

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Task A.25PNRS II Test Facility Sample Event Report No. 3

**Progress Report** 

November 2010



HAZEN AND SAWYER Environmental Engineers & Scientists In association with



OTIS ENVIRONMENTAL CONSULTANTS, LLC

# Florida Onsite Sewage Nitrogen Reduction Strategies Study

# TASK A.25 PROGRESS REPORT

# PNRS II Test Facility Sample Event Report No. 3

# **Prepared for:**

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**FDOH Contract CORCL** 

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Prepared by:



In Association With:





# PNRS II Test Facility Sample Event Report No. 3

# 1.0 Background

Task A of the Florida Onsite Sewage Nitrogen Reduction Strategies Study includes the evaluation of passive treatment systems to remove nitrogen from septic tank effluent. The Passive Nitrogen Removal Study II (PNRS II) is a follow-up to the previous experimental evaluations of passive nitrogen removal technologies conducted in Passive Nitrogen Removal Study I. The objective of the PNRS II study is to extend and expand into field pilot testing the two-stage biofiltration process that was initiated in PNRS I. A unique test facility was constructed for the purpose of this evaluation. The Task A.15 PNRS II Quality Assurance Project Plan (QAPP) documents the objectives, experimental biofiltration systems, monitoring framework, sample frequency and duration, and analytical methods to be used at the PNRS II Test Facility.

# 2.0 Purpose

This sample event report documents data collected from the third PNRS II monitoring and sampling event which was conducted November 10, 2010. This monitoring event consisted of an assessment and evaluation of PNRS II operation, measurement of flowrates for all systems, measurement of field parameters, and collection of biofilter influent and effluent samples and their analyses in a NELAC certified laboratory.

# 3.0 Materials and Methods

# 3.1 Project Site

The PNRS II Test Facility is located at the University of Florida Gulf Coast Research and Education Center (GCREC) in southeast Hillsborough County, Florida. The specially designed facility enables the simultaneous operation and performance testing of numerous biofilter treatment trains in parallel using the same wastewater source. The source of the influent wastewater is the septic tank effluent from the existing onsite wastewater system serving the GCREC. Details of the design and construction of the PNRS II test facility were presented previously in Task A.17, A.18, A.19, and A.24 documents.

# 3.2 Monitoring and Sampling Locations and Identification

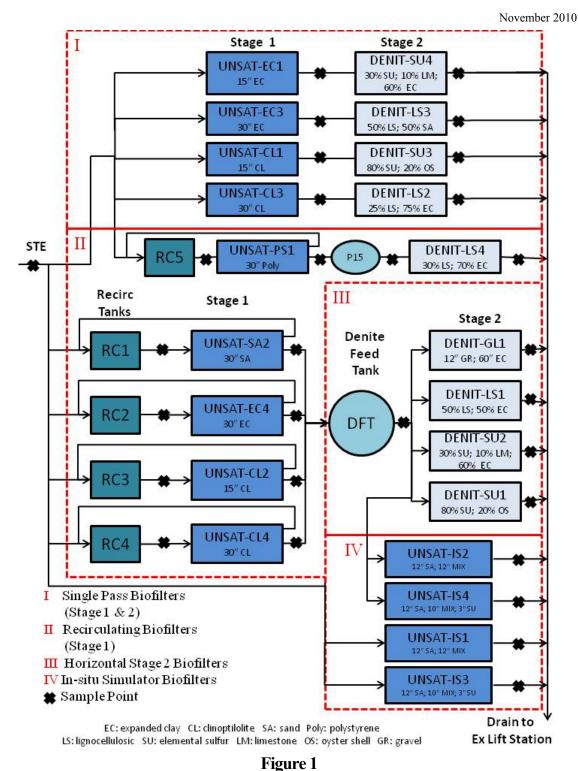
A schematic of the PNRS II test facility is shown in Figure 1. Septic tank effluent (STE) from GCREC is pumped from PNRS II-STE-T1 into the PNRS II systems through four points of entry: Hydro-1, Hydro-2, UNSAT-IS-1, and UNSAT-IS3. PNRS II biofilters are grouped into the four types of systems shown in Figure 1. The nomenclature and reactor/sample identification used for the PNRS II test facility sampling events are listed in Table 1. The sample designations listed in Table 1 also largely correspond to the locations at which flow volumes are measured in each sample event.

The previously submitted Data Summary Report No. 2 recommended several modifications to address performance issues with the test systems. Modifications that were implemented before this sample event include:

- The unsaturated single pass biofilter with polystyrene media (UNSAT-PS1) was re-configured to a recirculation biofilter.
- A fifth recirculation tank (RC5) was installed upstream of UNSAT-PS1.
- A pump tank (P15-T) was installed downstream of UNSAT-PS1 to feed UNSAT-LS4.
- The media within upflow denitrification biofilter (DENIT-LS2) was revised to be a mixture of 25% lignocellulosic and 75% expanded clay media.
- The sodium sesquicarbonate supplied as an alkalinity supplement in one upflow denitrification biofilter (DENIT-SU4) and one horizontal denitrification biofilter (DENIT-SU2) was replaced with limestone. The media composition in both biofilters was modified to 30% elemental sulfur, 10% limestone, and 60% expanded clay.
- Two additional in-situ simulators containing vertically stacked media layers were constructed to evaluate alternative media designs. UNSAT-IS3 will receive STE and UNSAT-IS4 will receive nitrified STE. The media configuration of UNSAT-IS3 from top to bottom is: 3 in. coarse sand, 9 in. filter sand, 10 in. mixed lignocellulosic media and expanded clay, 2 in. pea gravel, 3 in. elemental sulfur, and 2 in. gravel as underdrain. The media configuration of UNSAT-IS4 from top to bottom is: 12 in. filter sand, 10 in. mixed lignocellulosic media and expanded clay, 2 in. gravel as underdrain. The media configuration of UNSAT-IS4 from top to bottom is: 12 in. filter sand, 10 in. mixed lignocellulosic media and expanded clay, 2 in. pea gravel, 3 in. elemental sulfur, and 2 in. gravel as underdrain.
- Additional and revised sample locations are included in Table 1 and Figure 1.

	PNRS II Sample Identification	
Group (Figure 1)	Sample Location	Sample Identification
	STE PNRS II Storage Tank 1	PNRS II-STE-T1
		UNSAT-EC1
	Stage 1 Single Deep Diefilters	UNSAT-EC3
	Stage 1 Single Pass Biofilters	UNSAT-CL1
		UNSAT-CL3
1		DENIT-SU4
		DENIT-LS3
	Stage 2 Single Pass Upflow Biofilters	DENIT-SU3
		DENIT-LS2
		DENIT-LS4
		RC1
		RC2
	Recirculation Tanks	RC3
		RC4
		RC5
II		UNSAT-SA2
		UNSAT-EC4
	Stage 1 Recirculating Biofilters	UNSAT-CL2
		UNSAT-CL4
		UNSAT-PS1
	Pump 15 Tank	P15-T
	Denite Feed Collection Tank	DFT
		UNSAT-SU1
III	Stage 2 Herizentel Diefiltere	UNSAT-SU2
	Stage 2 Horizontal Biofilters	UNSAT-LS1
		UNSAT-GL1
		UNSAT-IS1
11/	In Situ In Tank Simulator Single Dage Disfilter	UNSAT-IS2
IV	In-Situ In-Tank Simulator Single Pass Biofilter	UNSAT-IS3
		UNSAT-IS4

Table 1
PNRS II Sample Identification



**PNRS II Test Facility System Schematic** 

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# **3.3** Operational Monitoring

Start-up of the PNRS II test facility occurred on May 17<sup>th</sup>, 2010 and all systems have operated continually since that time. The entire facility operation is checked at least once per week and a detailed log of operational observations and activities is maintained. In addition, the programmable logic controller (PLC) which controls many of the dosing and pump controls also records pump run times and flow data from flow meters at the facility, and these data can provide useful insight into facility operations. Appendix A provides summary tables of the PLC recorded data of daily runtimes and flows for the test facility between September 1<sup>st</sup> and November 9<sup>th</sup> (Day 107 through Day 176 since start-up) used to check general pump operation and performance.

# 3.4 Water Quality Sample Collection and Analyses

Influent and effluent water quality samples from the PNRS II test systems for Sample Event 3 were collected November 10, 2010. A sample of STE was collected from the feed line connecting STE Storage Tank 1 (PNRS II-STE-T1) to Hydrosplitter 1 which supplies STE to the single pass Stage 1 biofilters (Figure 1). A manual dose event was initiated on the control panel until sufficient STE sample volume was collected in a clean sample container. Stage 1, 2, and in-situ simulator biofilter and recirculation tank effluents were each sampled by directing the entire flow from the biofilter into a large, clean sample container over a period of time sufficient to obtain the desired sample volume (approximately 3.5 liters). Sample containers were immediately placed in coolers on ice prior to subdivision of the composited sample.

The composite samples in the 3.5 liter sample containers were then subdivided into analysis-specific sample containers. The analysis-specific containers were supplied by the analytical laboratory and contained appropriate preservatives. The analysis-specific containers were labeled, placed in coolers and transported on ice to the analytical laboratory. Each sample container was secured in packing material as appropriate to prevent damage and spills, and was recorded on chain-of-custody forms supplied by the laboratory. Chain of custody forms, provided in Appendix D, were used to document the transfer of samples from field personnel to the analytical laboratory. One chain of custody form was filled out for each set of samples and placed inside the cooler.

Equipment blank, field blank, and field sample duplicates were taken. The equipment blank was collected using a previously cleaned STE sample collection bottle. The bottle was filled with distilled water provided by the laboratory and allowed to sit for eight minutes. The sample containers were then analyzed for the same parameters as the samples. The field blank was collected by filling sample containers with distilled water that had been transported from the laboratory into the field along with other sample contain-

ers. The field sample duplicate was collected immediately subsequent to the regular STE sample. The duplicate sample containers were filled with PNRS II T1-STE effluent.

Field parameters were measured using portable electronic probes and included temperature (Temp), dissolved oxygen (DO), oxidation-reduction potential (ORP), pH, and specific conductance. Temperature (Temp), dissolved oxygen (DO), and oxidation-reduction potential (ORP) were measured with probe tips placed in flow through samplers located directly in the outlet pipe at each sample location. Specific conductance and pH were measured using external sample collection reservoirs. Field parameter results are listed in Appendix B. The influent and effluent samples were analyzed by the laboratory for: total alkalinity, total Kjeldahl nitrogen (TKN-N), ammonia nitrogen ( $NH_3$ -N), nitrate/nitrite nitrogen ( $NO_X$ -N), carbonaceous biochemical oxygen demand ( $CBOD_5$ ), total dissolved solids (TDS), total suspended solids (TSS), and chemical oxygen demand (COD). For the denitrification biofilters containing elemental sulfur media, influent and effluent sample analyses were also conducted for sulfate ( $SO_4$ ) and hydrogen sulfide ( $H_2S$ ). Table 2 lists the analytical parameters, analytical methods, and detection limits for these analyses.

Analytical Falameters;	Welliou of Allalysis, and	
Analytical Parameter	Method of Analysis	Laboratory Detection Limit (mg/L)
Total Alkalinity as CaCO <sub>3</sub>	SM 2320B	2 mg/L
Total Kjeldahl Nitrogen (TKN-N)	EPA351.2	0.05 mg/L
Ammonia Nitrogen (NH <sub>3</sub> -N)	EPA350.1	0.01 mg/L
Nitrate/Nitrite Nitrogen (NO <sub>X</sub> -N)	EPA353.2	0.01 mg/L
Carbonaceous BOD (CBOD <sub>5</sub> )	SM 5210B	2 mg/L
Total Dissolved Solids (TDS)	SM 2540C	10 mg/L
Total Suspended Solids (TSS)	SM 2540D	1 mg/L
Chemical Oxygen Demand (COD)	EPA 410.4	10 mg/L
Total Phosphorus (TP)	SM 4500PE	0.01 mg/L
Fecal Coliform (fecal)	SM9222D	1 ct/100mL
Sulfate (SO <sub>4</sub> )	EPA300.0	0.2 mg/L
Hydrogen Sulfide Unionized (H <sub>2</sub> S)	SM4500S F	0.01 mg/L
Sulfide	SM4500S F	0.1 mg/L

Table 2
Analytical Parameters, Method of Analysis, and Detection Limits

# 3.5 Flow Monitoring

Flow rates for all PNRS II systems were calibrated at initial start-up. The flow rates are measured at each sampling event and adjusted as necessary to maintain flow rates consistent with the experimental design. Flow measurements and adjustments are made after collection of liquid samples and field parameter analyses.

A flow test was conducted November 19, 2010. These flow measurements are considered to represent those in effect leading up to and during the Sample Event 3. The measured volumes and relative errors between measured and target flow rates are presented in Appendix C, Table 1. For the Group 1 systems, measured STE inputs to four of the five Stage 1 biofilters were within the 15% operational target that is considered acceptable for PNRS II flow rates. The measured influent volume of UNSAT-PS1 was -36.2% of the target volume. Measured effluent volumes for Stage 1 single pass biofilters (Stage 2 influent) were within 13% of the target volume for four of the five systems (Appendix C, Table 1). The DENIT-LS4 measured influent volume was substantially less than the target volume. The low measured flow to the DENIT-LS4 (RE = -27.1%) is associated with the low influent volume of the directly connected UNSAT-PS1 biofilter.

For the Group 2 systems, all measured STE volumes to the Stage 1 recirculation tanks were within 9% of target volumes. All recycle flow volumes as recorded by the PLC were within 6% of target volumes based on the experimental design recycle ratio of 3.0. The calculated recycle ratios (i.e. recycle flow volume divided by the STE flow volume) for four of the five recirculation systems were within 5% of the target recycle ratio of 3.0. Although the recycle rate to the UNSAT-PS1 was close to target, the recycle ratio was high due to the low influent STE flow that was previously discussed.

For Group 3 systems, the measured influent volumes to the Stage 2 horizontal denitrification biofilters were all within 5% of target.

For Group 4 biofilters, the measured influent volumes were within 10% of target volumes for three of the four in-situ simulators. The measured influent volume of UNSAT-IS 1 was -26.9% of the target volume. The system tubing was replaced and recalibrated December 3<sup>rd</sup>; the influent volume to UNSAT-IS1 and UNSAT-IS2 was then measured to be within 8% of target.

After evaluating the influent flow test results, a few maintenance items were conducted:

- Peristaltic Pump 10 pump tubing was calibrated November 19<sup>th</sup>
- Peristaltic Pump 5 pump and system tubing was replaced and calibrated December 3<sup>rd</sup>
- Pump 4 (which feeds Hydrosplitter 1) runtime was modified December 8<sup>th</sup> from 31 seconds to 44 seconds
- Hydrosplitter 1 petcock valves were adjusted December 8<sup>th</sup> to provide equal distribution of flow to each of the five Stage 1 biofilters with input volumes as close to the target volume as possible

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The flows were rechecked after modifications to the systems were made and are provided in Appendix C, Table 2. The UNSAT-PS1 measured influent volume is closer to the target as measured on December 8<sup>th</sup> which will continue to be monitored. After replacing and calibrating the Pump 5 pump and system tubing on December 3<sup>rd</sup>, the influent doses to UNSAT-IS1 and UNSAT-IS2 were closer to the target volume. After calibrating the Pump 10 pump tubing on November 19<sup>th</sup>, the influent doses to UNSAT-IS3 and UNSAT-IS4 were equal to the target volume.



# **Appendix A: PLC Data**

### Table A.1 Summary of PLC Recorded Daily Flows (9/1/10 – 11/9/10)

	(9/	1/10 - 11	1/9/10)			
	Average Recorded Flow (gpd)	Std. Dev.	MIN (gpd)	MAX (gpd)	Target Flow (gpd)	Relative Error <sup>1</sup> (%)
Pump 4 to Hydro 1	70	2.52	65	76	73.7	-4.8%
Pump 14 to Hydro 2	62	1.38	59	68	58.9	4.6%
Pump 6 to Recirc. System 1	44	0.97	43	51	44.2	0.2%
Pump 7 to Recirc. System 2	45	1.65	43	52	44.2	2.5%
Pump 8 to Recirc. System 3	44	0.46	43	45	44.2	-0.4%
Pump 9 to Recirc. System 4	44	0.64	42	45	44.2	-0.5%
Pump 15 to Recirc. System 5	42	0.60	41	43	44.2	-5.4%

<sup>1</sup>Relative Error = (Recorded Flow – Target Flow)/ Target Flow \*100

### Table A.2 Summary of PLC Recorded Daily Runtimes (9/1/10 – 11/9/10)

			10 - 11/3			
	Average Recorded Daily Runtime (minutes/day)	Std. Dev.	MIN (minutes)	MAX (minutes)	Target Daily Runtime (minutes)	Relative Error <sup>1</sup> (%)
Pump 4 to Hydro 1	12.8	0.4	12.0	13.0	12.4	3.0%
Pump 14 to Hydro 2	10.8	0.4	10.0	11.0	10.4	3.7%
Pump 6 to Recirc. System 1	6.4	0.5	6.0	7.0	6.0	6.4%
Pump 7 to Recirc. System 2	6.5	0.5	6.0	7.0	6.0	8.1%
Pump 8 to Recirc. System 3	6.4	0.5	6.0	7.0	6.0	6.4%
Pump 9 to Recirc. System 4	6.4	0.5	6.0	7.0	6.0	6.4%
Pump 15 to Recirc. System 5	6.4	0.5	6.0	7.0	6.0	6.5%

<sup>1</sup>Relative Error = (Recorded Runtime – Target Runtime)/ Target Runtime \*100



# **Appendix B: Field Parameter Analyses**

		Field Paramete			
Sample Identification	рН	(November 1 Temperature (°C)	0, 2010) Specific Conductance (μS)	Dissolved Oxygen (mg/L)	ORP (mV)
STE					
STE-Tank 1	7.2	25.1	1,250	2.40	-235.0
STE-Tank 1-D	7.3	25.3	1,250	2.20	-230.0
Stage 1 Single Pass Bio	filter Efflue	nt			
UNSAT-EC1	6.9	20.6	1,150	7.1	108.0
UNSAT-EC3	6.8	21.5	1,250	6.8	105.0
UNSAT-CL1	7.1	22.0	1,130	7.3	105.5
UNSAT-CL3	7.4	22.0	1,280	7.6	100.5
Stage 2 Single Pass Up	low Biofilte	r Effluent			
DENIT-SU4	7.3	21.0	1,510	7.8	-118.0
DENIT-LS3	6.9	20.0	1,200	4.7	67.5
DENIT-SU3	7.2	21.4	1,480	7.7	-180.0
DENIT-LS2	7.4	21.5	1,200	4.1	71.0
DENIT-LS4	7.3	20.0	900	3.8	81.0
<b>Recirculation Tank Effl</b>	uent				
RC1	7.3	20.6	1,000	2.1	57.0
RC2	7.2	19.5	1,020	1.6	58.5
RC3	7.2	19.2	1,040	2.3	57.5
RC4	7.4	19.7	1,090	1.9	49.3
RC5	7.3	22.0	1,050	3.3	96.0
Stage 1 Recirculating B	iofilter Efflu	ent			
UNSAT-CL4	7.2	23.5	1,040	8.0	52.8
UNSAT-CL2	7.0	23.1	1,000	5.4	50.2
UNSAT-EC4	6.9	22.2	980	7.3	46.5
UNSAT-SA2	6.9	22.5	930	7.7	47.5
UNSAT-PS1	7.2	23.8	950	7.8	90.0
P15-Tank	7.4	20.7	970	7.1	18.8

### Table B.1 Field Parameter Results (November 10, 2010)

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## Appendix B

Sample Identification	рН	Temperature (°C)	Specific Conductance (µS)	Dissolved Oxygen (mg/L)	ORP (mV)
Denite Feed Tank (Tan	k 3)		•		
DFT	7.2	18.5	980	8.3	62.2
Stage 2 Horizontal Biof	ilters Efflue	nt			
DENIT-SU1	6.9	28.0	1,250	1.6	-270.0
DENIT-SU2	7.0	25.5	1,350	0.2	-90.0
DENIT-LS1	7.4	21.4	970	1.1	-120.0
DENIT-GL1	6.9	21.0	900	0.8	-180.0
In-situ Simulator Biofil	ter Effluent				
UNSAT-IS1 (STE)	6.8	20.5	1,120	1.9	-161.0
UNSAT-IS2 (Nitrified STE)	6.8	19.2	1,300	0.8	-130.0
UNSAT-IS3 (STE)	6.67	18.7	1,505	0.4	158.3
UNSAT-IS4 (Nitrified STE)	7.48	18.3	0.01	9.0	152.8
Blanks					
Field Blank	6.5	24.5	25	8.0	12.5
Equipment Blank	6.7	23.0	28	8.5	-80.0



# **Appendix C: Flow Test Results**

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## Table C.1 Flow Test Results

			Target Input	:	Measure	ed Input	Recycl	e Ratio
Group (Figure 1)	Biofilter/Flow	Target Input Volume	Dose/day	Target Input Volume	Measured Input Volume	Relative Error (%)	Calculated Recycle Ratio (RR)	Relative Error (%)
(1.1501.0.2)		(mL/day)	(Dose/day)	(mL/dose)	(mL/dose)	(Measured Input -Target Input) / Target Input * 100	Volume Recycle / Volume STE	Measured RR - Target RR / Measured RR * 100
	Stage 1 Single Pass Biofilters (Hydrosplitter 1)							
	Date				11/19/2010 Dose			
	UNSAT-PS1				@ 9:00 am 1,480	-36.2%		
	UNSAT-CL3				2,000	-13.8%		
	UNSAT-CL1	55,656	24	2,319	2,320	0.0%		
	UNSAT-EC3				1,970	-15.0%		
	UNSAT-EC1				2,115	-8.8%		
1	Mean				1,977	-14.7%		
1	Stage 2 Single Pass Upflow Biofilters							
	Date				11/19/2010 8:00- 9:00 am			
	DENIT-LS4				1,690	-27.1%		
	DENIT-LS2				2,090	-9.9%		
	DENIT-SU3	55,656	24	2,319	2,425	4.6%		
	DENIT-LS3				2,025	-12.7%		
	DENIT-SU4				2,120	-8.6%		
	Mean Stage 1 Recirculating Biofilters				2,070	-10.7%		-
	(Hydrosplitter 2)							
	Date				(11/19/10) dose @ 9:30 am			
	RC1 : UNSAT-SA2				2,105	-9.2%		
	RC2 : UNSAT-EC4	55,656	24	2,319	2,270	-2.1%		
	RC3 : UNSAT-CL2	55,650	2.1	2,515	2,345	1.1%		
	RC4 : UNSAT-CL4				2,220	-4.3%		
	Mean Stage 1 Recirculating Biofilters				2,235 Flowmeter	-3.6%		
	(Recycle)				11/19/10 8:30 am			
	RC1 : UNSAT-SA2				6,586	-5.3%	3.13	4.1%
2	RC2 : UNSAT-EC4				7,116	2.3%	3.13	4.3%
	RC3 : UNSAT-CL2	166,968	24	6,957	7,002	0.7%	2.99	-0.5%
	RC4 : UNSAT-CL4				6,586	-5.3%	2.97	-1.1%
	RC5 : UNSAT-PS1				6,662	-4.2%	4.50	33.3%
	Mean Stage 1 Recirculating Biofilters (Hydrosplitter + Recycle)				6,790	-2.4%	3.34	10.3%
	RC1 : UNSAT-SA2				8,691			
	RC2 : UNSAT-EC4				9,386			
	RC3 : UNSAT-CL2	222,624	24	9,276	9,347			
	RC4 : UNSAT-CL4				8,806			
	RC5 : UNSAT-PS1 Mean			<u> </u>	8,142 8,874			
	Horizontal Denitrification Biofilters							
	Date				11/19/10 dose @			
					8:25 am	2.20/		
3	DENIT-SU1 DENIT-SU2				302 295	-2.2%		
	DENIT-SU2 DENIT-GL1	7,409	24	308.7	295	-4.4%		
	DENIT-US1				300	-2.8%		
<u> </u>	Mean				298	-3.5%		
	In-Situ Simulators				44 (40 (20) 2			
	Date				11/19/2010 manual dose			
4	UNSAT-IS1 (STE)		<i>.</i>		1,805	-26.9%		
	UNSAT-IS2 (Nitrified STE)	14,814	6	2,469	2,715	10.0%		
	UNSAT-IS3 (STE)	594	6	99	93	-6.1%		
	UNSAT-IS4 (Nitrified STE)		culated values		93	-6.1%		

Notes: Yellow-shaded cells are measured values; grey-shaded cells are calculated values

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			Target Input		Measur	ed Input	Recycl	e Ratio
Group (Figure 1)	Biofilter/Flow	Target Input Volume	Dose/day	Target Input Volume	Measured Input Volume	Relative Error (%)	Calculated Recycle Ratio (RR)	Relative Error (%)
,		(mL/day)	(Dose/day)	(mL/dose)	(mL/dose)	(Measured Input -Target Input) / Target Input * 100	Volume Recycle / Volume STE	Measured RR - Target RR / Measured RR * 100
	Stage 1 Single Pass Biofilters (Hydrosplitter 1)							
	Date				(12/8/10) manual dose @ 8:45 am			
	UNSAT-PS1				2,320	0.0%		
	UNSAT-CL3				2,395	3.3%		
	UNSAT-CL1	55,656	24	2,319	2,340	0.9%		
	UNSAT-EC3				2,300	-0.8%		
	UNSAT-EC1				2,340	0.9%		
1	Mean				2,339	0.9%		
	Stage 2 Single Pass Upflow Biofilters							
	Date				11/19/2010 8:00- 9:00 am			
	DENIT-LS4				1,690			
	DENIT-LS2				2,090			
	DENIT-SU3	55,656	24	2,319	2,425			
	DENIT-LS3				2,025			
	DENIT-SU4				2,120			
	Mean							
	Stage 1 Recirculating Biofilters (Hydrosplitter 2)							
	Date				(11/19/10) dose @ 9:30 am			
	RC1 : UNSAT-SA2				2,105	-9.2%		
	RC2 : UNSAT-EC4				2,270	-2.1%		
	RC3 : UNSAT-CL2	55,656	24	2,319	2,345	1.1%		
	RC4 : UNSAT-CL4				2,220	-4.3%		
	Mean				2,235	-3.6%		
	Stage 1 Recirculating Biofilters (Recycle)				Flowmeter 11/19/10 8:30			
	RC1 : UNSAT-SA2				6,586	-5.3%	3.13	4.1%
2	RC2 : UNSAT-SA2				7,116	2.3%	3.13	4.1%
_	RC3 : UNSAT-CL2	166,968	24	6,957	7,002	0.7%	2.99	-0.5%
	RC4 : UNSAT-CL4			.,	6,586	-5.3%	2.97	-1.1%
	RC5 : UNSAT-PS1				6,662	-4.2%	2.98	-0.7%
	Mean				6,822	-1.9%	3.05	1.8%
	Stage 1 Recirculating Biofilters (Hydrosplitter + Recycle)							
	RC1 : UNSAT-SA2				8,691		ļ	
	RC2 : UNSAT-EC4			0.000	9,386			
	RC3 : UNSAT-CL2	222,624	24	9,276	9,347			
	RC4 : UNSAT-CL4 RC5 : UNSAT-PS1				8,806 8,982			
	Mean				9,042			
	Horizontal Denitrification Biofilters							
	Date				11/19/10 dose @			
	DENIT-SU1				8:25 am 302	-2.2%		
3	DENIT-SU2				295	-2.2%		
	DENIT-GL1	7,409	24	308.7	295	-4.4%		
	DENIT-LS1				300	-2.8%		
	Mean				298	-3.5%		
	In-Situ Simulators							
	Date				12/3/2010 manual dose			
4	UNSAT-IS1 (STE) UNSAT-IS2 (Nitrified STE)	14,814	6	2,469	2,600	5.3% 7.7%		
	Date				11/19/2010 manual dose			
					00	0.0%		
	UNSAT-IS3 (STE)	594	6	99	99	0.076		

### Table C.2 Flow Test Results following Modifications



# **Appendix D: Chain of Custody Forms**

FLORIDA ONSITE SEWAGE NITROGEN REDUCTION STRATEGIES STUDY PNRS II TEST FACILITY SAMPLE EVENT REPORT NO. 3

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Client Name	a								Cont	Contact / Phone:				
	2	Hazan and Sawyer	Sawyer						Jose	phin Edebac	Josephin Edeback-Hirst 813-630-4498	630-4498		
roject Na	Project Name / Location	DNDS II Mostewater System Ar	ictowator	Svetam An	Jahrees				jedet	<u>oack@hazar</u>	jedeback@hazanandsawyer.com	<u>Hoo</u>		
amplers:	Samplers: (Signature)				202			PARA	PARAMETER / CONTAINER DESCRIPTION	TAINER DES	CRIPTION			
°. GW-	Matrix Codes: DW-Drinking Water WW-Wastewater SW-SurfaceWater SL-Sludge SO-Soil GW-Groundwater SA-Saline Water O-Other R-Reagent Water	ster Soil -Other					,88T ,00E		ace POSi apyli apylide	Los Co H		(	I	
SAL Use Only <sup>Sample</sup> No.	Sample Description		Date	əmiT	xirtsM	Composite Grab	1LP, Cool Alkalinity, Cl TDS	201 ) 116 C001	ALP, Zn Ace B negen S No Headsp S50ml P, H2		Field pH	imeT blei <del>1</del>	Field Conc	Field DO
_	PNRS II STE-T1	16 100	110	1350	MM	×		) -	-	<u>}</u>				
02 RC31	31		_	1250	MM	×	+		-					
03 RC2	2			1300	MM	×	-							
04 RC3	33		_	1310	MM	×	+				_			
05 RC4	¥			1320	MM	×	-							
06 RC5	25			1610	ŴŴ	×	-							
07 P15-T	5-T			5451	MM	×	-							
08 UN:	UNSAT-IS1			100)	MM	×	-	-	-					
09 UN	UNSAT-IS2			5760	MM	×	-	-	-					
10 UN:	UNSAT-IS3			1	MM	×	ł	ł	4	+				
11 UN	UNSAT-IS4			1515	MM	×	+	Θ	<i>t</i>	(F				
12 UN:	UNSAT-EC1		$\rightarrow$	1600	ΜM	×		٢	)	\ <u>-</u>				
inquished:	Containers Prepared/ Date/Tin Relinquished:	Date/Time: 1130 Rece	Received	- Co	$\left( \right)$	Date/Time:	* 5 1 1/2	Seal intact? Samples int	Seal intact? Samples intact upon arrival?	z z ≻≻	N/A Instruct	Instructions / Remarks	arks k/ $\swarrow$ .	
Relinguieherd:		1750	Received:			Date/Time		Received	Received on ice? Temp	z z >	NA (1.116)	(Limited Lucrue) (Limited Lucrue)	80,00 80,00	
Relinquished:			Received:			Date/Time:	à	Proper pr Rec'd w itl	Proper preservatives indicated? Rec'd w ithin holding time?	z z ≻ ≻	NA NA	(2.3.2)	TKN (	
Relinquished:	d: Date/Time:		Received:			Date/Time:	ä	Volatiles I	Volatiles rec'd w/out headspace Proper containers used?	z ≻	₩ ₩ 2			
Relinquished:	1: Date/Time:		Received:			Date/Time:				z z >	N/A			

Chain of Custody.xls Rev.Date 11/19/01

Chain of Custody

# SOUTHERN ANALYTICAL LABORATORIES, INC.

SAL Project No. [00] (427

Client Name	lame									Contact / Phone. Josephin Edeba	hone: deback-Hir	Contact / Phone; Josephin Edeback-Hirst 813-630-4498	-4498		
		Hazan	Hazan and Sawyer												
Project	Project Name / Location	PNRS	∏ Wastewate	PNRST Wastewater System Analyses	vses				•	<u>edeback@</u>	<u>hazanands</u>	jedeback@hazanandsawyer.com			
Sample	Samplers: (Signature)	M	$\int$					PARA	PARAMETER / C	CONTAINE	CONTAINER DESCRIPTION	NOITo			
	Matrix Codes: DW-Drinking Water WW-Wastewater SW-SurfaceWater SL-Sludge SO-Soil GW-Groundwater SA-Saline Water O-Other R-Reagent Water	astewater le SO-Soil ater O-Other					,22T ,008		əpyı		meter)				
SAL Use Only Sample No.	Sample Description	otion	Date	əmiT	xinteM	Composite Grab	1LP, Cool Alkalinity, CE TDS	80 <del>1</del> ІГЬ' С <sup>00</sup>	ובף, Zn Ace Hydrogen Su No Headspa	250ml P, H2, 250ml P, H2	JneilO) 990	Hq bleif	qməT bləiT	bno <b>D bl</b> əiŦ	Field DO
1	UNSAT-SA2	<i>N</i>	1.010.	0111	MM	×	-			-					
	UNSAT-EC3			1530	MM	×				-					
15 (	UNSAT-EC4			1120	WM	×				~	-				
16 (	UNSAT-CL1			1540	Ŵ	×	-	-	-	-			-		
17	UNSAT-CL2			0511	ŴŴ	×				÷					
18	UNSAT-CL3			1550	MM	×				-	-				
19	UNSAT-CL4			1140	MM	×	-			-					
50 50	UNSAT-PS1			1350	MM	×				-					
21	DENIT-SU1			1015	MM	×	-	-	-	+					
22	DENIT-SU2			1025	MM	×		-		-			-		
23	DENIT-SU3			1330	MM	×	-		-	-					
24	DENIT-SU4		$\overline{}$	0761	WM	×	-	-	-	-					
Container Relinquist	Containers Prepared/ Relinquished:	Date/Time: //\$	Received			Date/Time	1/ 1/30	Seal intact? Samples int	Seal intact? Samples intact upon arrival?		× N NA × N NA × N NA	nstruction	Instructions / Remarks	S	
Relinquished			Received:			Date/Time	2	Received .	Received on ice? Temp	×	VN N				
Relinduished:	c/w //	Date/Time:	Received:			Date/Time:		Proper pre Rec'd w ith	Proper preservatives indicated? Rec'd w ithin holding time?	ndicated? Y te? Y	A N Z Z Z				
Relinquished:	led:	Date/Time:	Received:			Date/Time:		Volatiles r	Volatiles rec'd w /out headspace	adspace Y	z				
Relinquished:	hed:	Date/Time:	Received:			Date/Time:		Hoper cor	Proper containers used (	> ``	VN N		1 001627	27	
Chain of Custody xls Rev.Date 11/19/01	tody.xls 19/01										Chai	Chain of Custody	dy		

# SOUTHERN ANALYTICAL LABORATORIES, INC. 110 BAYVIEW BOULEVARD, OLDSMAR, FI 34677 R13466, 1812 055 7710

Client Name									contact / P	Contact / Phone:				
Project Name /1 acction	Haza	Hazan and Sawyer						<u>,</u>	osephin E	deback-Hir:	st 813-630	-4498		
	ARA	PMRS 11 Wastewater System Analyses	er Svstem And	alvses				.91	<u>edeback@</u>	edeback@hazanandsawyer.com	awyer.com			
Samplers: (Signature) <	len	N,	$\left  \right $				PARA	PARAMETER / CONTAINER DESCRIPTION	ONTAINFI	R DESCRIE	NOITO			
Matrix Codes: DW-Drinking Water WW-Wastewater SW-SurfaceWater SL-Sludge SO-Soil GW-Groundwater SA-Saline Water O-Other R-Reagent Water SAL Use Only Sampe Description	: -Wastewater Jdge SO-Soil Water O-Other ter ter	Date	∋miT	Matrix	Composite Grab	1LP, Cool Alkalinity, CBOD, TSS, TDS	504 ורבי כיסו	1LP, Zn Acetate/NaOH Hydrogen Sulfide Vo Headspace	נגמי מאס, נכסם נפטייו ג' אלצסק	סאף (Client meter)	Hq bləi <sup>=</sup>	qm∋T bl∍i∓	bno⊃ blei∓	Field DO
25 DENIT-LS1		11/1 L	1040	MM	+	-	;	-}   	-	>				
26 DENIT-LS2			1245	MM	×	-		   	-					
27 DENIT-LS3			1230	ww	×	-			-					
28 DENIT-LS4			5021	MM	×	+			-					
29 DENIT-GL1			1055	ŴŴ	×				-					
30 DFT			1150	νw	×	+	-							
31 T1-D			1400	ŴŴ	×	-			-					
32 FB			1500	ŴŴ	×	-		   	-					
33 EB		$\mathbf{\hat{>}}$	いとい	MM	×	-			-					
Containers Prepared/ Relinquished:	Date/Time: 1130	Beeetved:			Date/Time:	1470	Seal intact?		>	N N/A	nstructions	Instructions / Remarks	S	
Relinquished	11-08-10	(cm)	$\mathcal{I}$		160/M	)	Samples int	Samples intact upon arrival?	val? Y	N N/A				
(am )	([[], ], ]) 53	Keceived.		<u> </u>	Date/Time:		Received or	Received on ice? Temp_	>	N NA				
Relinquished:	Date/Time:	Received:			Date/Time:		Proper pres	Proper preservatives indicated?	ated?					
Relinquished:	Dete Cline						Rec'd w ithir	Rec'd w ithin holding time?	× د	AVN N				
		Keceived:			Date/Time:		Volatiles red	Volatiles rec'd w/out headspace	dspace Y	N NA				
Relinquished:	Date/Time:	Received:			Date/Time:				*	N NA		100	001627	
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Poptial Name Location     Instance       Poptial Name Location     Instance       Stration Constrained     Instance       Stration Constrate     Instanc		Client Name	and Causier							Contact / Phone: Josephin Edebac	Phone: Edeback-H	Contact / Phone: Josephin Edeback-Hirst 813-630-4498	0-4498		
BARDANE (Signature)       BARDANE (Signature)       BARDANE (Signature)       BARDANE (Signature)       BARDANE (Signature)       BARDANE (Signature)       PARADENT (	Project			ĩ						jedeback(	Dhazanand	sawyer.cor			
Sampler: Gippatural     PRAMETERI CONTANER Contraction       Marcher: Gippatural     DULDInny Water Witchersteinen       DULDInny Water Witchersteinen     DULDInny Water Witchersteinen       DULDInny Water Witchersteinen     DULDInny Water Witchersteinen       DULDInny Water Witchersteinen     DULDInny Water Witchersteinen       DULDINATION Water Witchersteinen     DULDINATION CONTANER       DULDINATION Water Witchersteinen     DULDINATION CONTANER       DULDINATION Water Witchersteinen     DILDINATION       DULDINATION Water Witchersteinen     DILDINATION       Michaelen Kassinger Coller     DILDINATION       Witchersteinen     DILDINATION       Michaelen Kassinger Coller     DILDINATION			II Wastewater		alyses	+									
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	Relinqui		Received:			Date/f ime:				-	N N N				

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Project Name / Location Samplers: (Signature) Matrix Codes: DW-Drinking Water WW-Wastewater SW-SurfaceWater SL-Sludge SO-Soil					-		Cont	Contact / Phone:	4			
Project Name / Location Samplers: (Signature) Matrix Codes: DW-Drinking Water WW-Wastewater SW-SurfaceWater SL-Sludge SO-So	Hazan and Sawyer	/er					lasor	Josephin Edeoack-Hirst		813-630-4498	8	
Samplers: (Signature) Matrix Codes: DW-Drinking Water WW-Wastewater SW-SurfaceWater SL-Sludge SO-So	4:22	is the second second					jedet	iedeback@hazanandsawyer.com	nandsawy	er.com	<sup>л</sup> и.	· · · ·
Matrix Codes: DW-Drinking Water WW-Wastewater SW-SurfaceWater SL-Sludge SO-So						PARAME	PARAMETER / CONTAINER DESCRIPTION	AINER DES	SCRIPTIO	7	- <b>1</b> 65 3 <b>9</b>	
GW-Groundwater SA-Saline Water O-Other R-Reagent Water	ii ther					ر <i>هم</i> <sup>ن</sup> ده						ners (Total
SAL Use Only Sample Na Nation	Date	īime	XithaM	Grab Grab	1LP, Cool SOY	1ки' ин <sup>3</sup> ' и 520 ш Б' Н <sup>3</sup>	20	8 No	an a	Field Temp	Field pH	No. of Contai per each loc
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iourier	Rec	Wullm	Jul	Date/Time: 1.1/1 ₹	Chi	Proper preservatives indit Rec'd w ithin holding time?	Proper preservatives indicated? Rec'd w ithin holding time?	SE	N N N N N			
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