are discharged by gravity to a distribution box, located inside the Stage 1 biofilter, which splits the flow between two perforated distribution pipes along the top of the unsaturated Stage 1 biofilter media. 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). Wastewater proceeds downward through the expanded clay media where nitrification occurs. Stage 1 biofilter effluent then flows into the pump tank (which contains the pump and float switches). 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 for recirculation with the rest proceeding to the Stage 2 biofilter. The system was designed with two modes of operation. The first option (which will initially be tested) is to have 100 percent of the Stage 1 effluent discharge to the Stage 2 biofilter. The second option is to have the recirculated effluent return to the top of the Stage 1 biofilter, dispersed by five spray nozzles. The recirculated effluent would have an opportunity to mix with incoming septic tank effluent discharged by the distribution box. Recirculation back to the Stage 1

biofilter increases the hydraulic loading on the Stage 1 biofilter. Effluent from the unsaturated (Stage 1) media tank enters the denitrification (Stage 2) biofilter into a standing water column lying above 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 Stage 2 biofilter contains 42-inches of lignocellulosic media in the first chamber. A collection pipe along the bottom transfers the effluent to the second chamber which contains 18-inches of elemental sulfur mixed with oyster shell media. The Stage 2 biofilter effluent discharges near the top of the tank; therefore denitrification occurs in the saturated environment. The denitrified treated effluent is discharged into the soil via the existing drainfield which is a standard bed. A flow schematic of the system is shown on Figure 2.

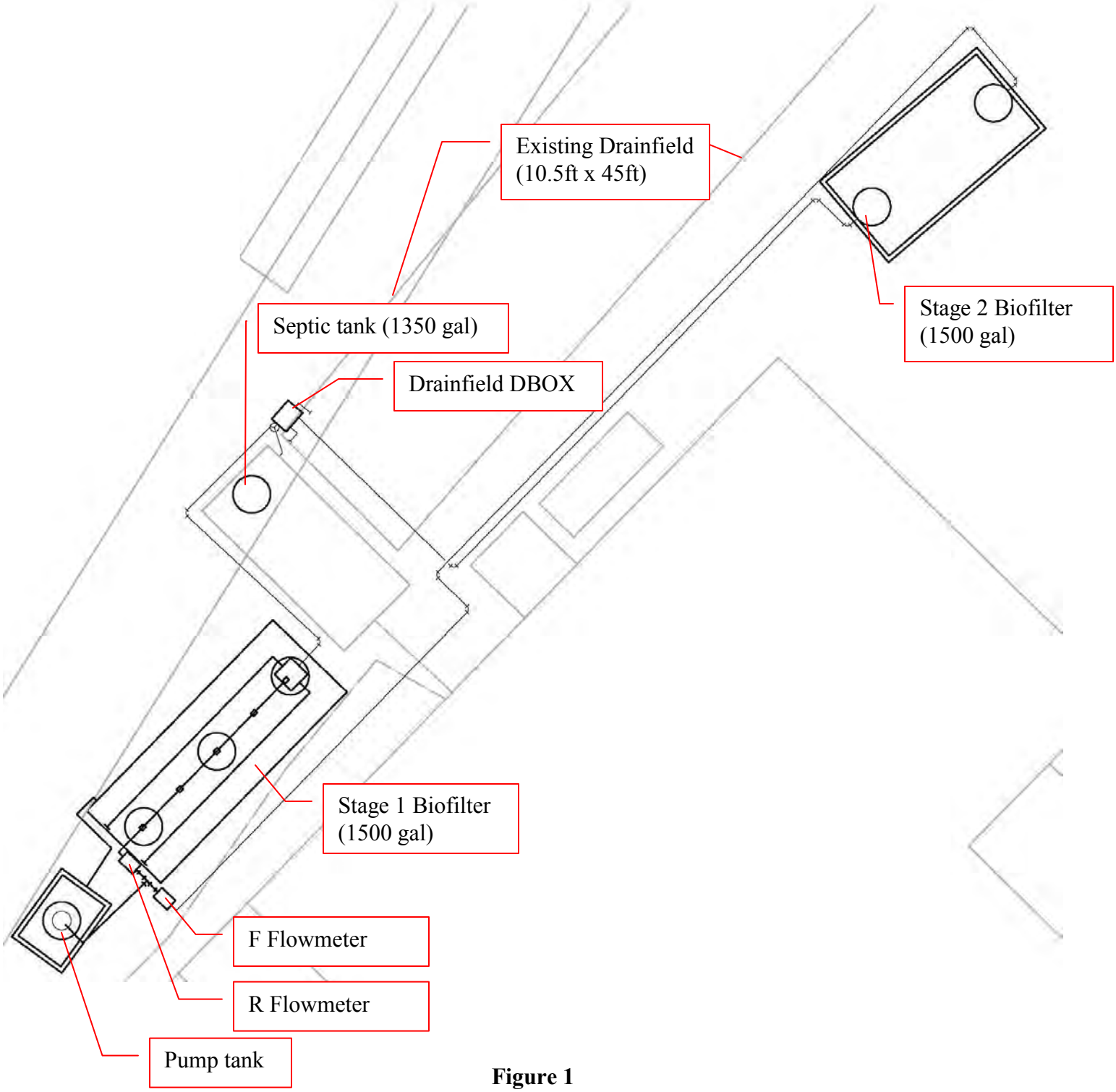

Figure 1
Schematic of B-HS5 PNRS installed in Seminole county

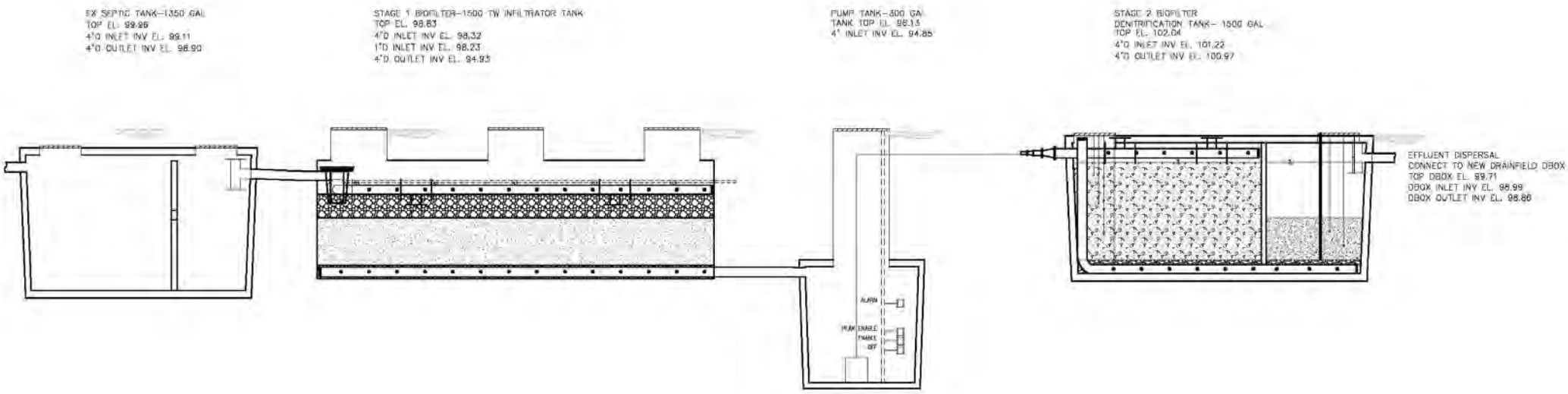

Figure 2
Flow Schematic of B-HS5 PNRS installed in Seminole county

Installation

Installation of the system commenced June 24, 2013 and was completed on June 28, 2013. The installation began with removing the existing concrete sidewalk (Figure 3) which was covering the existing septic tank outlet and existing concrete d-box for the drainfield (Figure 4). A new distribution box was installed (Figure 5). A bull run valve™ (Figure 5) was installed following the septic tank outlet to allow the flow to either be completely directed to the new passive system (to the Stage 2 biofilter) or to the distribution box (to the existing drainfield). A riser pipe was installed to grade over the valve, so that the valve can be turned after installation is complete. The valve is turned with a wrench on a rod which is long enough to reach with the riser installed.

Figure 3
Concrete sidewalk removed

Figure 4
Existing drainfield distribution box

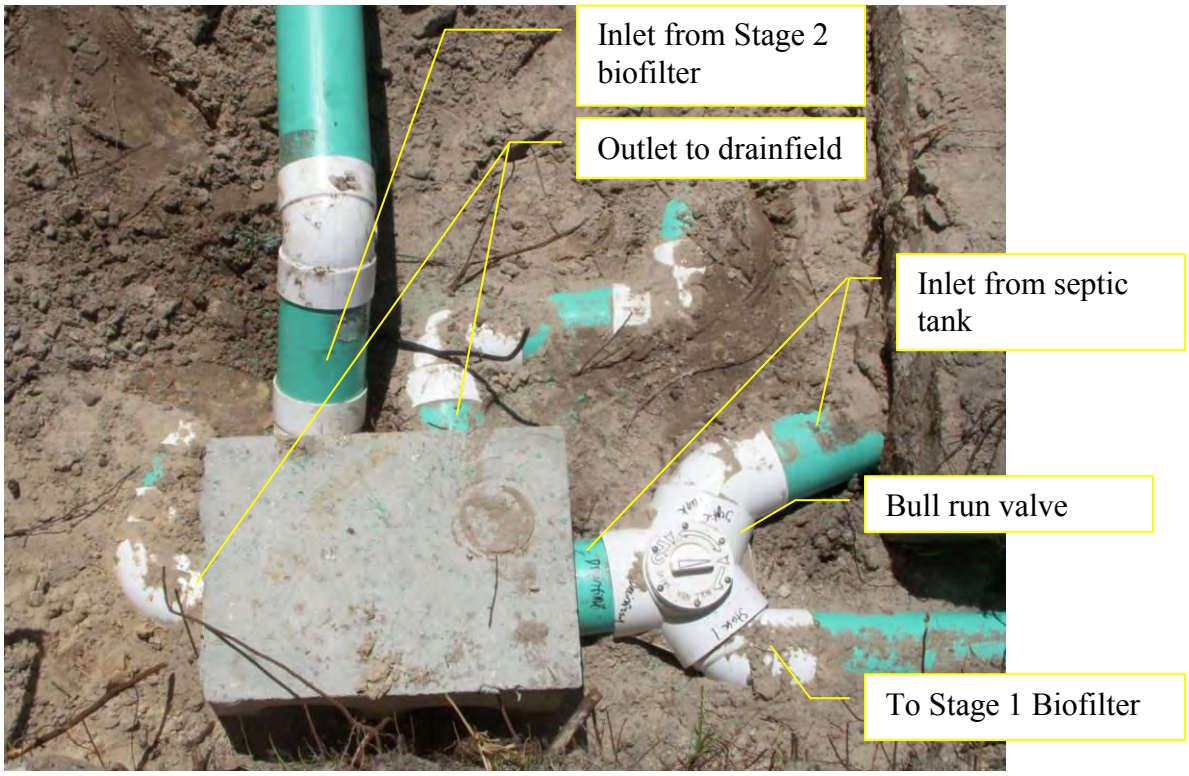

Figure 5
New drainfield distribution box

An effluent screen (Polylok^{TM}, PL-68) was installed in the outlet tee of the second chamber (Figure 6).

Figure 6
1,050 gallon, two chamber, primary Tank effluent screen

The remaining passive nitrogen reduction system components were installed (Table 1). A single chamber (1,500 gallon) plastic Infiltrator tank was installed beside the primary tank (Figure 7). The purpose of this tank is to hold the Stage 1 expanded clay media. The 4"D inlet of the tank is connected (gravity flow) to the septic tank outlet. The 1"D inlet, installed through the standard outlet, is connected (pressurized flow) to the recirculation pipe from the pump tank (Figure 8). The 3"D outlet (Figure 8) of the pipe is located near the bottom of the tank to allow for unsaturated operation. Following gravel installation and leveling (Figure 9), 21-inches of fine (3/16 Riverlite™) expanded clay media was installed (Figure 10). Above the fine media, 12-inches of coarse (1/4 Riverlite™) expanded clay media was installed (Figure 11). Following media installation and leveling, the influent distribution network was installed (Figure 11). The 4"D influent pipe, connected to the septic tank discharge, discharges into a distribution box which flows to two 3"D perforated pipes across the top of the media (Figure 11). The 1"D influent pipe was installed along the centerline with five spray nozzles attached to distribute the recirculated effluent (Figure 12). The spray nozzles are removable for cleaning in the event clogging occurs (Figure 12).

Table 1
Passive Nitrogen Reduction System Components

	Tank Volume (gal)	Surface Area (ft^2)	Media
Primary Tank	1,350	55	none
Stage 1 Biofilter	1,500	78	• 12" Riverlite 1/4 • 21" Riverlite 3/16
Pump Tank	300	12	none
Stage 2a Biofilter, downflow	1,000 (1,500 total)	36 (54 total)	42" lignocellulosic (Southern yellow pine)
Stage 2b Biofilter, upflow	500 (1,500 total)	18 (54 total)	18" Elemental sulfur (90%) & oyster shell mixture (10%)

Figure 7
1500 gallon, single chamber, stage 1 biofilter tank

Figure 8
Stage 1 biofilter 3”D outlet pipe, with cleanout

Figure 9
Stage 1 biofilter gravel underdrain

Figure 10
Stage 1 biofilter 21-inches of fine media (3/16 Riverlite™)

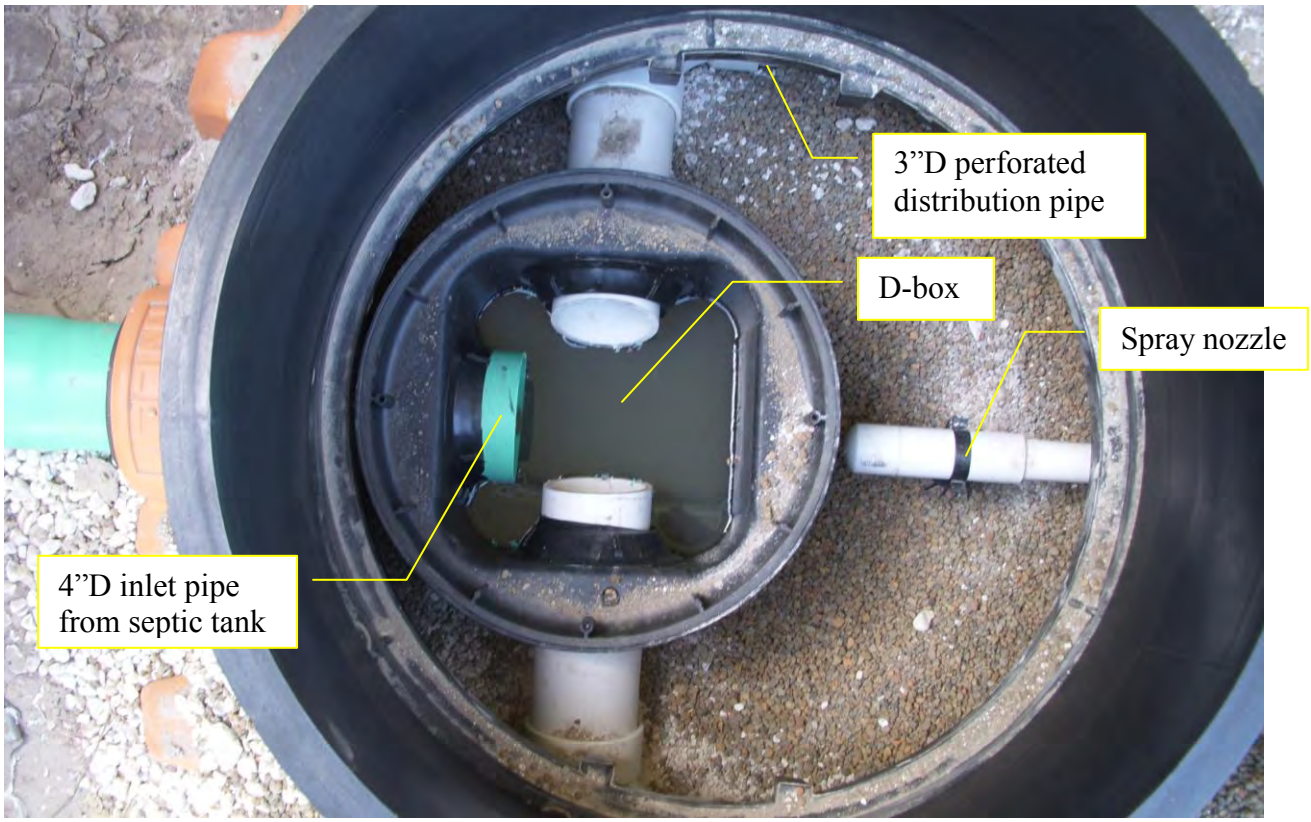

Figure 11
Stage 1 biofilter 12-inches of coarse media (1/4 Riverlite™)

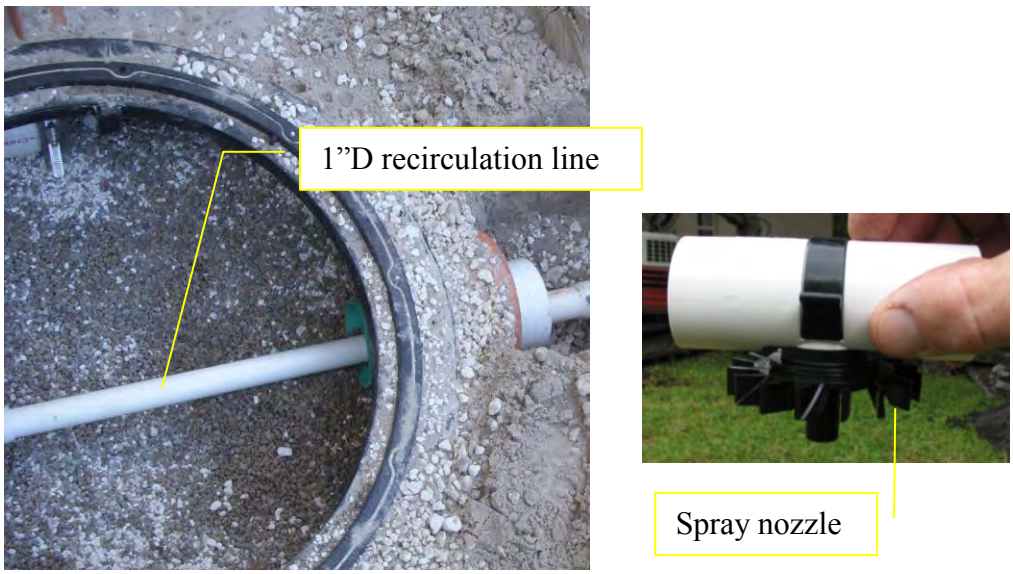

Figure 12
Stage 1 biofilter 1”D influent recirculation line

Next, the 300 gallon concrete pump tank was installed downgradient of the Stage 1 biofilter (Figure 13). The standard outlet pipe connection was plugged since the pump discharge pipe is installed through the riser. The pump was installed within a holding bracket which also supports the float tree (Figure 14). Three float switches were installed to maintain the effluent level in the pump tank and are attached to a float tree installed in the pump tank and connected to the control panel. The height of the floats is adjustable and once the proper heights were established, screws were used to secure the floats to the float tree.

Two inline flow meters were installed following the pump discharge (Figure 15). The pump discharge line was split so that a portion of the flow would be recirculated back to the Stage 1 biofilter while the rest of the flow proceeded to the Stage 2 biofilter. Two throttling gate valves were installed to allow for the adjustment of forward flow (F) and recirculated flow (R) to achieve the target recirculation ratio. The first inline flow meter installed downstream of the F globe valve measures the forward wastewater flow to the Stage 2 biofilter (Figure 15). The second flowmeter installed downstream of the R gate valve, to record the recirculated flow to the Stage 1 biofilter in gallons pumped from the pump tank (Figure 15). As previously discussed, the design includes two modes of operation. The first option (which will initially be tested) is to have the gate valves set so that there is no recirculation (100 percent F flow). Therefore, all the Stage 1 effluent is discharged to the Stage 2 biofilter. The second option is to have the recirculated effluent return to the top of the Stage 1 biofilter, dispersed by five spray nozzles. The recirculated effluent would have an opportunity to mix with incoming septic tank effluent discharged by the distribution box.

Figure 13
300 gallon pump tank

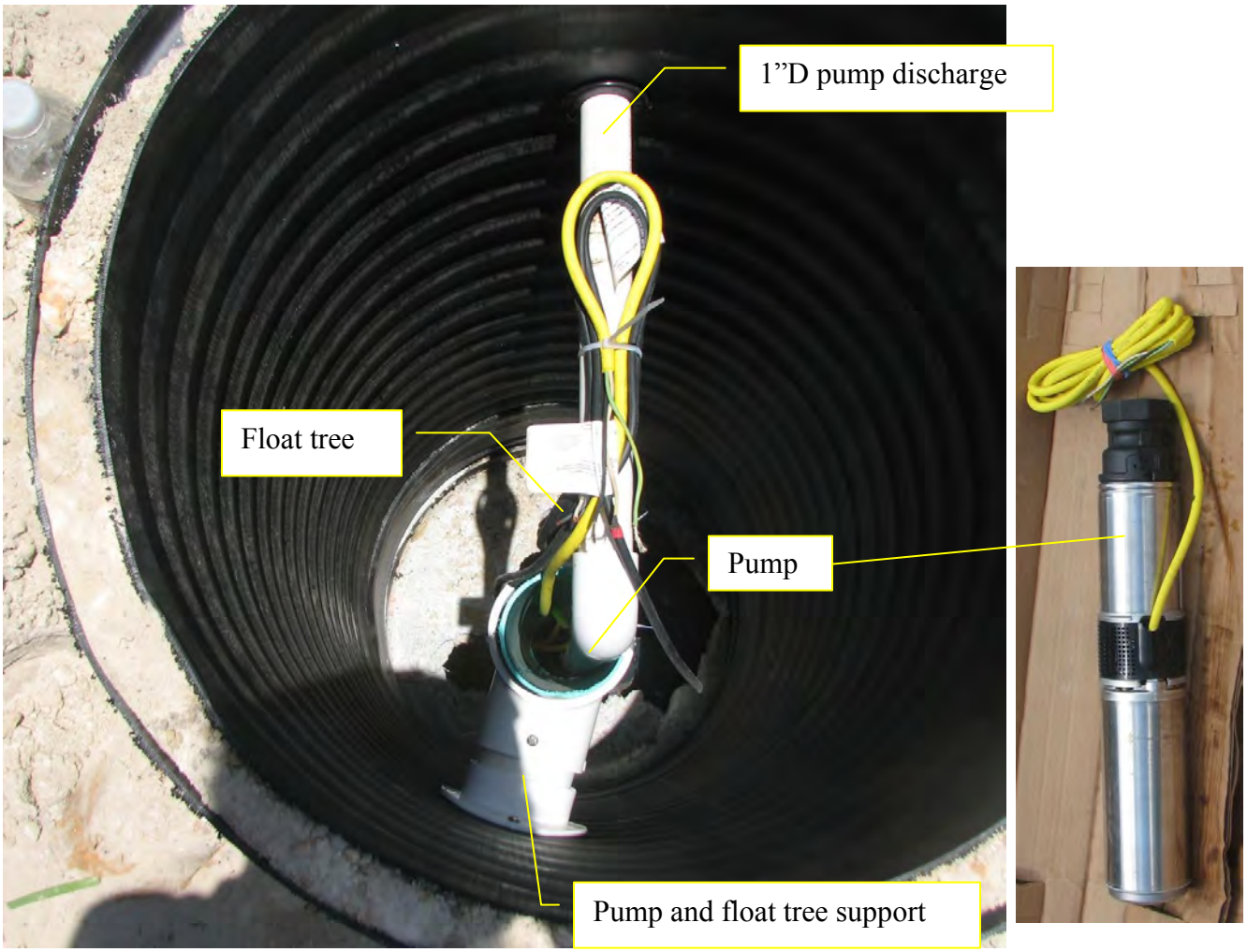

Figure 14
300 gallon pump tank (pump and float tree)

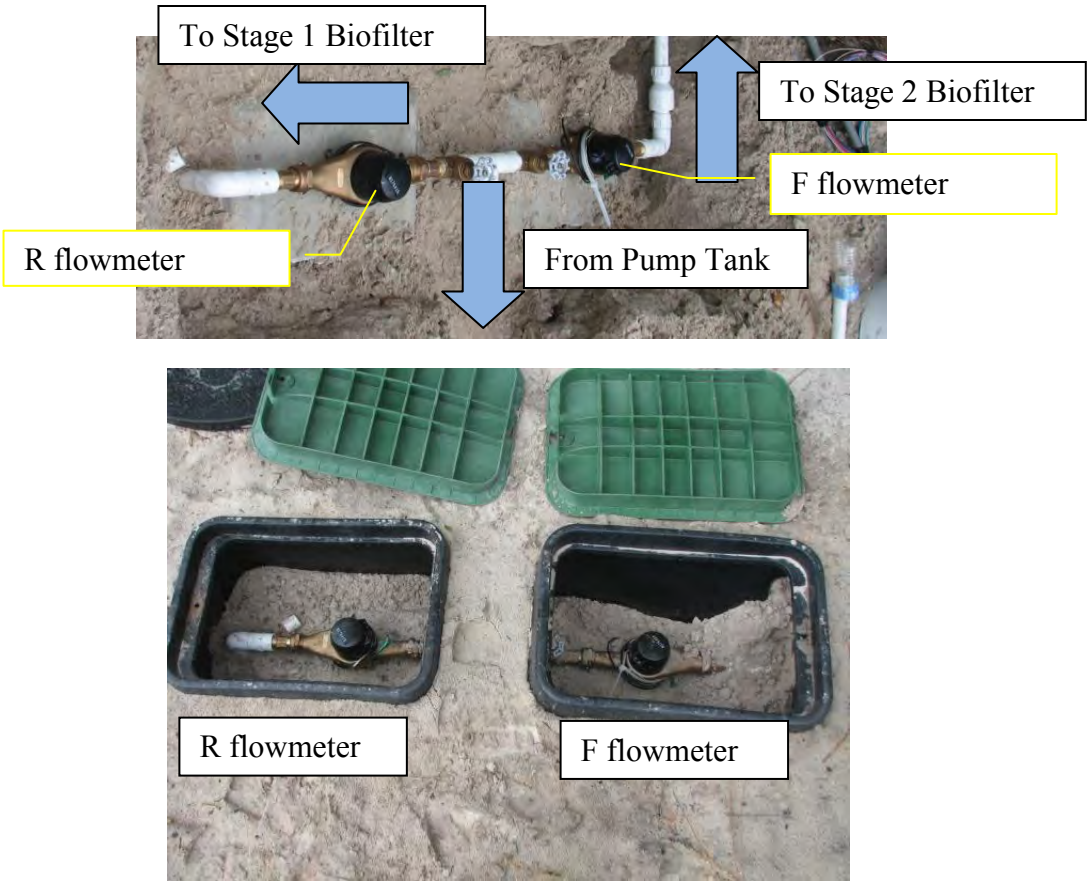

Figure 15
Flowmeters and flow split

The last tank installed was a two chamber (1,500 gallon) concrete tank (Figure 16). The purpose of this tank is to hold the Stage 2 lignocellulosic and sulfur media. The 1"D pipe downstream of the F flowmeter is expanded to 4"D and connects to a perforated pipe which distributes nitrified effluent over the lignocellulosic media within the first chamber of the Stage 2 biofilter. The nitrified effluent flows downward through the lignocellulosic media (within first chamber) and upward through the sulfur media mixture (within second chamber).

A 4"D underdrain pipe (perforated) with gravel surrounding was installed along the centerline of the bottom of the tank for transfer from the first chamber to the second chamber. The tank arrived with a coupling cast into the baffle wall near the bottom to connect both chambers of the tank. Following the underdrain gravel installation (Figure 17) and leveling, 18-inches of elemental sulfur and oyster shell media was installed and mixed (Figure 18) within the second chamber. A stainless steel drivepoint sampler tree (Figure 19) was installed for sampling at 6 and 12-inches above the bottom of the sulfur media mixture.

Above the gravel underdrain within the first chamber of the tank, 42-inches of lignocellulosic media was installed (Figure 19). A stainless steel drivepoint sampler tree was installed for sampling at 0, 12, 24 and 36-inches above the bottom of the lignocellulosic media (Figure 19). A 4"D perforated pipe was connected to the inlet of the tank for effluent dispersal above the lignocellulosic media (Figure 19). The 4"D outlet is connected to the distribution box to the existing drainfield.

Figure 16
1,500 gallon stage 2 biofilter tank

Figure 17
Stage 2 biofilter tank gravel underdrain covering perforated pipe along bottom

Figure 18
Stage 2 biofilter tank (sulfur mixed with oyster shell)

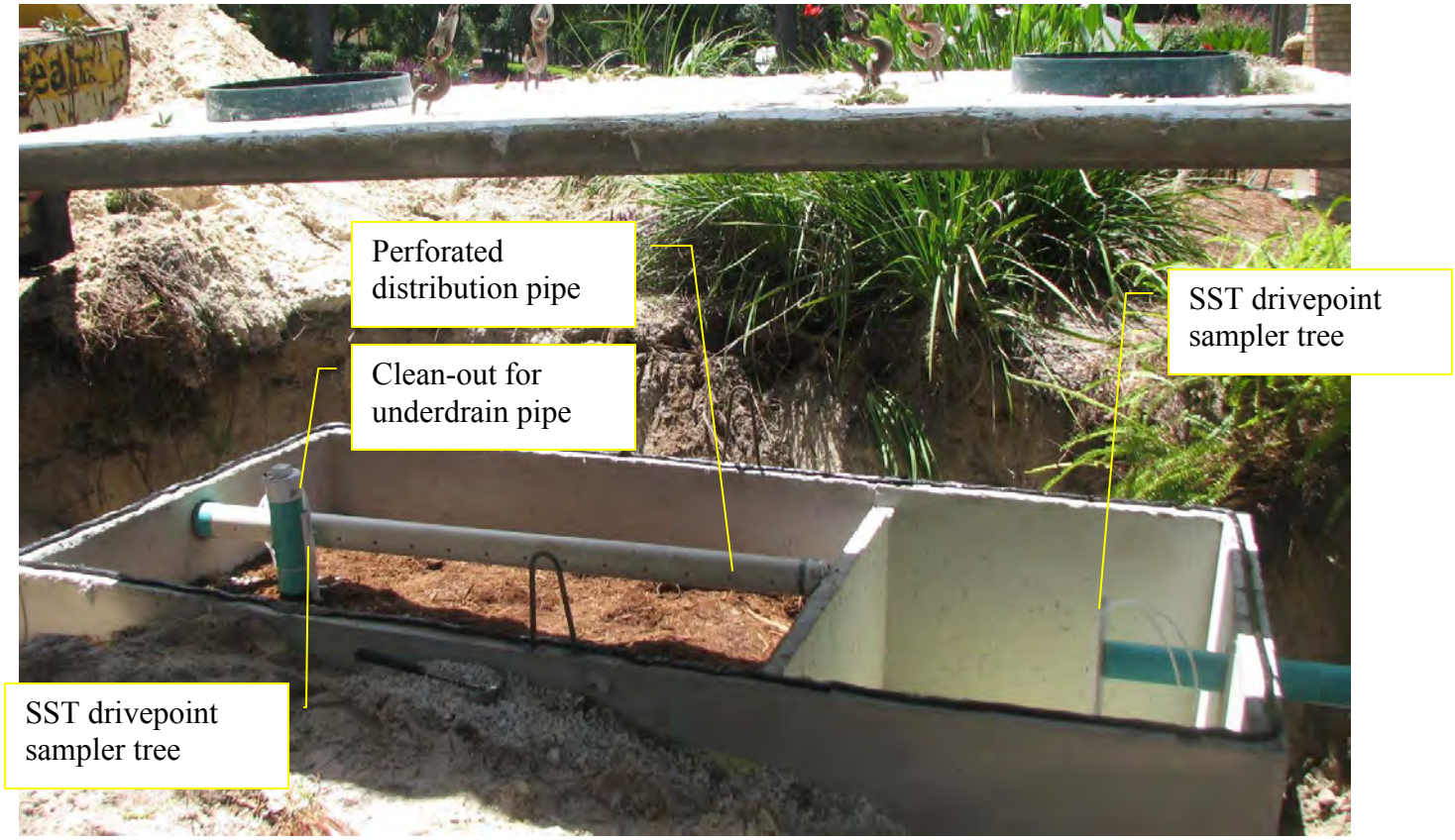

Figure 19
Stage 2 biofilter tank (lignocellulosic media)

A power meter was installed between the main power box of the house and the control panel to record cumulative power usage of the system in kilowatts. The equipment connected to the power meter are the pump and the control panel. Figure 20 shows the power meter installed inside the control panel.

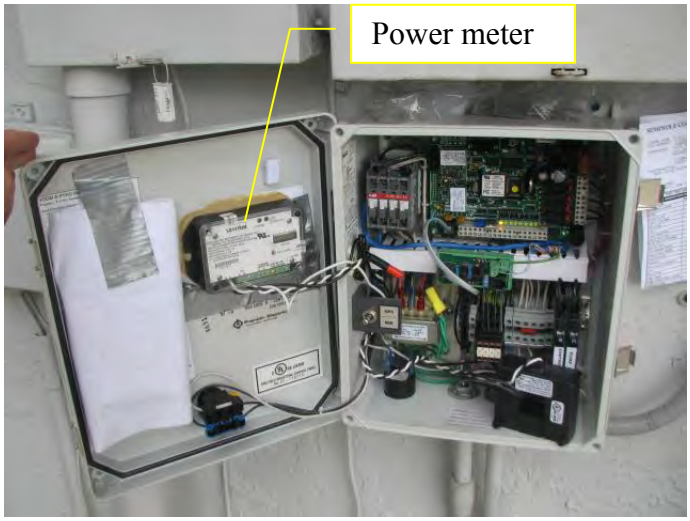

Figure 20
Control Panel

The system control panel (Figure 20) allows for a timed pump cycle which can be overridden if the effluent levels are too low or too high in the pump tank. If the floats indicate a low effluent level in the tank, the timed cycle is turned off to protect the pump. If the floats indicate a high effluent tank level, then the pump cycles faster (off cycle reduced) until the water level reaches the optimal range. An alarm will indicate if the water level goes above a critical level. The control panel is connected to a phone line which transmits data to Vericomm for monitoring.

During final testing of the system, the system operated with no visible signs of leaks, etc. The system area was filled and all disturbed areas on the property were graded (Figure 21).

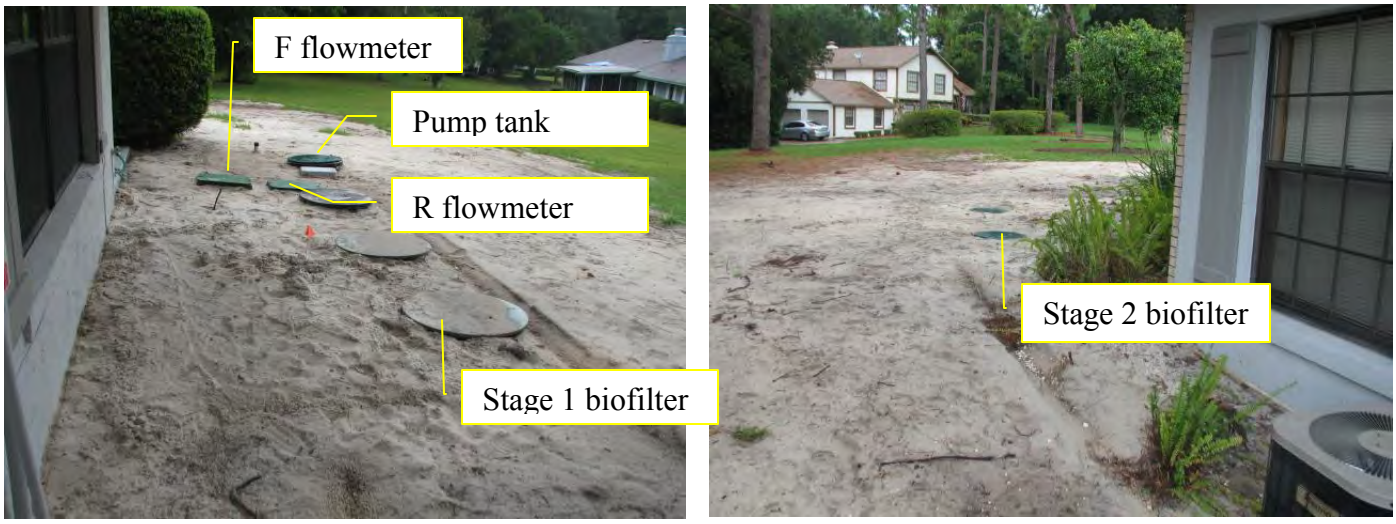

Figure 21
Overall PNRS system installed

Estimated Cost

The final construction cost for the installed system was $22,361.55 as detailed in Appendix B.

System Start-up

The system was started up July 8, 2013, when all flow was diverted to the new passive system. Routine checks of the system will be made to ensure the system is functioning as intended.

Florida Department of Health
Onsite Nitrogen Reduction Strategies Study

Contract CORCL

TASK B.6

Installation Report for Passive Nitrogen Reduction System B-HS6

November 2013

Task B of the Florida Onsite Nitrogen Reduction Strategies Study (FOSNRS) includes performing field experiments to critically evaluate the performance of nitrogen removal technologies that were identified and pilot tested in FOSNRS Task A. To meet this objective, full scale treatment systems will be installed at various residential sites in Florida, operated on septic tank effluent under actual onsite conditions, and monitored over an extended timeframe. 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 installation of a passive nitrogen reduction system at a home site in Wakulla County, Florida (B-HS6).

System Overview

The B-HS6 passive nitrogen reduction system (PNRS) was installed in Wakulla County, Florida in November 2013. The new system replaced the previously installed PNRS system installed at field site B-HS1. The previously installed Aerocell™ unsaturated media filter chamber, Nitrex™ media and split recirculation device were removed from the system. The existing 1,500 gallon dual chamber septic tank will continue to provide primary treatment for the new PNRS system. However, the effluent screen was moved to the outlet and a vented tee was installed between the chambers per 64E-6.013(2)(h). The existing pump and floats were moved from the second chamber of the primary tank into a new 275 gallon pump tank. A 1,650 gallon concrete combined Stage 1 and Stage 2 media biofilter was installed. The existing 1,500 gallon concrete single chamber tank which contained the Nitrex™ media was converted to a Stage 2 saturated sulfur media biofilter. Figure 1 is a site schematic showing the system components and layout of the installation. The complete as-built system drawings are included in Appendix A.

Household wastewater enters the 1st chamber of the primary tank and exits the second chamber as septic tank effluent through an effluent screen into the pump tank (which contains the pump and float switches). The pump tank contents are discharged to the top of the Stage 1 biofilter, dispersed by four spray nozzles. The Stage 1 biofilter contains 30 inches of coarse expanded clay media (Riverlite™ 1/4; 1.1 to 4.8 mm). Wastewater proceeds in downward unsaturated flow through the expanded clay media where nitrification occurs. Twelve inches of lignocellulosic media was installed underneath the

expanded clay media. The tank's outlet invert was installed 4-inches above the interior bottom of the tank. Therefore, approximately 4-inches of the lignocellulosic media is saturated, promoting oxygen depletion and denitrification of the nitrified effluent. The combination Stage 1 and Stage 2a biofilter effluent then flows into the bottom of the denitrification (Stage 2b) biofilter, where it proceeds upward through the elemental sulfur and oyster shell media mixture. The Stage 2b biofilter effluent discharges near the top of the tank; therefore denitrification occurs in the saturated environment. The denitrified treated effluent is discharged into the soil via the existing drainfield (standard trenches). A flow schematic of the system is shown on Figure 2.

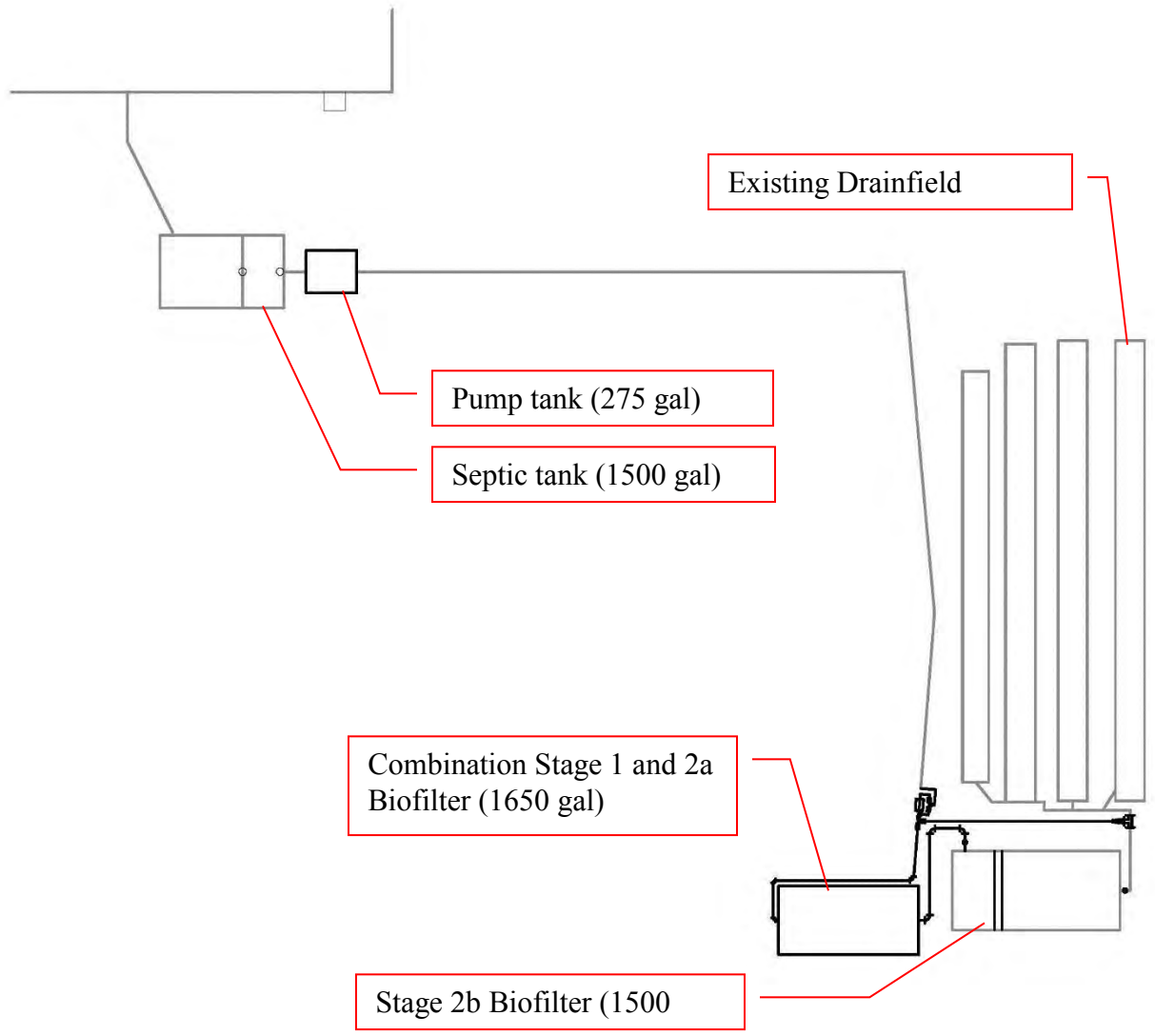

Figure 1
Schematic of B-HS6 PNRS installed in Wakulla county

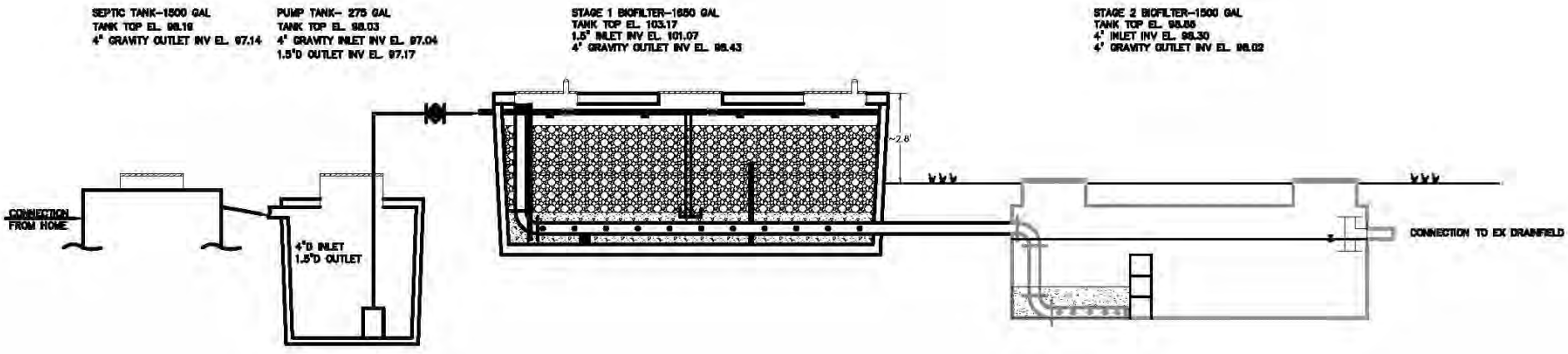

Figure 2
Flow Schematic of B-HS6 PNRS installed in Wakulla county

Installation

Installation of the system commenced November 5, 2013 and was completed on November 6, 2013. As previously discussed, the existing 1,500 gallon septic tank will continue to provide primary treatment. A vented tee was installed between the chambers (Figure 3) and the effluent screen was moved to the outlet (Figure 4).

Figure 3
Primary tank vented tee between chambers

Figure 4
Primary tank effluent screen moved to outlet

Following the primary tank modifications, the previously installed passive nitrogen reduction system components were removed. The previously installed Aerocell™ unsaturated media filter chamber (Figure 5), Nitrex™ media (Figure 6) and split recirculation device (Figure 7) were removed from the system.

Figure 5
Aerocell™ unsaturated media filter chamber removal

Figure 6
Nitrex™ media removal

Figure 7
Split Recirculation Device removal

Following the removal of the old system components, the remaining passive nitrogen reduction system components were installed (Table 1). A 275 gallon concrete pump tank was installed beside the primary tank (Figure 8). The 4"D inlet of the pump tank is connected (gravity flow) to the septic tank discharge. On the pump discharge line, the existing system flow meter was installed with a bypass line for the flowmeter (Figure 9). In addition, a PNRS system bypass for the Stage 1, 2a, and 2b biofilters was installed that connects the pump discharge directly to the drainfield (Figure 10). A single chamber (1,650 gallon) concrete tank was installed near the existing 1,500 gallon tank (Figure 11). The purpose of this tank is to hold the Stage 1 expanded clay media and Stage 2a lignocellulosic media. The Stage 1 and 2a combination tank 4"D outlet (Figure 11) is located near the bottom of the tank to allow for unsaturated operation through the expanded clay media and some saturation operation through the lignocellulosic media. The 4"D underdrain pipe (perforated) was installed along the centerline, 4-inches above the interior bottom of the tank for effluent collection. A 12-inch layer of lignocellulosic media, a blended urban waste wood from AAA Tree Experts, Tallahassee, FL, was installed in the bottom of the tank (Figure 12). Following lignocellulosic installation and leveling, 30-inches of coarse (1/4 Riverlite™) expanded clay media was installed (Figure 13) above a plastic mesh screen separating the two media layers. Following media installation and leveling, the influent distribution network was installed. The 1.5"D influent pipe, connected to the pump tank discharge, disperses the effluent through four spray nozzles (Figure 13). Vents were installed on the covers of the tank (Figure 14) to allow air into the tank promoting aerobic conditions for nitrification. The Stage 1 biofilter outlet pipe includes a sample port (Figure 15). The tank was hidden with a berm surrounding the tank (Figure 16).

Table 1
Passive Nitrogen Reduction System Components

	Tank Volume (gal)	Surface Area (ft^2)	Media
Primary Tank	1,500	67	none
Pump Tank	275	13	none
Stage 1 Biofilter and Stage 2a Biofilter	1,650	67	• 30" Riverlite 1/4 • 12" Lignocellulosic
Stage 2b Biofilter, upflow	~500 (1,500 total)	~20 (61 total)	12" Elemental sulfur (90%) & oyster shell mixture (10%)

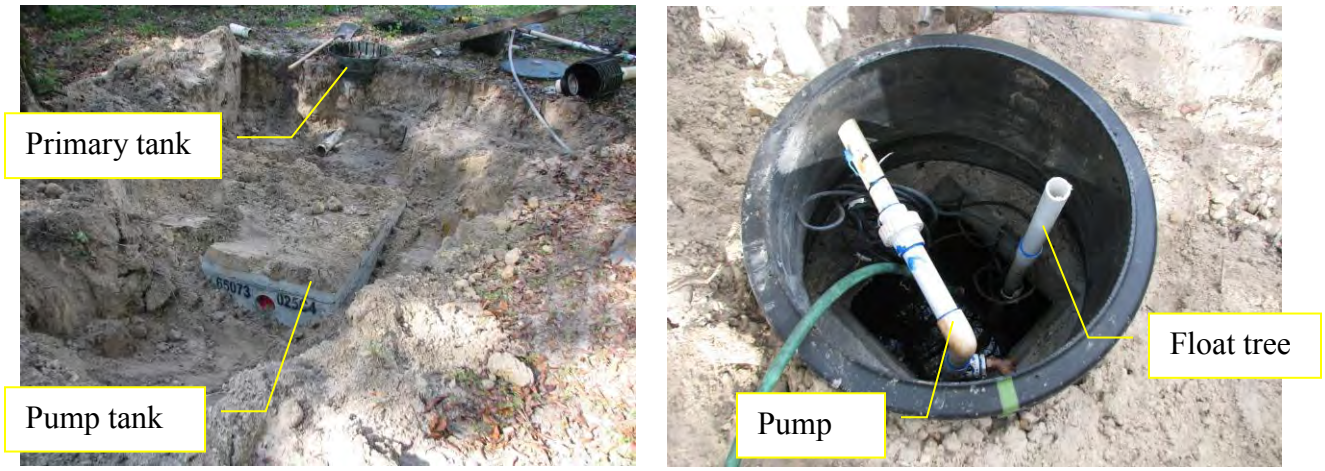

Figure 8
Pump tank (275 gallon)

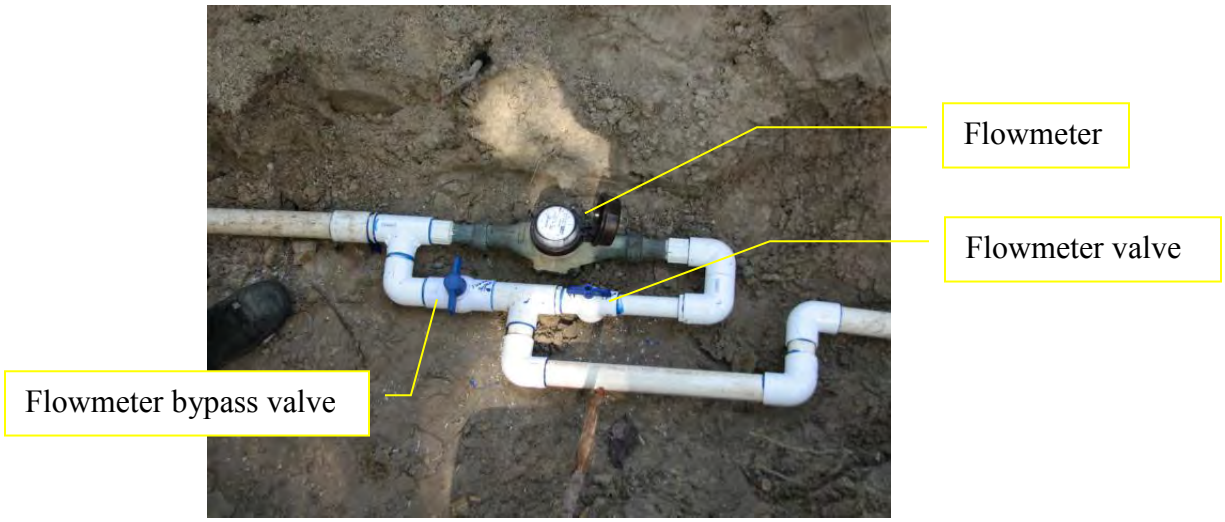

Figure 9
System flow meter

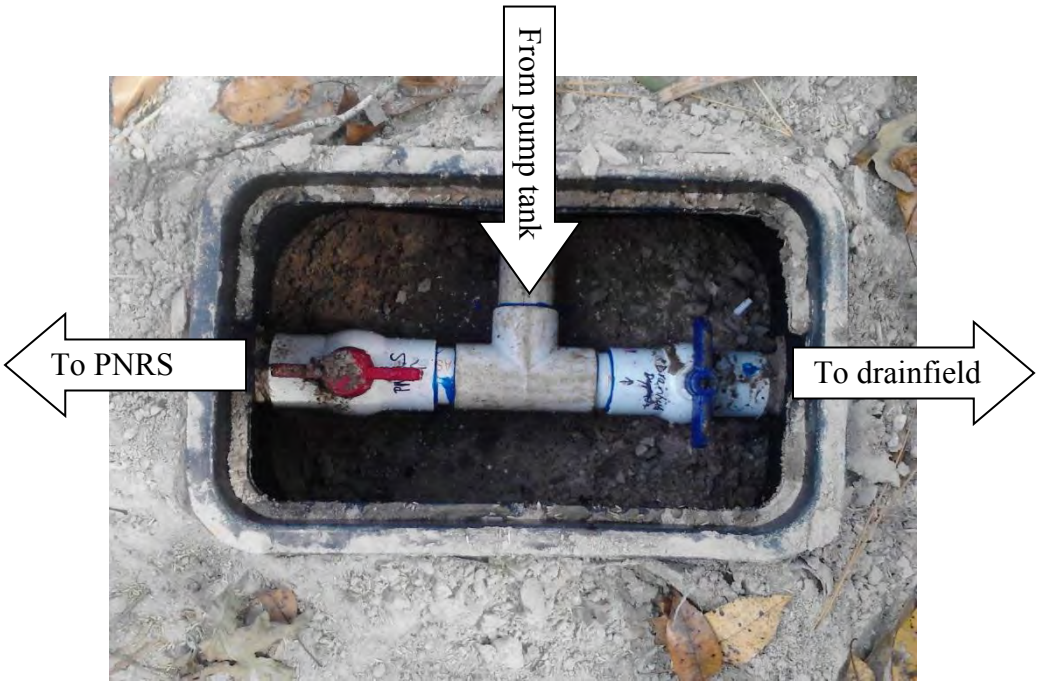

Figure 10
PNRS system bypass

Figure 11
Combination Stage 1 and 2a Biofilter (1650 gallon)

Figure 12
Lignocellulosic media installation

Figure 13
Expanded clay media installation

Figure 14
Vents on the covers

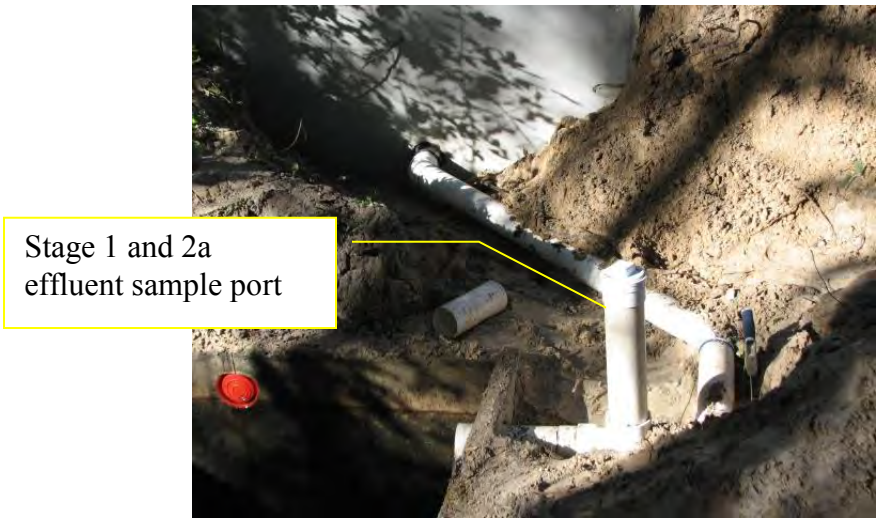

Figure 15
Stage 1 and Stage 2a effluent sample port

Figure 16
Stage 1 and Stage 2a berm hiding tank

The 1,500 gallon concrete tank that previously contained the Nitrex™ media (Figure 17) was converted to the new Stage 2b tank containing 90% pastille-shaped elemental sulfur (GreenSun® ES-99) and 10% oyster shell media (Remington Feed) mixture. The volume of sulfur media required for treatment is significantly less than lignocellulosic media; therefore a cinder block wall (3 blocks in height) was installed inside the tank to create two chambers. The inlet chamber created with the wall holds the sulfur media mixture and is approximately one-third of the tank volume (Figure 18). The 4"D pipe from the Stage 1 and 2a biofilter connects to a perforated pipe along the bottom of the inlet chamber (Figure 18). Above the perforated pipe, 12-inches of elemental sulfur and oyster shell media was installed and mixed (Figure 18). The outlet pipe is connected to the existing drainfield and contains a new sample port (Figure 19).

Figure 17
Cleaned Stage 2b tank (1500 gallon)

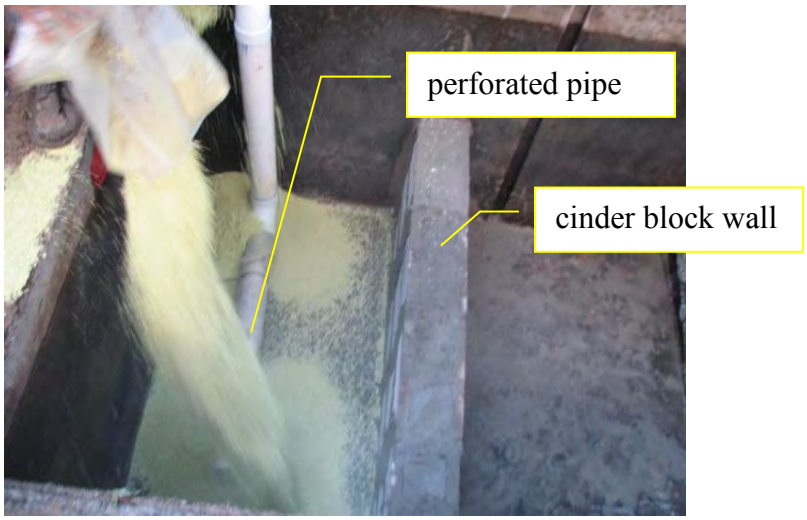

Figure 18
Stage 2b tank (1500 gallon)

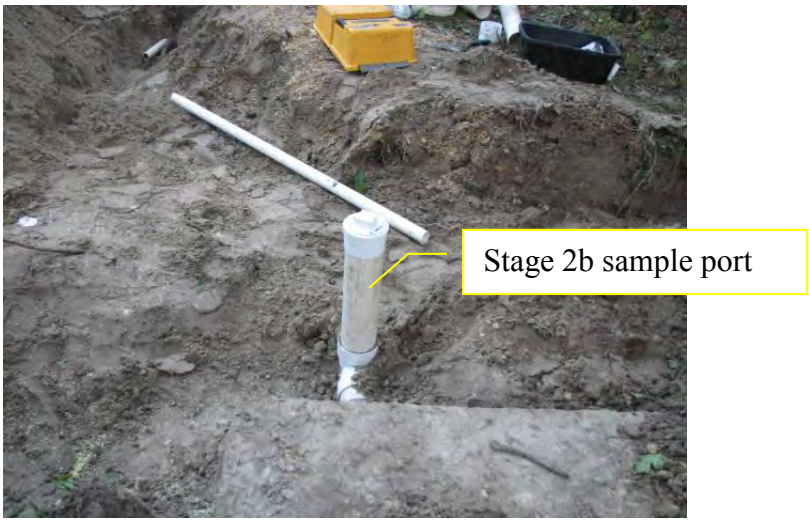

Figure 19
Stage 2b tank (1500 gallon) sample port

The previously installed power meter between the main power box of the house and the Vericomm control panel remains to record cumulative power usage of the pump in kilowatt-hours. Figure 20 shows the power meter installed inside an outdoor enclosure above the control panel.

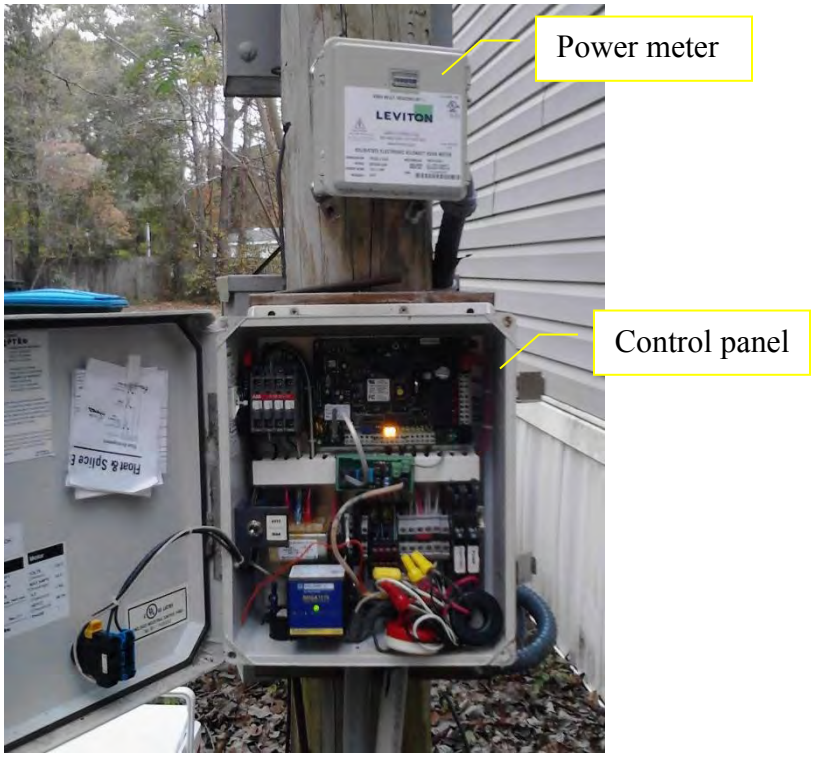

Figure 20
Power meter and Control Panel

During final testing of the system, the system operated with no visible signs of leaks, etc. The system area was filled and all disturbed areas on the property were graded (Figure 21).

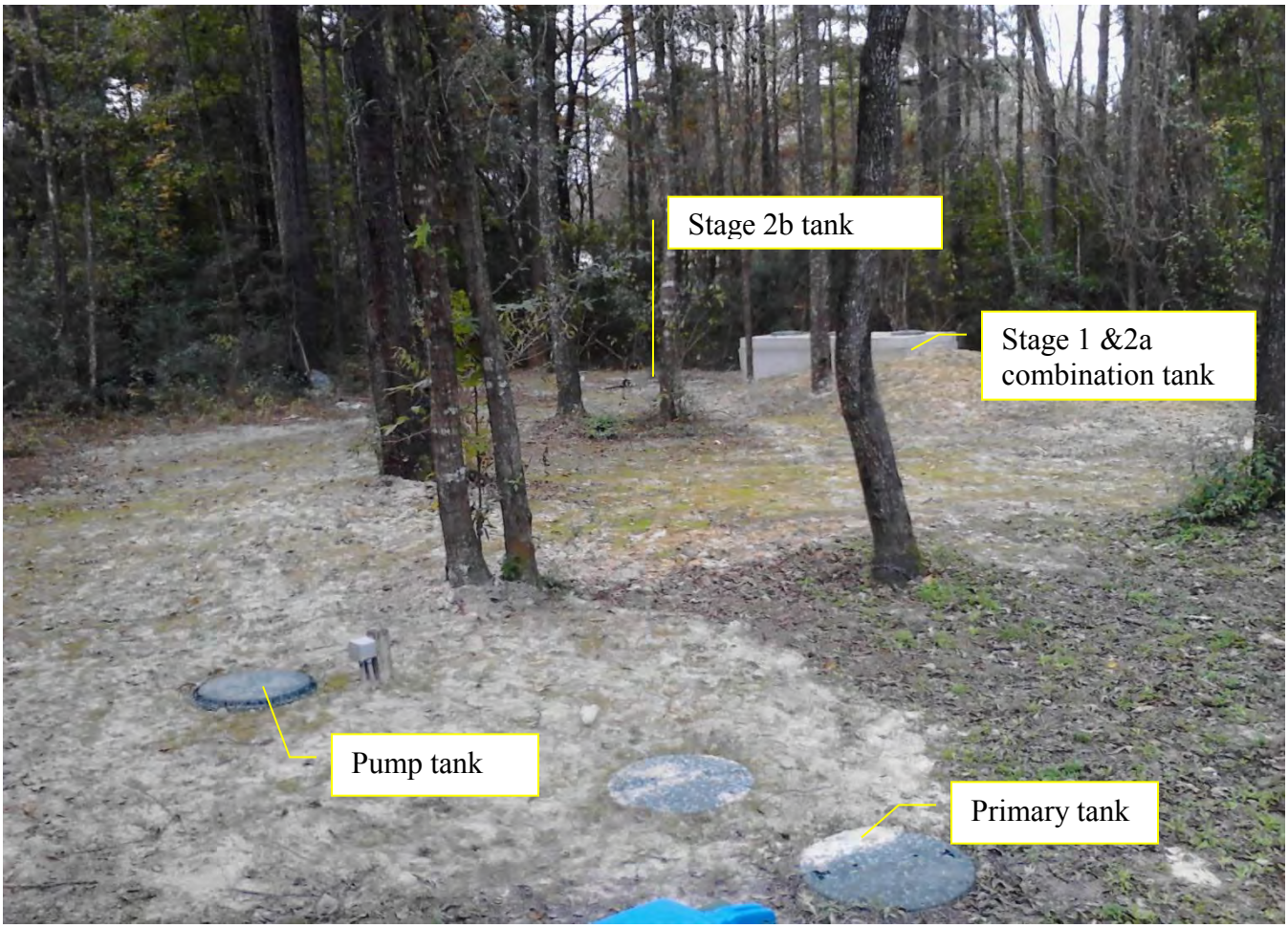

Figure 21
Overall PNRS system installed

Estimated Cost

The final construction cost for the installed system was $13,727.12 as detailed in Appendix B.

System Start-up

The system was started up November 6, 2013, when all flow was diverted to the new passive system. Routine checks of the system were made for the first two weeks to ensure the system was functioning as intended. Preliminary sampling will begin in November to monitor nitrification.

Florida Department of Health
Onsite Nitrogen Reduction Strategies Study

Contract CORCL

TASK B.6

Installation Report for Passive Nitrogen Reduction System B-HS7

November 2013

Task B of the Florida Onsite Nitrogen Reduction Strategies Study (FOSNRS) includes performing field experiments to critically evaluate the performance of nitrogen removal technologies that were identified and pilot tested in FOSNRS Task A. To meet this objective, full scale treatment systems will be installed at various residential sites in Florida, operated on septic tank effluent under actual onsite conditions, and monitored over an extended timeframe. 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 installation of a passive nitrogen reduction system at a home site in Marion County, Florida (B-HS7).

System Overview

The B-HS7 passive nitrogen reduction system (PNRS) was installed in Marion County, Florida in November 2013. It consists of adding a 300 gallon concrete pump tank, low-pressure distribution network, and a lined Stage 1 and 2 drainfield. The existing 900 gallon dual chamber septic tank will continue to provide primary treatment for the new PNRS system. Figure 1 is a plan view showing the system components and layout of the installation. The complete as-built system drawings are included in Appendix A.

Household wastewater enters the 1st chamber of the primary tank and exits the second chamber as septic tank effluent through an effluent screen. Screened effluent is directed to the pump tank which contains the pump and float switches. Pump tank contents are discharged through a low-pressure distribution network installed inside Infiltrator EQ36-LP^{TM} chambers. The low-pressure distribution network consists of a central manifold design with (4) 33-foot long, 1.25-inch diameter perforated laterals. The perforations are 0.25-inch in diameter and spaced 3-feet off-center. Below the infiltrators, 24-inches of native soil was installed. Below the native soil, 12-inches of lignocellulosic media was installed above a 30 mil PVC liner with a 6-inch lip around the outer perimeter. Therefore, approximately 6-inches of the lignocellulosic media is saturated promoting denitrification of the nitrified effluent. The treated effluent is discharged into the soil around the perimeter of the liner. A flow schematic of the system is shown in Figure 2.

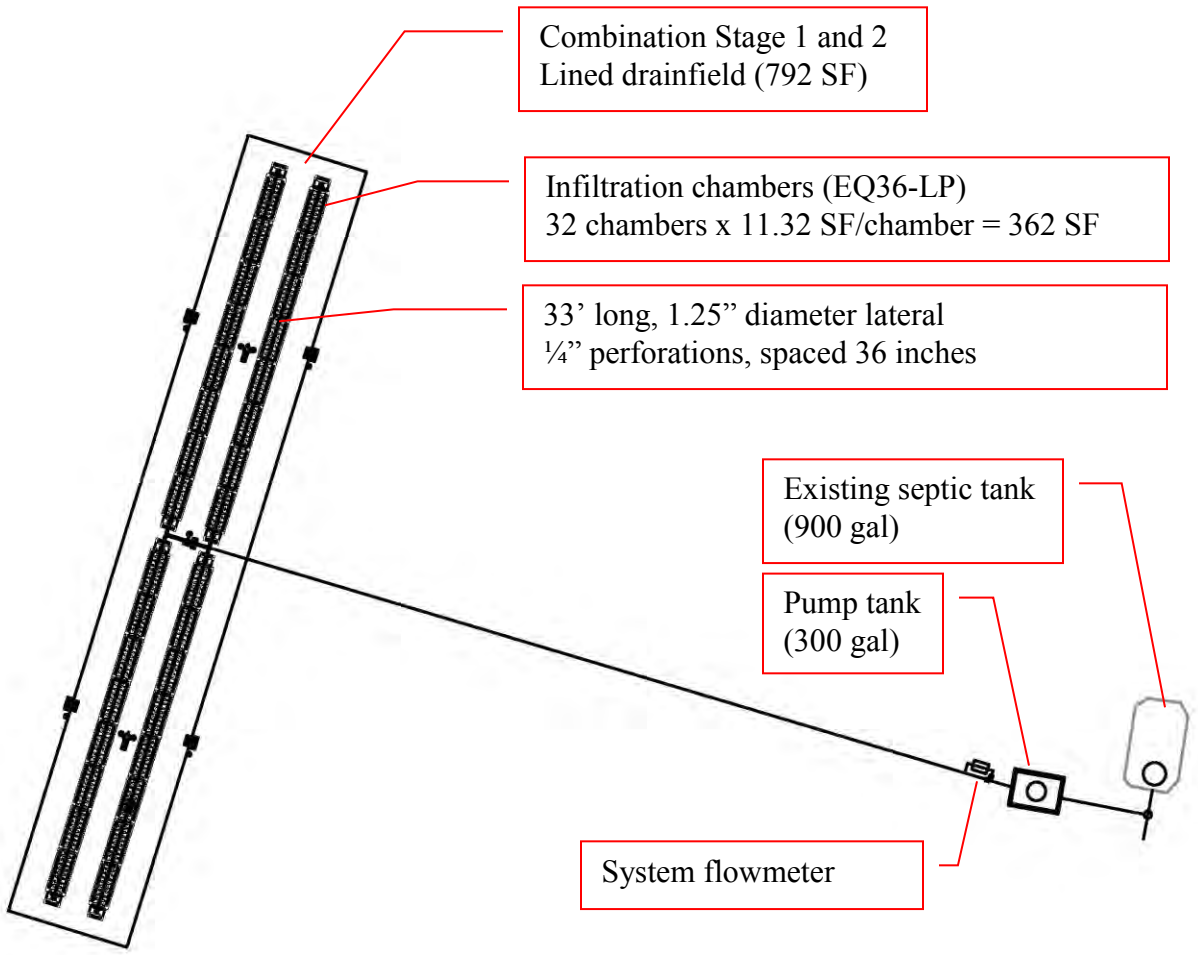

Figure 1
Plan view of B-HS7 PNRS layout installed in Marion county

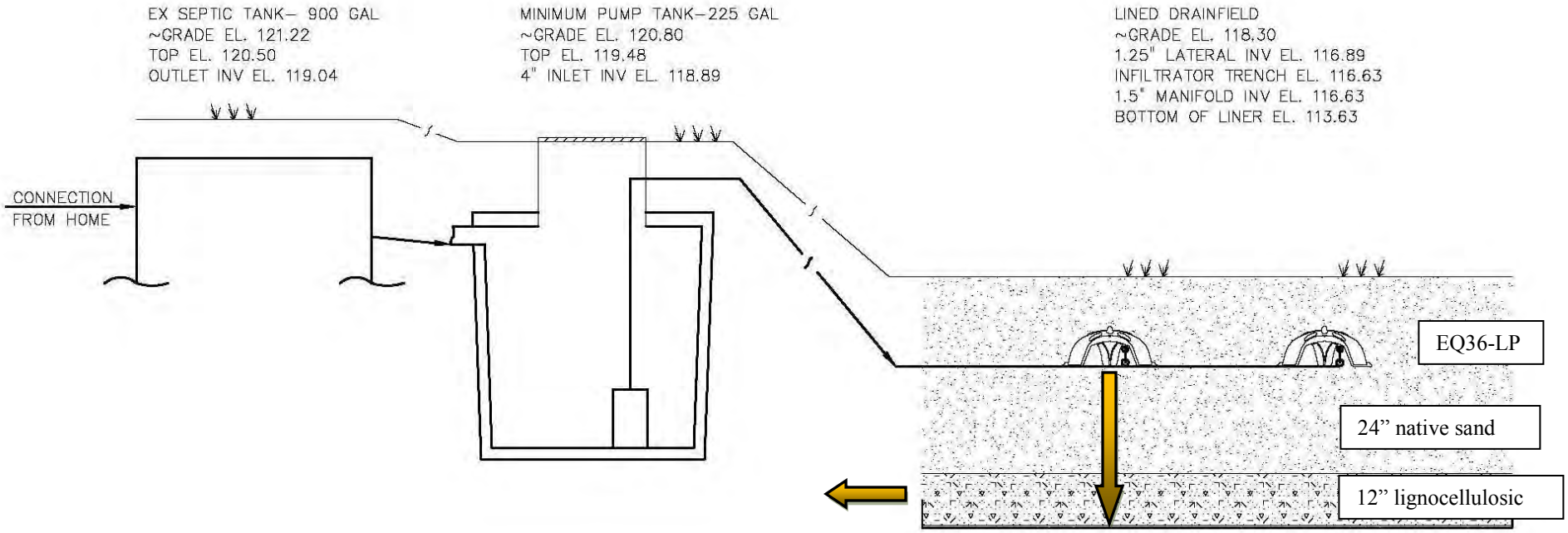

Figure 2
Flow Schematic of B-HS7 PNRS installed in Marion county

Installation

Installation of the system commenced November 13, 2013 and was completed on November 18, 2013. As previously discussed, the existing 900 gallon septic tank will continue to provide primary treatment. An access riser was installed above the second chamber of the primary tank (Figure 3) to allow for ease in maintenance of the existing outlet effluent screen. A two-way valve (Bull Run™) (Figure 4) was installed following the septic tank outlet to allow the flow to either be completely directed to the new passive system (to the pump tank) or to the existing drainfield. A riser pipe was installed to grade over the valve, so that the valve can be turned after installation is complete. The valve is turned with a wrench on a rod which is long enough to reach within the riser installed.

Figure 3
Primary tank access riser and cover

Figure 4
Bull Run™ valve

The remaining passive nitrogen reduction system components were installed (Table 1).

Table 1
Passive Nitrogen Reduction System Components

	Tank Volume (gal)	Surface Area (ft^2)	Media
Primary Tank	900		none
Pump Tank	300	12	none
Lined Drainfield Area		11' x 72' (792)	• 24" native sand • 12" lignocellulosic

The 300 gallon concrete pump tank was installed downgradient of the primary tank (Figure 5). The standard outlet pipe connection was plugged since the pump discharge pipe was installed through the riser. A Liberty LE51A-2 submersible pump was installed (Figure 6). One wide-angle piggyback float switch attached to the pump controls the effluent level in the pump tank. The height of the float is adjustable to calibrate a target dose volume. An additional float switch is connected to an audible/visual alarm (Figure 7) installed next to the power meter box to alarm for a high water level in the pump tank (pump failure). One inline flowmeter was installed following the pump discharge (Figure 8) with a bypass for maintenance/cleaning of the flowmeter.

Figure 5
Pump tank (300 gallon)

Figure 6
Submersible Liberty pump

Figure 7
High water level alarm

Figure 8
PNRS system flowmeter

The new treatment drainfield area was prepared for the 30 mil PVC liner installation (Figure 9). The liner was installed with a 6 inch lip around the outside perimeter. Above the liner, approximately a ½-inch sand layer (Figure 9) was installed to protect the liner during construction. Above the liner a 12-inch layer of lignocellulosic media, a blended urban waste wood from Wood Resource Recovery, Ocala, FL, was installed (Figure 9). Monitoring equipment surrounding the liner lip and inside the lignocellulosic media were installed (Figure 10). The various types of monitoring equipment installed

include: stainless steel drivepoints, stainless steel suction lysimeters and ceramic cup suction lysimeters (Figure 11). To separate the top of the lignocellulosic media and bottom of the native sand layer a plastic mesh screen (1/16-inch) was installed above the lignocellulosic media (Figure 10). Following placement of the plastic mesh screen, a 24-inch native sand layer was installed (Figure 12). Ceramic cup suction lysimeters were installed above the mesh screen to represent water quality just after downward passage through the sand layer.

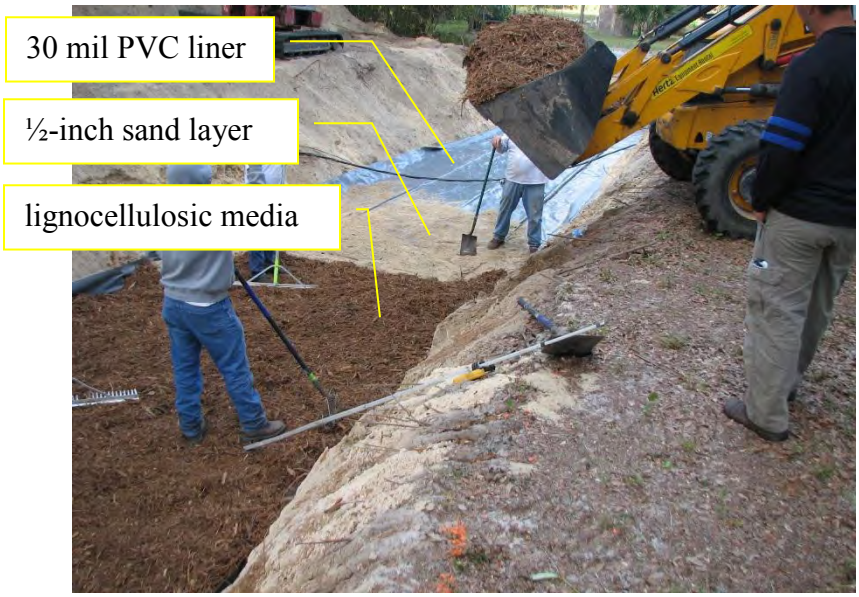

Figure 9
Lined area

Figure 10
Lignocellulosic media monitoring equipment

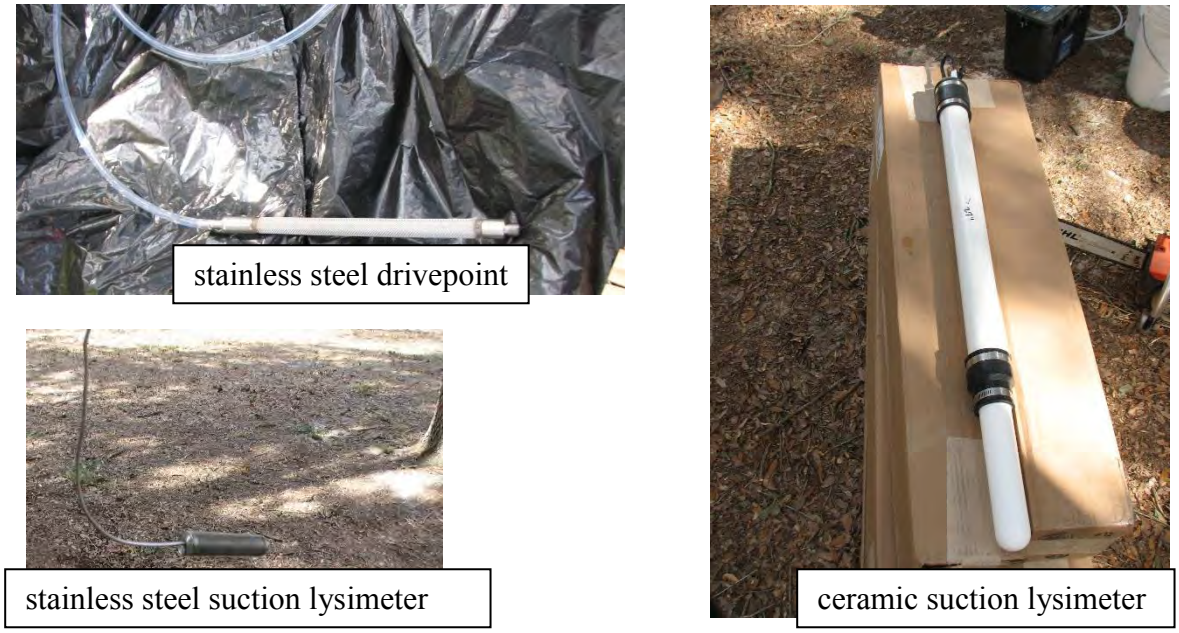

Figure 11
Lignocellulosic media monitoring equipment

Figure 12
Native sand media

The 2"D pipe downstream of the flowmeter is reduced to 1.5"D in the center manifold of the low pressure distribution network (Figure 13). The manifold is connected to 4 laterals of perforated pipe (Figure 13) which distribute septic tank effluent over native sand inside Infiltrator EQ36-LP™ low profile chambers. The laterals were installed using pressure dosing pipe supports, so that a wet pressure test could be conducted (Figure 14) prior to installing the chambers over the laterals. Following the wet pressure test, the Infiltrator EQ36-LP™ low profile chambers were installed (Figure 15). Above the chambers, 12-inches of native sand cover (Figure 16) was installed to support wheel loads of 16,000 lbs per axle per the manufacturer. This will allow the homeowner to continue to operate a small tractor in the area. Hay and grass seed mix was placed above the sand (Figure 17).

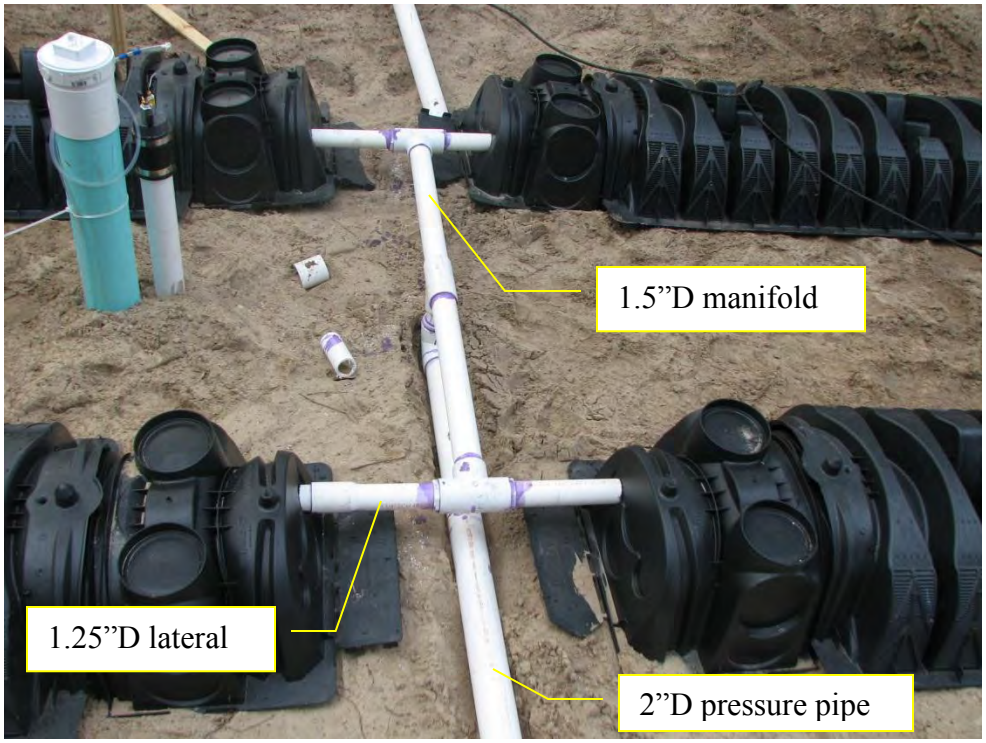

Figure 13
Center manifold of low pressure distribution network

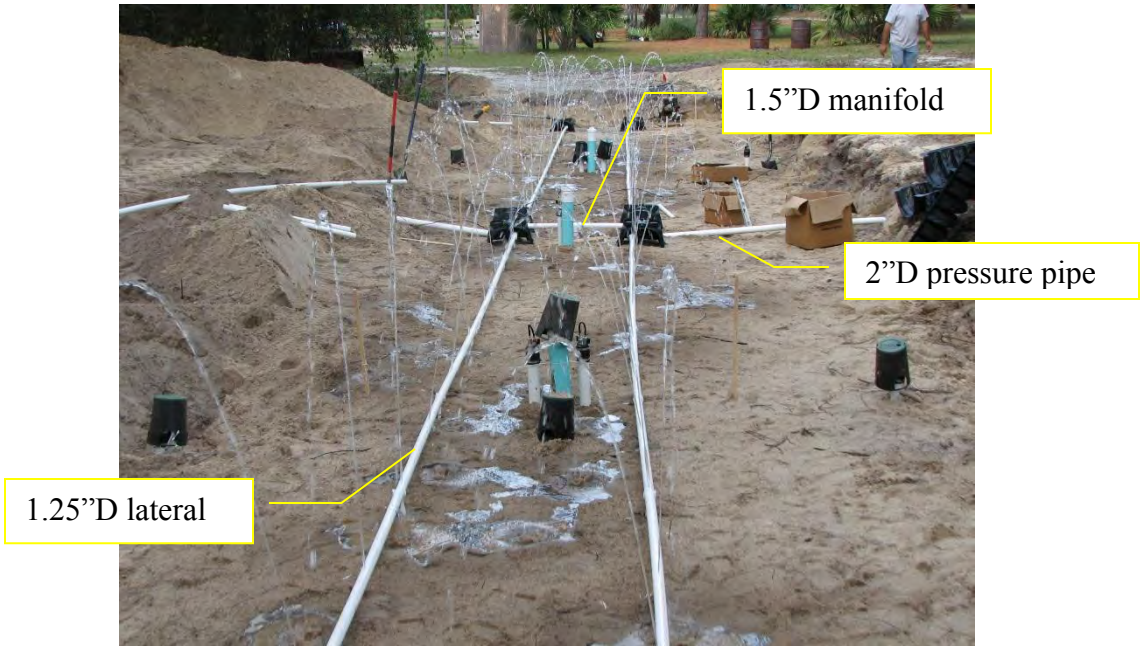

Figure 14
Wet pressure test

Figure 15
Infiltrator chambers

Figure 16
Sand cover

Figure 17
Hay and grass seed mix

Estimated Cost

The final construction cost for the installed system was $13,836.66 as detailed in Appendix B.

System Start-up

The system was started up November 19, 2013, when all flow was diverted to the new passive system. Preliminary sampling will begin in December to monitor nitrification.