



# Florida Onsite Sewage Nitrogen Reduction Strategies Study

Task A.17

**PNRS II Specification Report I**

**Revised Final Report**

May 2010

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**HAZEN AND SAWYER**  
Environmental Engineers & Scientists

In association with



**AET**  
Applied Environmental Technology

**OTIS  
ENVIRONMENTAL  
CONSULTANTS, LLC**

# **Florida Onsite Sewage Nitrogen Reduction Strategies Study**

## **TASK A.17 REVISED FINAL REPORT**

### **PNRS II Specification Report I**

#### **Prepared for:**

Florida Department of Health  
Division of Environmental Health  
Bureau of Onsite Sewage Programs  
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FDOH Contract CORCL

**May 2010**

#### **Prepared by:**

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## **PNRS II Specification Report I**

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The Florida Department of Health has contracted with a project team led by Hazen and Sawyer, P.C. to continue the study of passive nitrogen removal (PNRS II) under Task A of the Florida Onsite Sewage Nitrogen Reduction Strategies Study (FOSNRS). PNRS II is a follow up to the previous experimental evaluations of passive nitrogen removal technologies conducted by Applied Environmental Technology (AET) under FDOH Contract CORY6 (Passive Nitrogen Removal Study I). PNRS II will be conducted by staff from Hazen and Sawyer and AET. The FOSNRS Task A.15 Final PNRS II Quality Assurance Project Plan (QAPP) report details the pilot testing plan to evaluate candidate technologies that can be used to remove nitrogen from septic tank effluent with more passive on-site treatment systems. The pilot systems detailed in Task A.15 consist of various configurations of in-tank biofilters and passive in-situ systems constructed as mound systems. Construction of the PNRS II systems will be completed in two phases, with Phase 1 relating mostly to PNRS II pilot test facilities in-tank biofilters. The passive in-situ systems for PNRS II will be constructed in Phase 2 along with the mini-mounds for Task C. This PNRS II Specification Report is provided under Task A.17 of the FOSNRS Contract and is the first of two specification reports provided for PNRS II construction. This specification report provides details for Phase 1 of PNRS II construction and includes details of design, materials and media procurement and preparation. The PNRS II QAPP should be referred to for additional details on the systems and testing plan.

### **1.1 Media**

PNRS II will perform field testing of numerous onsite wastewater treatment configurations that use biofiltration media to enhance nitrogen reduction. The QAPP for PNRS II lists biofiltration media that will be evaluated in Stage 1 (unsaturated, nitrification) biofilters and Stage 2 (saturated, denitrification) biofilters (PNRS II QAPP Section 3.3). The PNRS II media are listed in Table 1.1 and detailed in the following sections. Figure 1-1 through Figure 1-15 are photographs of the various screened media.

**Table 1.1**  
**PNRS II Media**

Media ID	Material	Typical Particle Size Range as Supplied	Particle Screening	Volume	Unit	Supplier/Manufacturer	Supplier/Manufacturer Type or Size Designation	Cost
1.	Clinoptilolite	1.4 - 2.3 mm	None	17.2	CF	GSA Resources	US Sieve Size 8 x14	\$390 / ton (+\$525 to Transport)
2.	Clinoptilolite	0.3 - 1.2 mm	None	24.5	CF		US Sieve Size 16x50	\$390 / ton (+\$525 to Transport)
3.	Expanded Clay	0 – 3.1 mm	>1.53mm	13.9	CF	Big River Industries	1/8" to 0	\$1560 per truckload (44 CY) +\$1,300 to Transport
4.	Expanded Clay		<1.53mm	20.4	CF			
5.	Expanded Clay		>1.13mm	7.9	CF			
6.	Expanded Clay	0 – 3.1 mm	None	240	CF			
7.	Gravel	1.2 – 4 mm	>3mm	0.2	CF	National Sun-coast Media	US Sieve Size #5 x #16 Gravel	Donated
8.	Lignocellulosic	1 – 5 mm	None	193	CF	Robbins Products	Southern Yellow Pine Sawdust	Donated
9.	Oyster Shell	3 – 15 mm	>1.13 mm	3.1	CF	Shell's Feed Supply	Crushed	\$15 / 50 lbs
10.	Expanded Polystyrene	2.2 – 3.6 mm	None	12.3	CF	EZ-Set	EPS	Donated
11.	Sand	0.8-1.2 mm	None	8	CF	National Sun-coast Media	Torpedo Sand	Donated
12.	Sand	0.45-0.55 mm	None	8.2	CF		Silica Sand	Donated
13.	Sand		None	274	CF	Tampa Groves	Slightly Limited Fine Sand	\$220/ Truckload (16 CY)
14.	Sodium Sesquicarbonate	1 – 3 mm	>0.85 mm	1.3	CF	Solvay	T-50	Donated
15.	Sulfur	2 – 4 mm	>1.13 mm	10.3	CF	Georgia Sulfur	216	\$0.36 / lb + \$680 to Transport
16.	Sulfur		None	106	CF			

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**Figure 1-1**  
**Clinoptilolite Media 8 x 14 (1.4 – 2.3 mm)**



**Figure 1-2**  
**Clinoptilolite Media 16 x 50 (0.3 – 1.2 mm)**

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**Figure 1-3**  
**Expanded Clay (>1.53 mm)**



**Figure 1-4**  
**Expanded Clay (<1.53 mm)**

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**Figure 1-5**  
**Expanded Clay (>1.13 mm)**



**Figure 1-6**  
**Expanded Clay Raw Material (0 – 3.1 mm)**

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**Figure 1-7**  
**Gravel (>3 mm)**



**Figure 1-8**  
**Lignocellulosic (1 - 5 mm)**

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**Figure 1-9**  
**Oyster Shell (>1.13 mm)**



**Figure 1-10**  
**Expanded Polystyrene (2.2 – 3.6 mm)**

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**Figure 1-11**  
**Torpedo Sand (0.8 – 1.2 mm)**



**Figure 1-12**  
**Silica Sand (0.45 – 0.55 mm)**

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**Figure 1-13**  
**Slightly Limited Fine Sand**



**Figure 1-14**  
**Sodium Sesquicarbonate (>0.85 mm)**

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**Figure 1-15**  
**Sulfur (>1.13 mm)**

The media as received from vendors was screened where necessary using mesh screens listed in Table 1.2. Clinoptilolite, lignocellulosic, polystyrene, and sand was used as supplied while elemental sulfur, expanded clay, gravel, oyster shell, and sodium sesquicarbonate was screened to the particle size ranges listed in Table 1.1. Screening was accomplished using square weave stainless steel type 304 wire mesh as specified in Table 1.2. Screens were mounted on a tilting frame device underlain by a collection trough (Figure 1-16). Media to be screened was applied in batches to the surface of the screen, and the screen device was then tilted and vibrated until particles ceased to migrate through the screen.

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**Table 1.2**  
**Mesh Screens Used for Media Screening**

<b>Media Screened (From Table 1.1)</b>	<b>Opening Size (mm/inch)</b>	<b>Mesh Size</b>	<b>Wire Size (inch)</b>	<b>Material</b>	<b>Size (W x L)</b>
7	3.00 mm (1/8")	1/8"		23 Gauge Steel Wire Hardware Cloth	3' x 4'
3 & 4	1.53 mm (0.0603")	12	0.0230"	Stainless Steel 304, Square Weave Wire Mesh	3' x 4'
5, 9, 15	1.13 mm (0.0445")	16	0.0180"	Stainless Steel 304, Square Weave Wire Mesh	3' x 4'
14	0.85 mm (0.034")	20	0.0160"	Stainless Steel 304, Square Weave Wire Mesh	3' x 4'
4	0.23 mm (0.0092")	60	0.0075"	Stainless Steel 304, Square Weave Wire Mesh	3' x 4'



**Figure 1-16**  
**Media Screening Tilting Frame Device**

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Various mixtures of the media were prepared for the PNRS II biofilters. Table 1.3 lists the quantities of the screened material used for the various media mixtures. The media mixtures were made in batches onsite prior to placing the media in the test facility treatment tanks. Media mixtures were assembled by adding correct volumes of individual media components to a cement mixer and operating for 20 to 30 seconds. The media mixture was discharged from the cement mixer to a holding bin and the process was repeated until a sufficient volume of the media mixture was produced. Most of the biofilter systems to be tested under the PNRS II pilot study contain one or more of these media mixtures, in various quantities. Table 1.4 and 1.5 provide the details on the mixtures used for each biofilter to be tested.

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**Table 1.3**  
**Biofilter Media Mixtures**

Mixture #	Media ID	Biofilter IDs	Mixture <sup>a</sup>	Media	Total CF	Total Gal
1	Clinoptilolite 8X14	UNSAT-CL-1; UNSAT-CL-3	6.1 CF mixed with 0.31 CF Oyster Shell	Clino 8x14	6.13	45.9
				Oyster Shell	0.31	2.3
2	Clinoptilolite 16X50	UNSAT-CL-1; UNSAT-CL-3	12.3 CF mixed with 0.61 CF Oyster Shell	Clino 16x50	12.27	91.8
				Oyster Shell	0.61	4.6
3	Expanded Clay >1.53 mm	UNSAT-EC-1; UNSAT-EC-3	6.1 CF mixed with 0.31 CF Oyster Shell	E Clay >1.53	6.13	45.9
				Oyster Shell	0.31	2.3
4	Expanded Clay <1.53 mm	UNSAT-EC-1; UNSAT-EC-3	12.3 CF mixed with 0.61 CF Oyster Shell	E Clay <1.53	12.27	91.8
				Oyster Shell	0.61	4.6
5	Expanded Clay >1.13 mm	DENIT-LS-1; DENIT-LS-2	3.23 CF mixed with 3.23 CF Lignocellulosic	E Clay >1.13	3.23	24.1
				Ligno	3.23	24.1
6	Expanded Clay >1.13 mm	DENIT-LS-4	3.69 CF mixed with 1.58 CF Lignocellulosic	E Clay >1.13	3.69	27.6
				Ligno	1.58	11.8
7	Expanded Clay As Is	UNSAT-IS-1; UNSAT-IS-2	4.4 CF mixed with 3.4 CF Lignocellulosic and 2 CF Sulfur	E Clay As Is	4.42	33.0
				Ligno	3.43	25.7
				Sulfur As Is	1.96	14.7
8	Torpedo Sand	DENIT-LS-3	2.64 CF mixed with 2.64 CF Lignocellulosic	Torpedo Sand	2.64	19.7
				Ligno	2.64	19.7
9	Sulfur >1.13	DENIT-SU-1; DENIT-SU-3	5.16 CF mixed with 1.3 CF Oyster Shell	Sulfur >1.13	5.16	38.6
				Oyster Shell	1.29	9.7
10	Sulfur >1.13	DENIT-SU-2; DENIT-SU-4	5.16 CF mixed with 1.3 CF Sodium Sesqui-carbonate	Sulfur >1.13	5.16	38.6
				Sodium Sesq	1.29	9.7

- a. Media volumes were calculated based on tank diameter and desired media depth. These volumes were then converted to gallons so that calibrated buckets could be used to place media in the mixer.

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**Table 1.4**  
**Stage 1 Biofilter Media Quantities**

Biofilter #	Biofilter ID	Media Layer	Mixture ID # (See Table 1.3)	CF	Gal
1	UNSAT-EC-1	Upper 5"	Mixture 3	2.20	16.4
		Lower 10"	Mixture 4	4.24	31.7
2	UNSAT-SAND-2	Upper 10"	Torpedo Sand	4.09	30.6
		Lower 20"	Silica Sand	8.18	61.2
3	UNSAT-EC-3	Upper 10"	Mixture 3	4.40	32.9
		Lower 20"	Mixture 4	8.48	63.5
4	UNSAT-EC-4	Upper 10"	E Clay >1.53	4.09	30.6
		Lower 20"	E Clay <1.53	8.18	61.2
5	UNSAT-CL-1	Upper 5"	Mixture 1	2.20	16.4
		Lower 10"	Mixture 2	4.24	31.7
6	UNSAT-CL-2	Upper 5"	Clino 8x14	2.04	15.3
		Lower 10"	Clino 16x50	4.09	30.6
7	UNSAT-CL-3	Upper 10"	Mixture 1	4.40	32.9
		Lower 20"	Mixture 2	8.48	63.5
8	UNSAT-CL-4	Upper 10"	Clino 8x14	4.09	30.6
		Lower 20"	Clino 16x50	8.18	61.2
9	UNSAT-PS-1	Module	Polystyrene	12.27	91.8
10	UNSAT-IS-1	Upper 12"	Mound Sand	4.91	36.7
		Lower 12"	Mixture 7	4.91	36.7
11	UNSAT-IS-2	Upper 12"	Mound Sand	4.91	36.7
		Lower 12"	Mixture 7	4.91	36.7

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**Table 1.5  
Stage 2 Biofilter Media Quantities**

Biofilter #	Biofilter ID	Media Layer	Mixture ID # (See Table 1.3)	CF	Gal
1	DENIT-SU-1	Mixture 72"	Mixture 9	1.18	8.8
2	DENIT-SU-2	Mixture 72"	Mixture 10	1.18	8.8
3	DENIT-SU-3	Mixture 24"	Mixture 9	5.28	39.5
4	DENIT-SU-4	Mixture 24"	Mixture 10	5.28	39.5
5	DENIT-LS-1	Mixture 72"	Mixture 5	1.18	8.8
6	DENIT-LS-2	Mixture 24"	Mixture 5	5.28	39.5
7	DENIT-LS-3	Mixture 24"	Mixture 8	5.28	39.5
8	DENIT-LS-4	Mixture 24"	Mixture 6	5.28	39.5
9	DENIT-GL-1	Upper 12"	Gravel 5X16 >3 mm	0.20	1.5
		Lower 60"	E Clay >1.13	0.98	7.3

## 1.2 Construction of Systems

Pilot test systems consist of various configurations of in-tank biofilters and passive in-situ systems. As outlined in the PNRS II QAPP, Phase 1 of construction consists of a total of five two-stage single pass systems, four Stage 1 recirculating biofilter systems followed by four Stage 2 inclined saturated biofilters, and two in-tank in-situ simulators. The passive in-situ systems for PNRS II will be constructed in Phase 2 along with the mini-mounds for Task C.

### 1.2.1 PNRS II In-Tank Single Pass Biofilters

In the two-stage single pass biofilter process, a first stage unsaturated biofilter is followed in series by a second stage biofilter operated in a water saturated mode. Hydrosplitter 1 applies septic tank effluent to the top of the first stage media in each of the five single pass biofilters. This results in a downward percolation of wastewater over and through the media biofilter bed, through the support screen, and into a ¾" PVC line that conveys biofilter effluent to the directly connected Stage 2 biofilter. The Stage 2 biofilter configurations are 22-inch diameter circular upflow filters of 24-inch media depth. A valve and sample port are located in the line following the Stage 1 and 2 biofilters. The Stage 2 biofilter effluent flows to the drain connected to the existing pump lift station and is eventually discharged to the existing mound system. The construction of the biofilters consists of a polyethylene tank with cover and underdrain base to support the media.

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Table 1.6 details the Stage 1 and Stage 2 media utilized for the directly connected single pass biofilter systems. Figure 1-17 provides an as-built diagram of a single-pass biofilter system. Table 1.7 lists the materials of construction for these systems, as identified on the diagram.

**Table 1.6**  
**PNRS II Single Pass Biofilter Media**

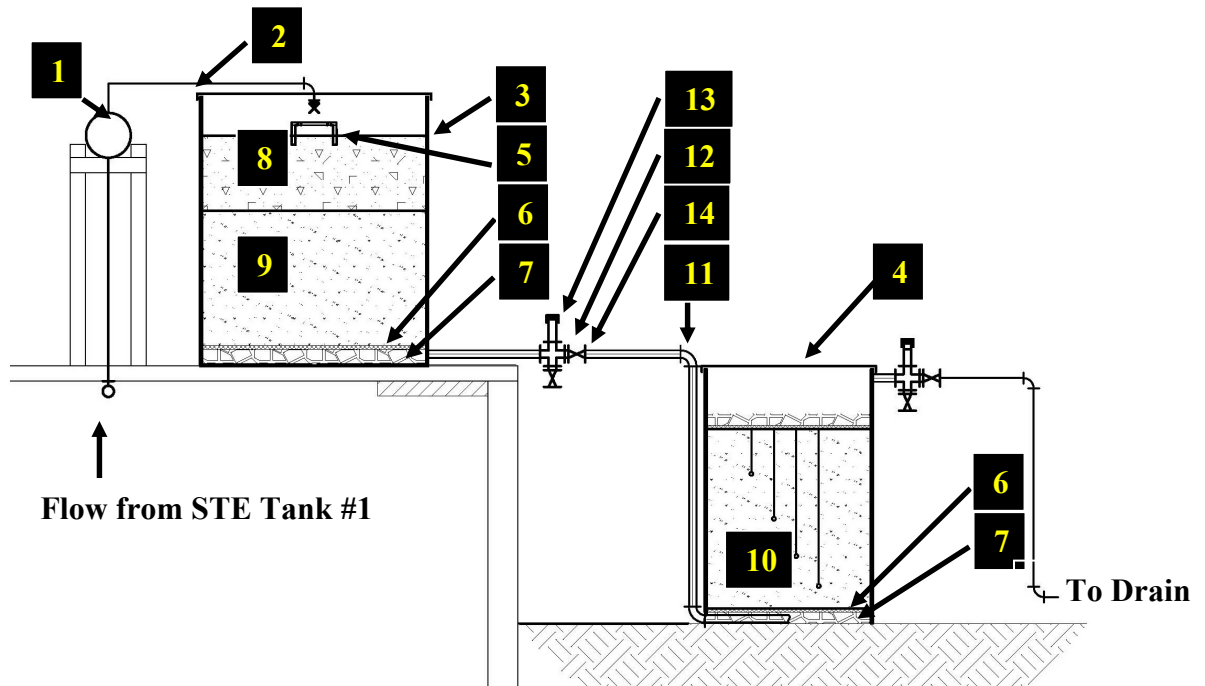
Single Pass System No.	Stage	Biofilter ID	Media	Media Depth (Inches)	Volume (ft <sup>3</sup> )	Supplier (Material/Size)
1	1	UNSAT-EC-1	Expanded Clay >1.53 mm	5	3.3	Florida Rock Industries (1/8 x 0)
			Expanded Clay <1.53 mm	10	4.1	Florida Rock Industries (1/8 x 0)
			Oyster Shell >1.13 mm	~5% of EC Mixture	0.3	Shell's Feed Supply
	2	DENIT-SU-4	Sulfur	24	4.2 (80% of Mixture)	Georgia Sulfur (216)
			Sodium Sesquicarbonate		1.1 (20% of Mixture)	Solvay (T-50)
2	1	UNSAT-EC-3	Expanded Clay >1.53 mm	10	5.3	Florida Rock Industries (1/8 x 0)
			Expanded Clay <1.53 mm	20	8.2	Florida Rock Industries (1/8 x 0)
			Oyster Shell >1.13 mm	~5% of EC Mixture	0.6	Shell's Feed Supply
	2	DENIT-LS-3	Lignocellulosic	24	2.6 (50% of Mixture)	Robbins Products (SYP)
			Sand		2.6 (50% of Mixture)	National Suncoast Media (Torpedo Sand)

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**Table 1.6 (con't)**  
**PNRS II Single Pass Biofilter Media**

Single Pass System No.	Stage	Biofilter	Media	Media Depth (Inches)	Volume (ft <sup>3</sup> )	Supplier (Material/Size)
3	1	UNSAT-CL-1	Clinoptilolite (8 x 14)	5	3.3	GSA Resources (8 x 14)
			Clinoptilolite (16 x 50)	10	4.1	GSA Resources (16 x 50)
			Oyster Shell >1.13 mm	~5% of CL Mixture	0.3	Shell's Feed Supply
	2	DENIT-SU-3	Sulfur >1.13 mm	24	4.2 (80% of Mixture)	Georgia Sulfur (216)
			Oyster Shell >1.13 mm		1.1 (20% of Mixture)	Shell's Feed Supply
4	1	UNSAT-CL-3	Clinoptilolite (8 x 14)	10	5.3	GSA Resources (8 x 14)
			Clinoptilolite (16 x 50)	20	8.2	GSA Resources (16 x 50)
			Oyster Shell >1.13 mm	~5% of CL Mixture	0.6	Shell's Feed Supply
	2	DENIT-LS-2	Lignocellulosic	24	2.6 (50% of Mixture)	Robbins Products (SYP)
			Expanded Clay >1.13 mm		2.6 (50% of Mixture)	Florida Rock Industries (1/8 x 0)
5	1	UNSAT-PS-1	Polystyrene	30	12.3	EZ-Set
	2	DENIT-LS-4	Lignocellulosic	24	1.6 (30% of Mixture)	Robbins Products (SYP)
			Expanded Clay		3.7 (70% of Mixture)	Florida Rock Industries (1/8 x 0)

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**Figure 1-17**  
**PNRS II Single Pass Biofilter System**

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**Table 1.7**  
**PNRS II Single Pass Biofilter Systems Materials of Construction**

Reference No.	Description	Quantity	Unit	Supplier/ Manufacturer	Model #	Specs	Cost
<b>1</b>	Hydrosplitter 1	1	EA	Custom			
<b>2</b>	Hydrosplitter Tygon Tubing 3/8" ID	30	LF	US Plastics	R-3603		\$1.33/LF
<b>3</b>	Polyethylene Stage 1 Tank 30" ID x 36" H	5	EA	US Plastics/ TAMCO	4158		\$302.74 EA
<b>4</b>	Polyethylene Stage 2 Tank 22" ID x 34.5" H	5	EA	US Plastics/ TAMCO	4032		\$95.20 EA
<b>5</b>	Perforated Splash Plate 6" D	5	EA	Plastics America			\$37.04 EA
<b>6</b>	Geotextile Fabric FW700	38	SF	F H Moore / Mirafi	FW700		\$0.35/SF
<b>7</b>	Gravel 1/2" Under-drain Material	6.29	CF	Misc. Locations			(see Table 1.1)
<b>8</b>	Stage 1 Upper Media (see Table 1.4)	Varies	CF	Varies	Varies	Varies	(see Table 1.1)
<b>9</b>	Stage 1 Lower Media (see Table 1.4)	Varies	CF	Varies	Varies	Varies	(see Table 1.1)
<b>10</b>	Stage 2 Media (see Table 1.5)	Varies	CF	Varies	Varies	Varies	(see Table 1.1)
<b>11</b>	3/4" PVC Pipe	75	LF	Misc. Locations		Sch. 40	\$1.56/LF
<b>12</b>	3/4" PVC Cross	10	EA	Misc. Locations		Sch. 40	\$1.70/EA
<b>13</b>	3/4" Cap	10	EA	Misc. Locations		Sch. 40	\$0.50/EA
<b>14</b>	3/4" Ball Valve	20	EA	Misc. Locations		Sch. 40	\$3.05/EA

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### 1.2.2 PNRS II In-Tank Recirculating Biofilter Systems

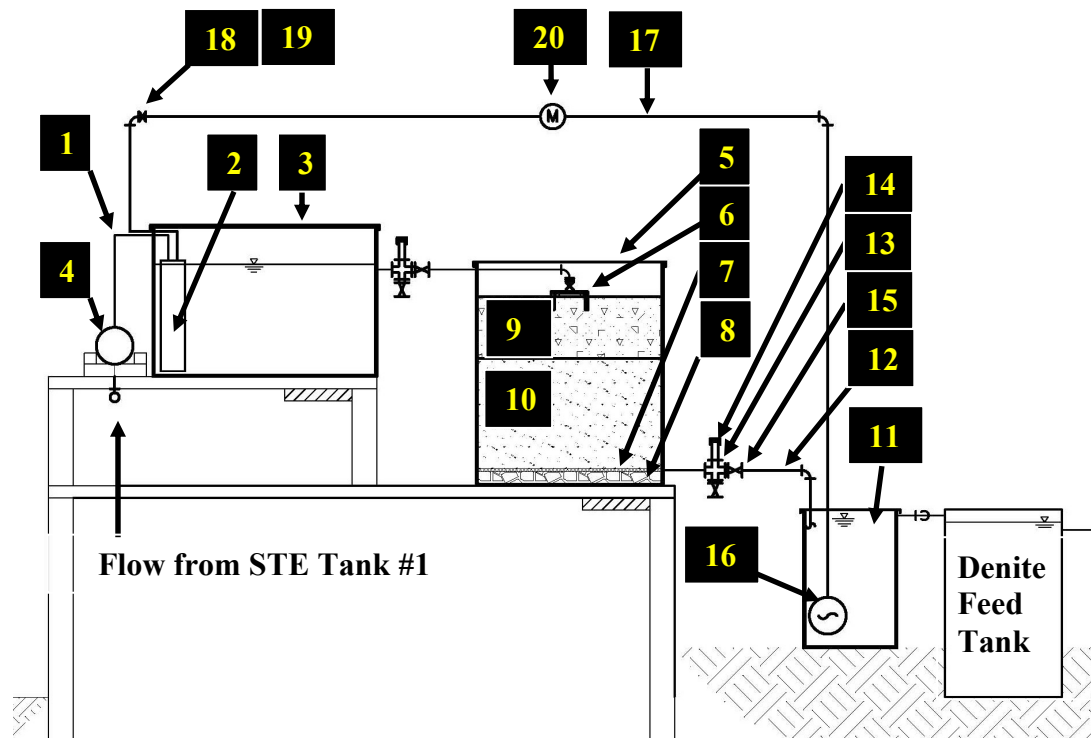
The two-stage biofilter process will also be tested utilizing recirculation of Stage 1 effluent. A recirculation tank receives STE from Hydrosplitter 2 and recycled Stage 1 effluent which then feeds the Stage 1 biofilter via a gravity line. The first stage biofilter effluent is directed to a dose tank with a submersible pump which recirculates the nitrified effluent at a 3:1 recycle ratio or other ratio as desired. A common Stage 1 effluent collection tank (the denite feed tank) receives the Stage 1 effluent which is not recycled. The construction of the Stage 1 biofilters consists of 30-inch inner diameter polyethylene tanks with covers and underdrain base to support the media. Table 1.8 summarizes the media utilized for Stage 1 of the recirculating two-stage biofilters. Figure 1-18 provides an as-built diagram of a Stage 1 recirculating biofilter system, while Table 1.9 lists the materials of construction for these systems, as identified on the diagram.

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**Table 1.8**  
**PNRS II Recirculating Stage 1 Biofilters Media**

	<b>Biofilter ID</b>	<b>Media</b>	<b>Media Depth (Inches)</b>	<b>Volume (ft<sup>3</sup>)</b>	<b>Supplier (Material/Size)</b>	<b>Recycle Ratio (α)</b>
1	UNSAT-SAND-2	Sand 0.8–1.2 mm	10	5.3	National Suncoast Media (Torpedo Sand)	3
		Sand 0.45–0.55 mm	20	8.2	National Suncoast Media (Silica Sand)	3
2	UNSAT-EC-4	Expanded Clay >1.53 mm	10	5.3	Florida Rock Industries (1/8 x 0)	3
		Expanded Clay <1.53 mm	20	8.2	Florida Rock Industries (1/8 x 0)	3
3	UNSAT-CL-2	Clinoptilolite (8 x 14)	5	3.3	GSA Resources (8 x 14)	3
		Clinoptilolite (16 x 50)	10	4.1	GSA Resources (16 x 50)	3
4	UNSAT-CL-4	Clinoptilolite (8 x 14)	10	5.3	GSA Resources (8 x 14)	3
		Clinoptilolite (16 x 50)	20	8.2	GSA Resources (16 x 50)	3

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**Figure 1-18**  
**PNRS II Recirculating Biofilter Stage 1**

**Table 1.9**  
**PNRS II Recirculating Biofilters Stage 1 Materials of Construction**

Reference No.	Description	Quantity	Unit	Supplier/ Manufacturer	Model #	Specs	Cost
<b>1</b>	Hydrosplitter Tygon Tubing 3/8" ID	24	LF	US Plastics	R-3603		\$1.33/LF
<b>2</b>	4" ID x 18" H Mixing Chamber	4	EA	Misc. Locations		Sch. 40	\$12.07 EA
<b>3</b>	Polyethylene Recirculation Tank 36" ID x 24" H	4	EA	US Plastics/ TAMCO	4157		\$308.35 EA
<b>4</b>	Hydrosplitter 2	1	EA	Custom			
<b>5</b>	Polyethylene Stage 1 Tank 30" ID x 36" H	4	EA	US Plastics/ TAMCO	4158		\$302.74 EA
<b>6</b>	Perforated Splash Plates 6" D	4	EA	Plastics America			\$37.04 EA
<b>7</b>	Geotextile Fabric FW700	20	SF	F H Moore / Mirafi	FW700		\$0.35/SF
<b>8</b>	Gravel 1/2" Under-drain Material	3.27	CF	Misc. Locations			(see Table 1.1)
<b>9</b>	Stage 1 Upper Media (see Table 1.4)	Varies	CF	Varies	Varies	Varies	(see Table 1.1)
<b>10</b>	Stage 1 Lower Media (see Table 1.4)	Varies	CF	Varies	Varies	Varies	(see Table 1.1)
<b>11</b>	Recirculation Dosing Tank (15 Gallon)	4	EA	US Plastics/ TAMCO	4030		\$53.26 EA
<b>12</b>	3/4" PVC Pipe	60	LF	Misc. Locations		Sch. 40	\$1.56/LF
<b>13</b>	3/4" PVC Cross	8	EA	Misc. Locations		Sch. 40	\$1.70/EA
<b>14</b>	3/4" Cap	8	EA	Misc. Locations		Sch. 40	\$0.50/EA
<b>15</b>	3/4" Ball Valve	16	EA	Misc. Locations		Sch. 40	\$3.05/EA
<b>16</b>	1/6 HP Submersible Pump	4	EA	Sarasota H2O Gardens/ Little Giant	505202	115V	\$151.20 EA

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**Table 1.9 (con't)**  
**PNRS II Recirculating Biofilters Stage 1 Materials of Construction**

Reference No.	Description	Quantity	Unit	Supplier/ Manufacturer	Model #	Specs	Quoted Price
<b>17</b>	½" Pipe	80	LF	Misc. Locations		Sch. 40	\$1.20/LF
<b>18</b>	½" 90° Bend	16	EA	Misc. Locations		Sch. 40	\$0.50 EA
<b>19</b>	½" Ball Valves	4	EA	Misc. Locations		Sch. 40	\$2.52 EA
<b>20</b>	½" Flow Meters	4	EA	Misc. Locations		Sch. 40	\$137.00 EA

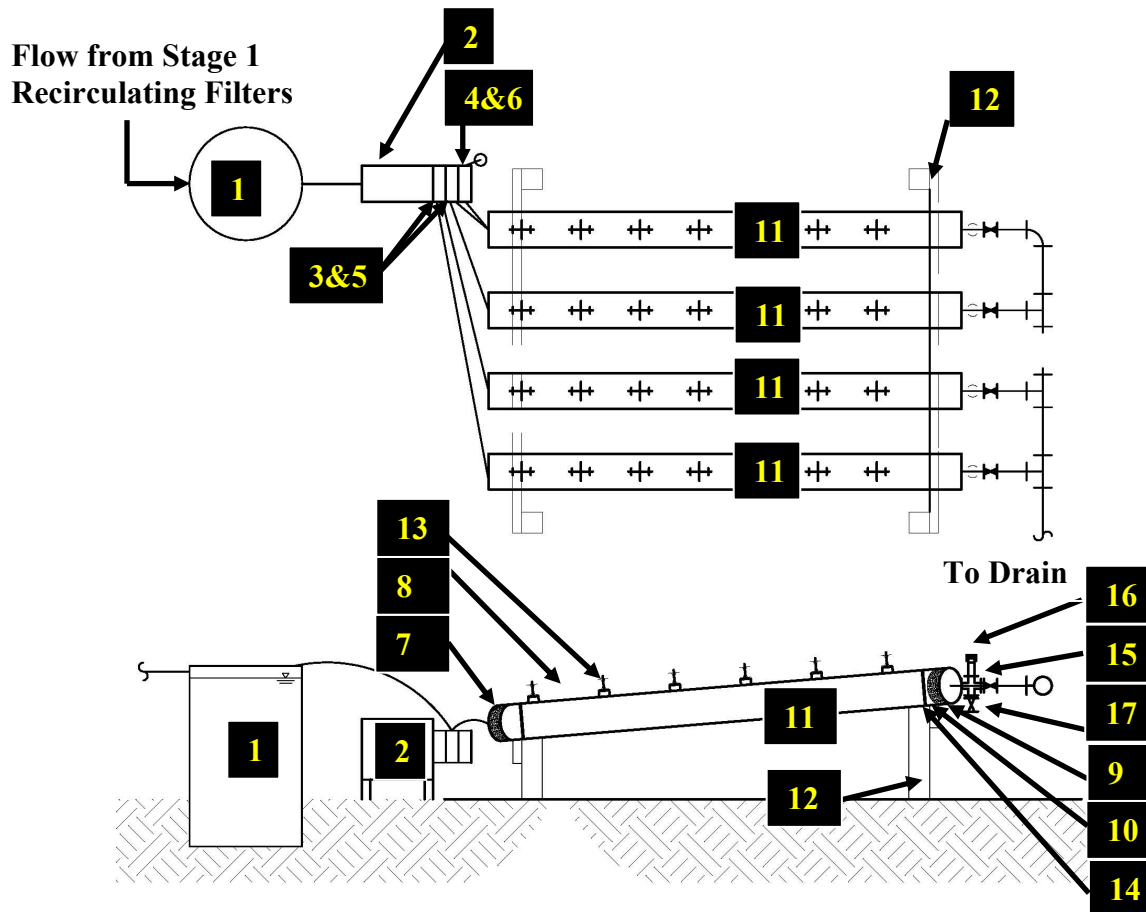
The Stage 1 effluent from the four recirculating biofilters is combined in the denite feed tank. This nitrified effluent is then pumped to Stage 2 inclined denitrification filters. Stage 2 biofilters are maintained in saturated mode by the Stage 2 overflow elevation pipe. The configuration of the Stage 2 biofilters is a 6-inch diameter pipe of 72-inch length which is inclined slightly upward. The Stage 2 biofilters effluent flows to the drain connected to the existing pump lift station and is eventually discharged to the existing mound system. The media installed in these Stage 2 biofilters is listed in Table 1.10. Table 1.11 lists the materials of construction for these systems, as identified on the as-built diagram provided in Figure 1-19.

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**Table 1.10**  
**PNRS II Recirculating Stage 2 Biofilters Media**

	Biofilter ID	Media	Media Depth (Inches)	Volume (ft <sup>3</sup> )	Supplier (Material/Size)
1	DENIT-SU-1	Sulfur >1.13 mm	72" (80% of Mixture)	0.9	Georgia Sulfur (216)
		Oyster Shell >1.13 mm	72" (20% of Mixture)	0.2	Shell's Feed Supply
2	DENIT-SU-2	Sulfur >1.13 mm	72" (80% of Mixture)	0.9	Georgia Sulfur (216)
		Sodium Sesquicarbonate >0.85 mm	72" (20% of Mixture)	0.2	Solvay (T-50)
3	DENIT-LS-1	Lignocellulosic (SYP)	72" (50% of Mixture)	0.6	Robbins Products (SYP)
		Expanded Clay >1.13 mm	72" (50% of Mixture)	0.6	Florida Rock Industries (1/8 x 0)
4	DENIT-GL-1	Gravel >3 mm	Upper 12" (17% of Mixture)	0.2	National Suncoast Media (Gravel #5 x #16)
		Expanded Clay >1.13 mm	Lower 60" (83% of Mixture)	1.0	Florida Rock Industries (1/8 x 0)

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**Figure 1-19**  
**PNRS II Recirculating Biofilter Systems Stage 2**

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**Table 1.11**  
**PNRS II Recirculating Biofilters Stage 2 Materials of Construction**

Reference No.	Description	Quantity	Unit	Supplier/ Manufacturer	Model #	Specs	Cost
<b>1</b>	Denite Feed Tank	1	EA	US Plastics / TAMCO	4031	30 gal	\$80.25 EA
<b>2</b>	Peristaltic Pump Drive	1	EA	Cole Parmer / Masterflex	R-07523-90		\$1,710.00 EA
<b>3</b>	2 Channel Pump Head for Stage 2	1	EA	Cole Parmer / Masterflex	R-77202-50	Easy Load II	\$256.00 EA
<b>4</b>	1 Channel Pump Head for Glycerol	1	EA	Cole Parmer / Masterflex	R-77200-50	Easy Load II	\$200.00 EA
<b>5</b>	Norprene Pump Tubing L/S 25 for Stage 2	1	EA	Cole Parmer / Masterflex		Norprene 50' L	\$46.00/ 50' L
<b>6</b>	Norprene Pump Tubing L/S 13 for Glycerol	1	EA	Cole Parmer / Masterflex		Norprene 50' L	\$38.00/ 50' L
<b>7</b>	6" PVC Cap with hole for tubing	8	EA	Misc. Locations		Sch. 40	\$15 EA
<b>8</b>	6" PVC (6' segments)	4	EA	Misc. Locations		Sch. 40	\$30 EA
<b>9</b>	Gravel ½" Under-drain Material	0.13	CF	Misc. Locations			(see Table 1.1)
<b>10</b>	Geotextile Fabric FW700	4	SF	F H Moore / Mirafi	FW700		\$0.35/SF
<b>11</b>	Stage 2 Media (see Table 1.5)	Varies	CF	Varies	Varies	Varies	(see Table 1.1)
<b>12</b>	Wood Frame	1	LS	Misc. Locations			\$25.00
<b>13</b>	Sample Port	36	EA	Misc. Locations			\$20.00 EA
<b>14</b>	Pipe Strap	8	EA	Misc. Locations			
<b>15</b>	¾" PVC Cross	4	EA	Misc. Locations		Sch. 40	\$1.70/EA
<b>16</b>	¾" Cap	4	EA	Misc. Locations		Sch. 40	\$0.50/EA
<b>17</b>	¾" Ball Valve	8	EA	Misc. Locations		Sch. 40	\$3.05/EA

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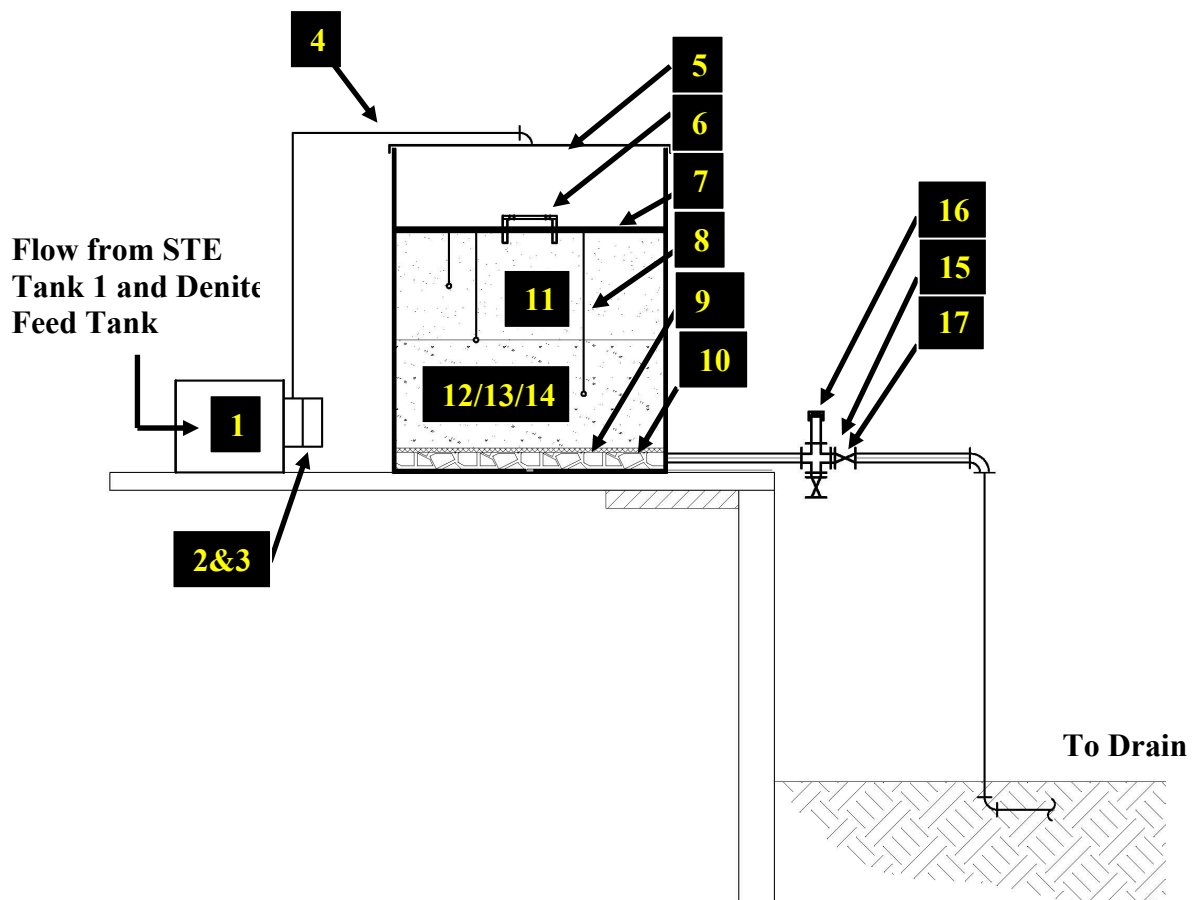
### 1.2.3 In-situ In-Tank Simulators Biofilters

Biofilter Systems 10 and 11, Stage 1 biofilters UNSAT-IS-1 and UNSAT-IS-2 respectively, are in-tank analogs of the media to be used in in-situ systems that will be constructed as mound systems at the research facility as part of the Phase 2 construction. System 10 receives primary effluent and System 11 receives nitrified effluent supplied over a capillary seepage mat that has been used for irrigation of agricultural plants by scientists at the University of Florida Gulf Coast Research and Education Center (GCREC). The upper layer of these biofilters is typical mound sand media, and the lower portion of the biofilter consists of an engineered mixed media of expanded clay, sulfur, and lignocellulosic media as listed in Table 1.12. The effluent flows to the drain connected to the existing pump lift station and is eventually discharged to the existing mound system. Figure 1-20 illustrates an as-built diagram of the in-situ simulator systems while Table 1.13 details the materials of construction for the systems. System 10 does not include line item No. 8 the capillary seepage mat.

**Table 1.12**  
**PNRS II In-Tank In-Situ Simulator Biofilters Media**

	Biofilter ID	Media	Media Depth (Inches)	Volume (ft <sup>3</sup> )	Supplier (Material/Size)
1	UNSAT-IS-1	Mound Sand	Upper 12"	4.91	Tampa Groves
		Expanded Clay (As Is)	Lower 12"	2.2 (45% of Mixture)	Florida Rock Industries (1/8 x 0)
		Lignocellulosic		1.7 (35% of Mixture)	Robbins Products (SYP)
		Sulfur (As Is)		1.0 (20% of Mixture)	Georgia Sulfur (216)
2	UNSAT-IS-2	Mound Sand	Upper 12"	4.91	Tampa Groves
		Expanded Clay (As Is)	Lower 12"	2.2 (45% of Mixture)	Florida Rock Industries (1/8 x 0)
		Lignocellulosic		1.7 (35% of Mixture)	Robbins Products (SYP)
		Sulfur (As Is)		1.0 (20% of Mixture)	Georgia Sulfur (216)

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**Figure 1-20**  
**PNRS II In-Tank In-situ Simulator Systems**

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**Table 1.13**  
**PNRS II In-Tank In-situ Simulators Materials of Construction**

Reference No.	Description	Quantity	Unit	Supplier/ Manufacturer	Model #	Specs	Quoted Price
<b>1</b>	Peristaltic Pump Drive	1	EA	Cole Parmer / Masterflex	R-07523-90		\$1,710.00 EA
<b>2</b>	Pump Head	2	EA	Cole Parmer / Masterflex	R-77200-52		\$200.00 EA
<b>3</b>	Masterflex Norprene Pump Tubing (A 60 G) L/S 35	1	EA	Cole Parmer / Masterflex	R-06404-35	Norprene 50' L	\$102.00/ 50'L
<b>4</b>	Tubing	10	LF	Various			\$10/ 50LF
<b>5</b>	Polyethylene Stage 1 Tank 30" ID x 36" H	2	EA	US Plastics/ TAMCO	4158		\$302.74 EA
<b>6</b>	Perforated Splash Plates 6" D	2	EA	Plastics America			\$37.04 EA
<b>7</b>	Capillary Seepage Mat (UNSAT-IS-2)	1	EA	GCREC			N/A
<b>8</b>	Micro Samplers	6	EA	Soil Moisture Equipment	1908D2.5L10		\$24.90 EA
<b>9</b>	Geotextile Fabric FW700	18	SF	F H Moore / Mirafi	FW700		\$0.35/SF
<b>10</b>	Gravel ½" Under-drain Material	1.64	CF	Misc. Locations			(see Table 1.1)
<b>11</b>	Sand Media	9.8	CF	Tampa Groves		Mound Sand	(see Table 1.1)
<b>12</b>	Expanded Clay Media	4.4	CF	Florida Rock Industries	Livlite 1/8 to zero		(see Table 1.1)
<b>13</b>	Sulfur Media	2.0	CF	Georgia Sulfur	216		(see Table 1.1)
<b>14</b>	Lignocellulosic Media	3.4	CF	Robbins Products	SYP		(see Table 1.1)
<b>15</b>	¾" PVC Cross	2	EA	Misc. Locations		Sch. 40	\$1.70/EA
<b>16</b>	¾" Cap	2	EA	Misc. Locations		Sch. 40	\$0.50/EA
<b>17</b>	¾" Ball Valve	4	EA	Misc. Locations		Sch. 40	\$3.05/EA

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## **Appendix A**

### **Summary of Media for PNRS II**

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Table A.1 provides a summary of the quantities of media that were procured for the PNRS II project.

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BIOFILTER		Clino		Expanded Clay					#5 x #16 Gravel		Ligno		Oyster shell		Poly.	Sand				Sodium sesqui		Sulfur (216)			
		8x14	16x50	> 1.53 mm	< 1.53 mm	%	> 1.13 mm	%	As Is	%	> 3 mm	%	SYP	%	> 1.13 mm	As Is	%	Torp.	Silica	Mound	%	> 0.85 mm	%	> 1.13 mm	As Is
STAGE 1 BIOFILTERS																									
1	UNSAT-EC-1			3.3	4.1									5%	0.3										
2	UNSAT-SAND-2																5.3	8.2							
3	UNSAT-EC-3			5.3	8.2									5%	0.6										
4	UNSAT-EC-4			5.3	8.2																				
5	UNSAT-CL-1	3.3	4.1											5%	0.3										
6	UNSAT-CL-2	3.3	4.1																						
7	UNSAT-CL-3	5.3	8.2											5%	0.6										
8	UNSAT-CL-4	5.3	8.2																						
9	UNSAT-PS-1															12.3									
10	UNSAT-IS-1							45%	2.2			35%	1.7							4.9			20%		1.0
11	UNSAT-IS-2							45%	2.2			35%	1.7							4.9			20%		1.0
STAGE 2 BIOFILTERS																									
1	DENIT-SU-1													20%	0.2								80%	0.9	
2	DENIT-SU-2																			20%	0.2		80%	0.9	
3	DENIT-SU-3													20%	1.1								80%	4.2	
4	DENIT-SU-4																			20%	1.1		80%	4.2	
5	DENIT-LS-1					50%	0.6				50%	0.6													
6	DENIT-LS-2					50%	2.6				50%	2.6													
7	DENIT-LS-3										50%	2.6				50%	2.6								
8	DENIT-LS-4					70%	3.7				30%	1.6													
9	DENIT-GL-1					83%	1.0		17%	0.2															
Total Cubic Feet Required		17.2	24.5	13.9	20.4		7.9		4.4		0.2		10.9		3.1	12.3		8.0	8.2	9.8		1.3		10.3	2.0
% Usable When Screening Material		AS IS	AS IS	55%	17%		65%		AS IS		25%		AS IS			AS IS		AS IS	AS IS	AS IS		34%		57%	AS IS
Additional Volume Required				11.4	74.5		4.3				0.6										2.5		7.8		
Extra Safety Factor (30%)		5.2	7.4	7.6	28.5		3.6		1.3		0.2		3.3		0.9	3.7		2.4	2.5	2.9		1.1		5.4	0.6
Total Cubic Feet to Purchase		22.3	31.9	32.9	123.5		15.8		5.7		1.0		14.1		4.1	15.9		10.3	10.6	12.8		4.9		23.6	2.6
Total Cubic Yards to Purchase		0.8	1.2	1.2	4.6		0.6		0.2		0.04		0.5		0.2	0.6		0.4	0.4	0.5		0.2		0.9	0.1