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MEMO

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From:
David S. Briley

Date:
August 26, 2008

ARCADIS Project No.:
NCCURR01.0004

Subject:
Ocean Sands Wastewater Treatment Plant Denitrification
Currituck County, North Carolina

1.1. Background and Purpose

The Ocean Sands Wastewater Treatment Plant (WWTP) was constructed in 1978 to serve residents of the 678-acre Ocean Sands development. The plant's original treatment capacity was 100,000 gallons per day (gpd). The plant consisted of four independent extended aeration, activated sludge treatment units followed by secondary clarifiers and tertiary filters. Since 1978, the Ocean Sands WWTP has been expanded three times to a permitted capacity of 500,000 gpd as shown in Table 1. A schematic of the existing WWTP is shown in Appendix 1.

Table 1. Ocean Sands WWTP Expansions

Phase	Type	Number of Trains	Capacity (gpd)
Original Plant (1978)	Concrete	2	100,000
Expansion	Steel Package Plant	1	50,000
Expansion (1989)	Steel Package Plant	3	150,000
Expansion (1993)	Steel Package Plant	4	200,000
		TOTAL CAPACITY	**500,000**

Effluent is disinfected using free chlorine and then conveyed to ten rotary distributors where it is land applied. The Ocean Sands WWTP is permitted to discharge up to 600,000 gallons per day, which equates to a loading rate of 7.65 gallons per day/square foot (gpd/ft^2). The site is surrounded by a canal which serves to manage groundwater levels. A pump station located in the northeast corner of the site conveys groundwater through a force main to a ditch that eventually drains to Currituck Sound.

The Ocean Sands WWTP is required to monitor effluent water quality prior to point of irrigation, as well as groundwater quality in nine (9) monitoring wells located around the site. The wells are sampled for the following parameters: nitrate, TOC, ammonia nitrogen, fecal coliforms, TDS, pH, chloride, and water level. Monitoring data for wells 1 thru 8 are available and are included in Appendix 3. Well MW9 was installed per the request of the re-issued High Rate Infiltration System Permit (February 16, 2005); however, no data are available.

On November 9, 2006 the Washington Regional Office of the Aquifer Protection Section issued a Notice of Regulatory Requirement (NORR) to Currituck County for the Ocean Sands WWTP. The NORR was issued due to consistent, elevated concentrations of nitrates detected in multiple monitoring well sites. The State Groundwater Quality Standard indicates a nitrate limit of 10 mg/L. At the time the NORR was issued, groundwater analytical data indicated that nitrates had recently been detected in four of the site's monitoring wells which exceeded the standard. In a letter dated December 6, 2006, the Aquifer Protection Section expressed concerns that the nitrate plume may be increasing in size on the Ocean Sands WWTP site. A corrective action was mandated. One alternative offered was to submit plans for alteration of existing site conditions, facility design or operational controls that would prevent a violation at the compliance boundary. A deadline for this submittal was February 13, 2007.

Effluent data, as shown in Appendix 2, suggests that the high nitrate concentrations in the groundwater are the result of elevated levels leaving the WWTP. In response to the NORR, Currituck County requested the services of ARCADIS to develop a treatment modification to the existing Ocean Sands WWTP in order to provide increased removal of nitrate.

This memorandum presents recommendations to effectively assess current WWTP effluent water quality and potential treatment upgrades to meet regulated effluent limits.

1.2. Project Development

Three treatment options were considered for the Ocean Sands WWTP upgrade, including a Modified Ludzack-Ettinger process (MLE), an Enhanced MLE Process, and a Moving Bed Biological Reactor (MBBR) process. The Enhanced MLE and MBBR processes can potentially achieve effluent nitrate concentrations of 4 mg/L and effluent TN concentrations of less than 7 mg/L. The MLE process can also achieve similar effluent nitrate concentrations depending on the strength of the influent wastewater. Influent TN less than 40 mg/L can be treated to less than 7 mg/L TN.

1.2.1 Monitoring Data

Influent data to the Ocean Sands WWTP consists of limited grab samples along with one month of average influent data. Data collection is essential for design purposes; however, the data from the Oceans Sands plant is too limited to confidently estimate maximum monthly and monthly average concentrations of total nitrogen (TN) in the influent waste water. In order to account for limitations in monitoring data, influent TN estimations are conservative and could lead to overestimates in the treatment upgrades required. It is recommended that daily monitoring be undertaken to assess influent wastewater characteristics and upgrades to the existing WWTP should also include daily monitoring to assess treatment performance.

1.2.2 MLE Process

The MLE process (Figure 1) is designed to remove biological oxygen demanding material (BOD) as well as provide total nitrogen (TN) removal for medium strength wastewaters. The MLE process utilizes biological processes and can typically achieve average effluent NO_3-N concentrations of 4-7 mg/L and less 10 mg/L of TN (Metcalf and Eddy 2003).

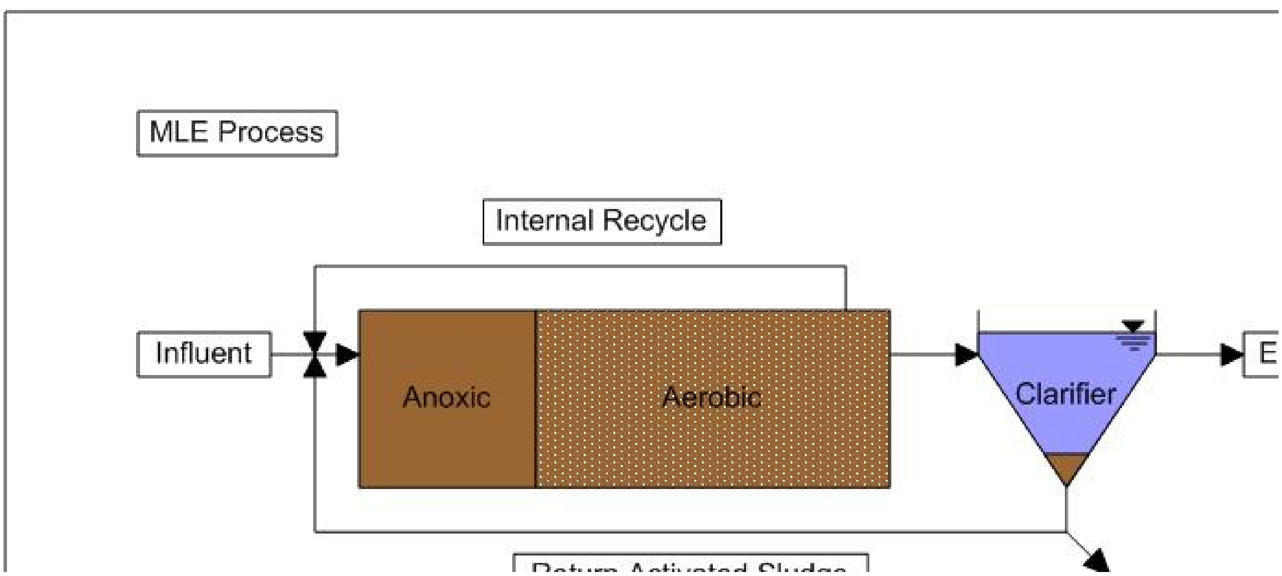

Figure 1: MLE Schematic

The process is configured to include one anoxic and one aerobic zone in the treatment basin. The MLE process nitrifies influent Total Kjeldahl Nitrogen (TKN), which is the sum of organic nitrogen and ammonia, to nitrate (NO_3), and the NO_3 is recycled back to the anoxic zone where it is denitrified to N_2 gas and removed from the wastewater. The MLE process is effective for TN removal in domestic wastewater which typically has a TKN concentration of less than 40 mg/L. Due to limited data, the Ocean Sands wastewater is considered much stronger with influent TKN as high as 153 mg/L.

Important reactor conditions that should be maintained in the MLE process are:

- Anoxic Reactor
  - Low DO concentrations (<1 mg/L)
- Aerobic Reactor
  - DO concentrations • 2 mg/L
  - Limit DO concentration at end of aerobic zone to prevent DO carry over in the internal recycle
  - Mixed liquor internal recycle rate should be regulated in order to optimize nitrate removal
  - Alkalinity is consumed during the nitrification and should be monitored to ensure adequate alkalinity for nitrification

Modifications are needed to convert the existing WWTP to the MLE process and calculations for the modification are attached in Appendix 5. The proposed process modifications focus on one 50,000 gpd steel treatment system. Preliminary cost opinions are presented in Table 2.

Modifications for the MLE process are shown in Appendix 4. Anoxic basins, shown in gray, will be maintained by turning off aeration. Without aeration, mixing is achieved by paddle mixers added to the basins. Additionally, nitrified mixed liquor is recycled with two new internal recycle pumps to the anoxic basins at an appropriate flow rate (• 4Q). The pumps will be oversized to allow for a recycle rate of up to 8Q (400,000 gallons per day or 300 gpm) to provide redundancy in the system. An alkalinity addition system is provided to maintain alkalinity to the basins to ensure optimal TN removal. Carbon addition would not be required because the BOD:TKN ratio is greater than 4:1 which means enough carbon is present for denitrification.

In summary, following equipment will be added:

- Recycle Pumps (2)
- Mixers (2)
- Chemical Feed System (1) for adding alkalinity

1.2.3 Enhanced MLE Process

The Enhanced MLE process (Figure 2) is designed to remove biological oxygen demanding material (BOD) as well as provide total nitrogen (TN) removal for high strength wastewaters or where low effluent TN is required. The Enhanced MLE process utilizes biological processes and can typically achieve average effluent NO_3-N concentrations less than 4 mg/L and total nitrogen (TN) less than 7 mg/L (Metcalf and Eddy 2003).

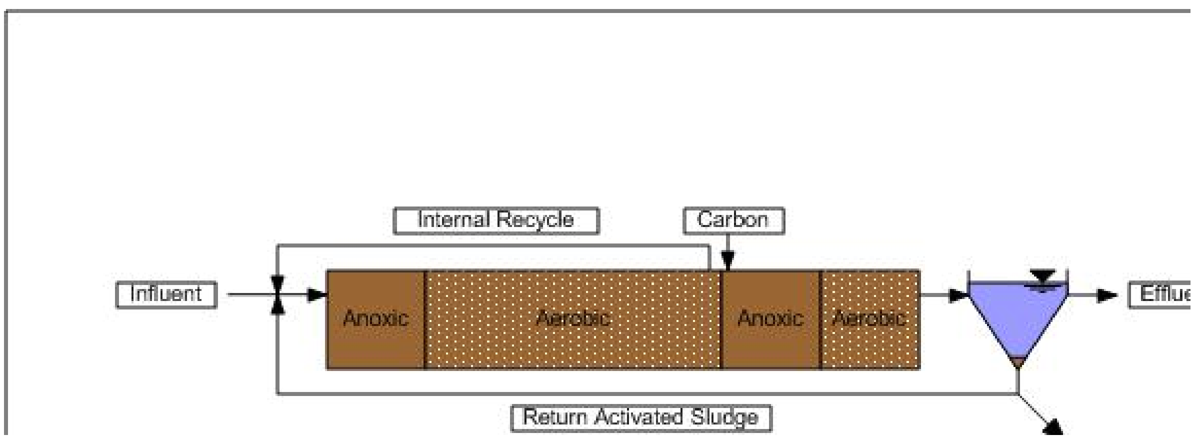

Figure 2: Enhanced MLE Schematic

The process is configured to include two anoxic zones and two aerobic zones in the treatment basins. The first anoxic and aerobic zones perform the typical MLE process, where biological oxygen demand (BOD) and total nitrogen (TN) are removed utilizing an internal recycle flow. The MLE process nitrifies influent Total Kjeldahl Nitrogen (TKN), which is the sum of organic nitrogen and ammonia, to nitrate (NO_3), and the NO_3 is recycled back to the anoxic zone where it is denitrified to N_2 gas and removed from the wastewater. The MLE process is effective for TN removal in domestic wastewater which typically has TKN of 40 mg/L. Ocean Sands wastewater is much stronger with influent TKN as high as 153 mg/L. Therefore, extra anoxic and aerobic stages were included to effectively treat the wastewater. The secondary anoxic stage performs denitrification similar to the first; however, the denitrifying organisms require a carbon source to proceed. In the first stage, carbon was supplied by the influent BOD, but the second stage requires addition of carbon. Typically methanol is chosen as a carbon source. The secondary aerobic stage is important because it prevents carryover of carbon from the secondary anoxic stage to the effluent and prevents denitrification to occur in the clarifier which can lead to rising solids.

There is not sufficient volume in the existing tanks to accomplish TN removal. Therefore, fixed media must be installed to support biological populations and increase TN removal in the limited reactor volumes. Several options exist for fixed media but structured plastic media and dispersed plastic media are recommended.

Important reactor conditions that should be maintained in the Enhanced MLE process are:

- Anoxic Reactor
  - o Low DO concentrations (<1 mg/L)
  - o Adequate carbon source for denitrification
- Aerobic Reactor
  - o DO concentrations • 2 mg/L
  - o Limit DO concentration at end of aerobic zone to prevent DO carry over in the internal recycle
  - o Mixed liquor internal recycle rate should be regulated in order to optimize nitrate removal
  - o Alkalinity is consumed during the nitrification and should be monitored to ensure adequate alkalinity for nitrification

Modifications are needed to convert the existing WWTP to the Enhanced MLE process and calculations for the modification are attached in Appendix 5. The proposed process modifications focus on one 50,000 gpd steel treatment system. Preliminary cost opinions are presented in Table 2.

Modifications for the Enhanced MLE process are shown in Appendix 4. The anoxic basins, shown in gray, will be maintained by turning off aeration. Without aeration, mixing is achieved by paddle mixers added to the basins. Additionally, nitrified mixed liquor is recycled with two new internal recycle pumps to the anoxic basins at an appropriate flow rate (• 4Q). The pumps will be oversized to allow for a recycle rate of up to 8Q (400,000 gallons per day or 300 gpm) to provide redundancy in the system. Methanol and alkalinity addition systems are provided to add carbon and maintain alkalinity to the basins. These systems are typically added to ensure optimal TN removal

In summary, following equipment will be added:

- o Hydrostatic walls with media retention screens (3)
- o Wedge wire media retention screens (3)
- o Recycle Pumps (2)
- o Mixers (2)
- o Chemical Feed Systems (2) for adding methanol and alkalinity
- o HDPE media or structured plastic media

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1.2.4 Moving Bed Biological Reactor (MBBR) Process

The MBBR process (Figure 3) is a technology offered Aquapoint. The process works by utilizing the fixed film biomass that grows on HDPE plastic media added to the tanks. The process uses the fixed biomass to treat the wastewater influent for BOD and TN removal which allows the process to absorb shock and process flow variations. The total biomass is retained in the treatment tanks which allow for a high biomass concentrations without overloading the clarifiers with solids.

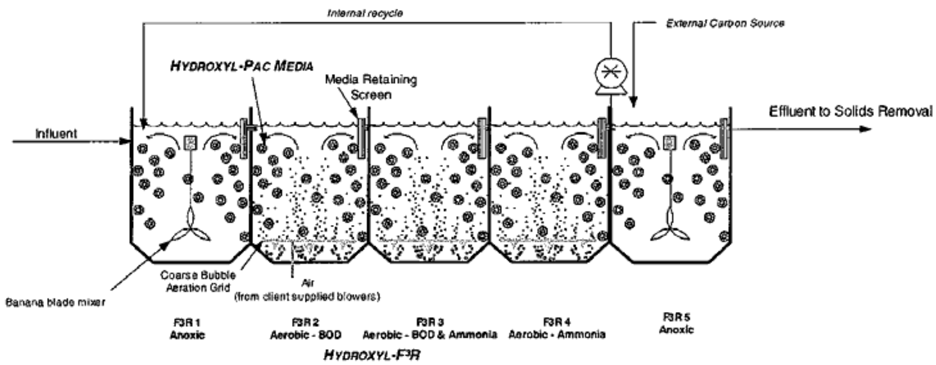

Figure 3: MBBR Process Schematic

The process is configured similarly to the Enhanced MLE process, however, the suspended growth is not considered in the design of the MBBR process. By omitting suspended growth processes, the process is less susceptible to upsets from flow or loading spikes. But, the fixed media requirements are much higher than the comparable Enhanced MLE system.

The following modifications are needed to the existing process in order to convert the 50,000 gpd steel extended aeration process to the pilot Moving Bed Biological Reactor. A proposal from EnviroTech is attached in the Appendix 6.

Additional system requirements include:

- Automated raking bar screen for influent (1)
- Hydrostatic walls with media retention screens (6)
- Wedge wire media retention screens (5)
- Recycle Pumps (2)
- Mixers (2)
- Chemical Feed Systems (3) for adding methanol, alkalinity and coagulant
- HDPE media (87 m^3)

1.2.5 Demonstration Testing

There is significant seasonal variation in flow and influent TKN concentrations to the Ocean Sands WWTP, peaking during June, July, and August. Due to limited monitoring data, we recommend demonstration testing on one train of the existing wastewater treatment plant to confirm whether nitrate removal can meet the desired effluent quality goal at the Ocean Sands WWTP. The demonstration testing should proceed this winter to respond to the NORR issued by North Carolina Division of Water Quality and upgrade should proceed as soon as possible.

2. Preliminary Cost Estimate

The preliminary opinion of probable construction cost for the two alternatives is presented below in Table 2. The costs are presented for both demonstration testing and for total plant retrofit.

Table 2: Preliminary Cost Opinion for Process Modifications

Process	Items	Estimated Cost for Demonstration Retrofit (50,000 gpd)	Estimated Cost for Total Plant Retrofit (500,000 gpd)
MLE	Mixers, recycle pumps, and related plumbing	$ 56,000	$ 350,000
Enhanced MLE	All system additions listed above under Enhanced MLE Process	$ 200,000	$ 2,500,000
Active Cell Conversion	All system additions listed above under MBBR Process	$ 250,000	$ 3,200,000

3. Recommendation and Approach

ARCADIS has reviewed the influent and effluent data for the Ocean Sands WWTP and based on our analyses, the Enhanced MLE process and the MBBR processes may achieve an Effluent TN concentration of less than 7 mg/L, which is required to utilize reduced setbacks. Reduced setbacks are needed to allow for relocation of the infiltration disposal field and provide for space for upset storage for a build out capacity of 1.2 MGD as outlined in the *Ocean Sands Water and Sewer District Master Plan* (ARCADIS, August 2008). The estimated costs for converting the existing 500,000 gpd WWTP to Enhanced MLE or MBBR exceed the available budget without rate increases. Since reduced setbacks are not required until sections G and T develop, we recommend converting the existing WWTP to MLE to address high effluent nitrate levels pending results of demonstration testing.

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APPENDICES

Appendix 1: Ocean Sands WWTP Schematic

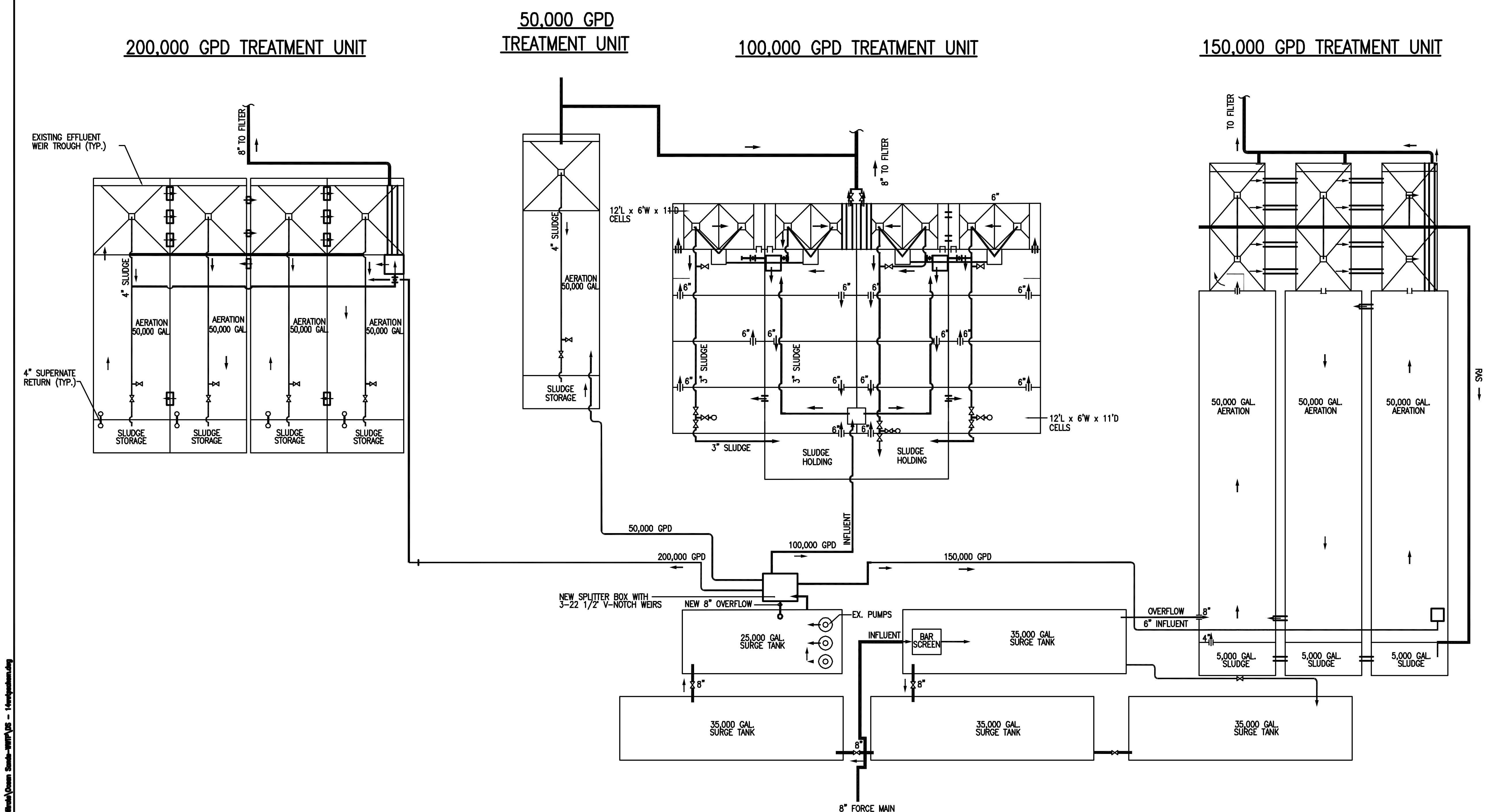
Appendix 2: Ocean Sands WWTP Monitoring

Appendix 3: Ocean Sands Well Monitoring

Appendix 4: Upgrade Schematics

Appendix 5: Upgrade Calculations

Appendix 6: MBBR Proposal from Enviro-Tech and Aquapoint



1 W-1 OCEAN SANDS WASTEWATER TREATMENT PLANT
NOT TO SCALE

NO.	DATE	REVISION DESCRIPTION	BY / CKD

EXISTING PROCESS SCHEMATIC OCEAN SANDS WASTEWATER TREATMENT PLANT

ARCADIS
801 Corporate Center Drive, Suite 300
Raleigh, NC 27607-5073
Tel: 919/854-1282 Fax: 919/854-5448

PROJECT MANAGER: D. BRILEY	DEPARTMENT MANAGER: R. WYCHE
LEAD DESIGN PROF.: A. GHORPADE	CHECKED: W. WHEELER
DRAWN: D. SARAMOSING	DATE: 01-18-08
PROJECT NUMBER: NCCURR01	DRAWING NUMBER: W-1

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Ocean Sands WWTP Data

Effluent Data									
	Fecal Coliform Colonies/100mL	TDS mg/L	pH	TOC mg/L	Chloride mg/L	Ammonia Nitrogen mg/L	Nitrate mg/L	TSS mg/L	VOC mg/L
Limit	1 col./100/mL	500	6.5-8.5	10 mg/L	250 mg/L		10 mg/L		
13-Jul-94	<1	376	7.2	3.14	102	0.5	5.83	<1	
10-Sep-94		178		7.4	67		0.50		
1-Dec-94	<2	350		7.7	70	0.5	7.60		<10
2-Feb-95	<2	180	6.7	5	65			2	
13-Jul-95	<2								
1-Sep-95	<2								
14-Dec-95	<2	322		2.9	77	0.5	10.11	2.8	<0.5
8-Feb-96	<2	370		2.7	68	0.5	24.36		
25-Jul-96	<2	436		7.3	113.5		6.60		
12-Sep-96	<2	546		10	120	0.5	13.10	2.5	
5-Dec-96	<2	346		5.59	67		2.25	2.5	
6-Feb-97		244		6.6	61	0.5	6.75	1	
2-Jul-97		506		5.59	129		13.32		
17-Sep-97		610		3.62	124		2.56		
3-Dec-97		370		16.59	65		7.97		
18-Feb-98		241		6.09	46		11.82		
22-Jul-98	<1	464	6.9	6.8	139	2	2.50	2	
2-Sep-98	<2	372	6.9	8	102	1	16.00	3	
2-Dec-98	<1	286	6.8	4	99	1	3.20	2	
3-Feb-99	<1	372	6.7	4.9	112	0.1	2.90	1	
13-Jul-99	1		7			5.4		2	
14-Sep-99	1	579	7	8.33	148	0.04	27.80	1	
7-Dec-99	<1	403	7.1	6.2	95	0.23	19.30	1	
8-Feb-00	<1	363	7	7.5	105	0.04	20.70	54	
1-Jul-00									
26-Sep-00	<1	579		7.1	152	0.04	28.62	1	
1-Dec-00			6.9						
1-Feb-01			7.3						
19-Jul-01	<1	674	7.2	8.68	226	<0.04	15.7		
27-Sep-01	<1	599	7.2	9.01	173	<0.1	32		
20-Dec-01	<1	472	7	7.9	118	<0.1	25.3		
14-Feb-02	<1	431	7	6.44	137	<.1	13		
18-Jul-02	1	567	7.2	9.61	217	<0.1	14.5		
12-Sep-02	<1	568	7	8.54	163		0.98		
5-Dec-02	<1	551	7	5.3	190	0.9			
6-Feb-03	<1	289	6.8	6.18	87.5	<0.1	9.68		
3-Jul-03	<1	494	7.1	10.7	170				
11-Sep-03	<1	597	6.9	6.35	170	<0.1	43		
4-Dec-03	<1	632	6.9	7.18	140	0.28	11		
5-Feb-04	<1		6.7			<.1	24.1		
1-Jul-04	5	610	6.8	8.6	380	0.1	18.78		
16-Sep-04	<1	516	6.4	10.4	128	<.1	48.2		

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Ocean Sands WWTP Data

	Influent Data								Effluent Data					
Month	**Avg Flow**	**BOD (mg/L)**	**TSS (mg/L)**	**Ammonia (mg/L)**	**TKN (mg/L)**	**NO_2^- (mg/L)**	**NO_3 (mg/L)**	**Date**	**BOD (mg/L)**	**TSS (mg/L)**	**Ammonia (mg/L)**	**TKN (mg/L)**	**NO_2^- (mg/L)**	**NO_3 (mg/L)**
Jan-07	42,129								8	8	0.1			
Feb-07	42,827								<	1	<			12.6
Mar-07	52,714								<	<	<			
Apr-07	89,312								<	1.5	<			
May-07	116,483								3	2.5	<			
June-07 *	236,488	260	152	30.7	55.2	<	0.21	7-Jun	<	<	<	8.1	4.39	<
June-07 *	311,321	220	210	60.1	73.9	<	<	14-Jun	12	7.4	<	21.7	<	2.44
July-07**	355,000	290	145	80.6	97.9	<	<	7-Jul	<	2.9	<	1.1	<	15.65
July-07**	324,843	400	309	125.7	153.6	<	0.3	12-Jul	<	1.3	0.2	7.7	<	10.54
Aug-07	384,000	490	142	83.4		<	<	2-Aug	5	8.1	<	6.7	<	11.32
Aug-07	392,600	210	132	40.6	46.8	<	<	9-Aug	2	5.3	<	2.8	0.09	5.46
Sep-07	142,900	320	157	39.4	51.5	<	<	6-Sep	3	<	<	7.7	<	29
Sep-07	118,200	280	283	41.7	67.6	<	<		<	<	<	3.5	<	34.65
Oct-07***	143,910	158	134	24.3	32.4	<	<	11-Oct	<	1.2	<	15.2	<	32.25
Oct-07****	106,500	140	76	25.2	31.9	0.05	<	18-Oct	2	1.7	<	14.4	<	31.8
Nov-07	92,820	9.6	438	9.6	41.7	x	x		<	1.2	9.6	6.7	<	31.65
Dec-07	76,796	141	460	8.2	33.1	0.1	4.2		<	<	<	5.6	<	4.2
Jan-08	59,627	109	104	16.2	30.1	<	0.24	1-Jan	<	<	<	1.6	<	15.27
Feb-08	80,766	102	234	12.3	21.5	<	<	7-Feb	<	3.5	<	3.5	<	12.44
Mar-08	11412.9	100	x	17.9	24.6	<	0.18	6-Mar	<	<	<	1.6	<	15.67
Apr-08		65	x	12.8	25.8	0.06	0.22	3-Apr	<	114	<	1.1	<	9.28

* June 1 flow 168,742 June 15 flow 354,514

** July was steady flow with Average

*** October flow = avg 1st thru 11th

**** October flow = avg 12th thru 18th

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Ocean Sands WWTP Groundwater Monitoring Wells

Monitoring Well Lab Analysis – MW4									
	Fecal Coliform Colonies/100mL	TDS mg/L	pH	TOC mg/L	Chloride mg/L	Ammonia Nitrogen mg/L	Nitrate mg/L	TSS mg/L	VOC mg/L
Limit	1 col./100/mL	500 mg/L	6.5-8.5	10 mg/L	250 mg/L		10 mg/L		
13-Jul-94	<1	464	6.6	3.07	78	0.5	1.71		
10-Sep-94	<2	213	6.3	8	37	2.75	0.10		
1-Dec-94	<2	346	6.9	34.2	78	0.5	5.31	233	<10
2-Feb-95	<2	348	6.8	4.5	95	0.67	4.72	25.4	<0.5
13-Jul-95	<2	520	6.5	6.3	78	0.65	0.32	27	
1-Sep-95	<2	211	6.3	8	31	0.5	0.10	15	
14-Dec-95	<2	310	6.5	2.4	64	0.5	5.95	73	<0.5
8-Feb-96	<2	362	6.2	3.7	80	0.5	5.32	105	BDL
25-Jul-96	<2	378	6.1	6.1	44	0.5	9.10	127	
12-Sep-96	<2	328	6.1	20.4	6.8	0.73	9.00	72	
5-Dec-96	<2	388	6.5	5.31	77	0.5	0.60	41	BDL
6-Feb-97	<2	248	6.6	4.3	72	0.5	3.74	19	BDL
2-Jul-97	<1	321	6.7	4.49	79	0.03	7.72	106	
17-Sep-97	<1	417	6.7	4.67	84	0.03	2.94	50	
3-Dec-97	<1	409	6.4	8.36	94	0.03	6.47	115	BDL
18-Feb-98	<1	324	6.6	7.02	90	0.03	2.63	44	BDL
22-Jul-98	<1	464	7.5	6.9	128	0.2	0.94	17	
2-Sep-98	<1	544	6.2	9.2	84	0.11	1.40	54	
2-Dec-98	<1	600	6.6	4	158	0.1	9.10	190	<.5
3-Feb-99	<1	329	6.3	8.2	61	0.1	6.80	173	<.5
13-Jul-99		14	6.5	6.1		0.14	1.81		
14-Sep-99	<1	377	6.9	5	72	0.04	4.50		
7-Dec-99	<1	488	6.4	6.5	172	0.19	1.20		<1
8-Feb-00	<1	432	6.6	4.5	153	0.04	3.80		<1
26-Sep-00	<1	495		6.4	289	0.04	83.00		
19-Jul-01	5	554	6.8	16.35	231	0.1	4.57		
27-Sep-01	<1	605	7	5.39	210	0.1	0.29		
20-Dec-01	<1	527	7	6.52	21	0.1	5.90		
14-Feb-02	<1	465	6.8	5.06	155	0.1	4.90		
18-Jul-02	3	632	6.8	10.51	245	0.1	7.36		
12-Sep-02	<1	530	6.7	5.63	161	0.1	9.00		
5-Dec-02	<1	583	6.8	5.2	180	0.1	13.80		
6-Feb-03	<1	490	6.3	6.28	165	1	8.71		
3-Jul-03	<l	467	6.6	4.88	99.8	0.1	7.15		
11-Sep-03	<1	264	6.4	3.82	54.98	0.1	2.62		
4-Dec-03	<l	519	6.81	3.15	81.64	0.1	3.54		
5-Feb-04	<l	420	6.3	5.25	106	0.1	9.29		
1-Jul-04	<l	431	6.6	6.3	119	0.1	9.54		
16-Sep-04	<1	439		5.2	109	0.1	17.30		

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Ocean Sands WWTP Groundwater Monitoring Wells

Monitoring Well Lab Analysis – MW5									
	Fecal Coliform Colonies/100mL	TDS mg/L	pH	TOC mg/L	Chloride mg/L	Ammonia Nitrogen mg/L	Nitrate mg/L	TSS mg/L	VOC mg/L
Limit	1 col./100/mL	500 mg/L	6.5-8.5	10 mg/L	250 mg/L		10 mg/L		
13-Jul-94	<1	180	6.2	22.67	43	0.5	0.46		
10-Sep-94	<2	288	6.9	6	20	6.95	0.10		
1-Dec-94	<2	354	6.5	8.8	102	0.81	3.01	3.9	<10
2-Feb-95	<2	374	6.7	19.5	82	0.8	1.14	367	<0.5
13-Jul-95	<2	196	5.1	12.5	34	0.62	0.84	119	
1-Sep-95	<2	310	6.4	4.2	61	0.5	0.84	37	
14-Dec-95	<2	374	6.1	34.8	99	0.5	6.42	157	<0.5
8-Feb-96	<2	514	5.9	58.4	79	0.8	2.38	149	BDL
25-Jul-96	<2	206	4.8	11	20	0.5	0.62	88	
12-Sep-96	4	306	5.7	47.9	75	0.57	0.98	89	
5-Dec-96	<2	370	5.9	19.2	87	0.5	1.00	109	BDL
6-Feb-97	<2	230	6.6	31.5	68	0.73	0.84	306	BDL
2-Jul-97	<1	269	6	5.5	55	0.7	7.65	41	
17-Sep-97	<1	429	5.9	4.32	129	0.03	5.99	43	
3-Dec-97	30	404	6	20.64	98	0.03	3.15	139	BDL
18-Feb-98	<1	143	6.3	13.01	20	0.03	0.03	58	BDL
22-Jul-98	<1	454	6.8	4	15.4	0.1	32.00	74	
2-Sep-98	<1	556	5.8	9.5	128	0.1	13.00	40	
2-Dec-98	<1	430	6.4	8.7	120	0.14	0.51	267	<.5
3-Feb-99	<1	554	5.8	9.4	43	2.1	0.10	185	<.5
13-Jul-99		5.9	6.6	7.1		0.04	9.90		
14-Sep-99	<1	347	7.4	18	91	0.25	1.86		
7-Dec-99	<1	405	6	19.2	138	0.11	5.80		<1
8-Feb-00	<1	310	6.1	13.7	87	0.45	3.80		<1
26-Sep-00	<1	696		12.3	260	0.29	7.24		
19-Jul-01	<1	523	6.8	8.98	170	0.1	4.82		
27-Sep-01	<1	678	6.9	12.31	255	0.1	16.90		
20-Dec-01	<l	651	6.6	10.23	227	0.1	17.40		
14-Feb-02	<l	607	6.7	13.76	208	0.1	1.37		
18-Jul-02	<l	164	17.8	14.26	58.4	0.1	2.55		
12-Sep-02	<1	493	6.7	17.58	181	0.1	12.80		
5-Dec-02	<1	327	6.8	10.2	120	0.1	14.40		
6-Feb-03	<	395	6.4	28.28	135	1	0.80		
3-Jul-03	<	130	6.4	12.8	380	0.1	0.73		
11-Sep-03	<1	486	5.8	7.41	155	0.1	14.70		
4-Dec-03	<l	667	6.73	8.28	143	0.1	3.70		
5-Feb-04	<1	271	6.4	6.72	92	0.1	2.45		
1-Jul-04	<1	109	6.5	8.9	33	0.1	0.13		
16-Sep-04	<l	327		8.7	127	0.1	13.10		

ARCADIS

Ocean Sands WWTP Groundwater Monitoring Wells

Monitoring Well Lab Analysis – MW6									
	Fecal Coliform Colonies/100mL	TDS mg/L	pH	TOC mg/L	Chloride mg/L	Ammonia Nitrogen mg/L	Nitrate mg/L	TSS mg/L	VOC mg/L
Limit	1 col./100/mL	500 mg/L	6.5-8.5	10 mg/L	250 mg/L		10		
13-Jul-94	<1	280	6.3	17.31	40	0.5	7.62		
10-Sep-94	<2	68	6.9	4	100	0.5	0.10		
1-Dec-94	<2	424	6.6	1.8	119	0.5	7.40	78	<10
2-Feb-95	<2	404	6.7	4.5	98	0.5	11.94	14.4	<0.5
13-Jul-95	<2	396	6	4.5	48	0.56	0.10	25	
1-Sep-95	<2	281	6.1	7.8	0.01	1.0`	0.02	82	
14-Dec-95	<2	464	6.3	1	114	0.5	8.48	19	<0.5
8-Feb-96	<2	292	6.1	2.7	62	0.5	17.05	21	BDL
25-Jul-96	<2	287	5.7	3.2	73	0.5	9.82	26	
12-Sep-96	<2	284	5.9	18.5	120	0.5	4.90	49	
5-Dec-96	<2	466	6.2	4.3	116	0.5	4.00	13	BDL
6-Feb-97	<2	186	6.7	4.9	66	0.5	9.74	19	BDL
2-Jul-97	<1	333	6.5	3.08	65	0.03	21.63	14	
17-Sep-97	<1	534	6.6	6.41	149	0.03	1.39	28	
3-Dec-97	<1	503	6.4	6.49	153	0.03	14.68	31	BDL
18-Feb-98	<1	256	6.7	4.22	65	0.03	4.14	116	BDL
22-Jul-98	<1	517	7.9	4	127	0.1	13.00	2.4	
2-Sep-98	<1	352	6.2	4.6	157	0.1	14.00	28	
2-Dec-98	<1	590	6.6	5.9	182	0.1	0.31	280	<.5
3-Feb-99	<1	486	6.4	4.5	146	0.1	14.00	61	<.5
13-Jul-99		24	6.5	3.6		0.04	7.80		
14-Sep-99	<1	237	7.2	5.4	54	0.04	9.90		
7-Dec-99	<1	541	6.2	4.2	148	0.04	29.30		1.1
8-Feb-00	<1	365	6.5	4.1	211	0.25	20.90		<1
26-Sep-00	<1	719		5.2	304	0.32	24.36		
19-Jul-01	<1	625	6.6	18.44	244	0.1	4.95		
27-Sep-01	<1	599	6.8	5.26	227	0.1	17.20		
20-Dec-01	<1	701	7	4.69	234	0.1	21.40		
14-Feb-02	<1	695	6.7	4.29	222	0.1	23.70		
18-Jul-02	<1	654	6.6	10.52	217	0.1	7.20		
12-Sep-02	<1	623	6.7	5.19	253	0.1	17.10		
5-Dec-02	<l	392	6.8	4.8	135	0.1	0.31		
6-Feb-03	<1	327	6.4	4.78	95	1	7.71		
3-Jul-03	<1	347	6.73	3.04	60.6	0.1	10.60		
11-Sep-03	<1	720	6	5.07	190	0.1	3.07		
4-Dec-03	<1	1030	19.9	4.23	260	0.1	10.50		
5-Feb-04	<1	641	6.9	4.42	220	0.14	30.00		
1-Jul-04	<1	206	6.5	4.2	51	0.3	19.78		
16-Sep-04	<1	581		5.8	220	0.1	28.50		

ARCADIS

Ocean Sands WWTP Groundwater Monitoring Wells

Monitoring Well Lab Analysis – MW7									
	Fecal Coliform Colonies/100mL	TDS mg/L	pH	TOC mg/L	Chloride mg/L	Ammonia Nitrogen mg/L	Nitrate mg/L	TSS mg/L	VOC mg/L
Limit	1 col./100/mL	500 mg/L	6.5-8.5	10 mg/L	250 mg/L		10 mg/L		
13-Jul-94	<1	126	5.9	3.41	28	0.5	0.24		
10-Sep-94	<2	180	6.4	9	60	0.5	0.33		
1-Dec-94	<2	84	5.9	18.8	21	0.5	0.94	110	<10
2-Feb-95	<2	140	5.8	13.2	51	0.5	0.41	46	<0.5
13-Jul-95	<2	170	5.5	13.2	24	0.82	0.10	65	
1-Sep-95	<2	280	6.6	4.04	43	3.4	0.50	74	
14-Dec-95	<2	168	5.7	18.5	30	1.1	0.78	63	<0.5
8-Feb-96	<2	62	5.6	8.2	25	0.5	0.70	86	BDL
25-Jul-96	<2	136	5.1	10.4	16	1.46	0.31	38	
12-Sep-96	<2	114	5.3	32.3	18.5	3.27	0.20	29	
5-Dec-96	<2	202	5.9	23.2	13	1.12	0.42	147	BDL
6-Feb-97	<2	38	5.8	20.4	14	1.49	0.90	84	BDL
2-Jul-97	<1	132	6	11.16	25	0.72	4.87	31	
17-Sep-97	<1	223	6.6	0.5	10	1.93	2.68	37	
3-Dec-97	<1	152	6.1	24.58	12	1.71	0.02	717	BDL
18-Feb-98	<1	76	6.8	10.3	9	0.5	0.03	184	BDL
22-Jul-98	<1	368	7.5	6	79	0.91	0.20	12	
2-Sep-98	<1	388	5.8	8.4	17	1.1	0.05	13	
2-Dec-98	<1	180	6.4	7.4	13	1.1	0.05	154	<.5
3-Feb-99	<1	140	6.1	7.8	21	0.9	0.10	60	<.5
13-Jul-99		112	6.6	6.4		0.7	0.04		
14-Sep-99	<1	137	6.3	7	56	0.52	0.04		
7-Dec-99	<1	112	6	4.2	30	0.04	0.50		<1
8-Feb-00	<1	167	6	3.8	45	0.16	0.08		<1
26-Sep-00	<1	236		7.2	36	0.19	<.04		
19-Jul-01	<1	85	6.7	4.9	31.11	0.1	0.08		
27-Sep-01	<1	130	6.9	8.7	44.36	0.1	<0.03		
20-Dec-01	<l	151	7	14.36	41.49	0.1	0.10		
14-Feb-02	<1	106	6.8	3.2	49.23	0.1	0.35		
18-Jul-02	<1	109	6.6	7.89	22.3	0.5	<0.03		
12-Sep-02	4	157	6.7	5.85	41.7	0.1	0.28		
5-Dec-02	<l	100	6.8	8.9	45	1	0.07		
6-Feb-03	<l	<10	6.2	13.74	47.5	1	0.78		
3-Jul-03	<l	82	6.41	4.46	22.6	0.14	2.84		
11-Sep-03	<l	164	5.9	4.05	49.98	0.1	2.14		
4-Dec-03	<1	437	6.69	2.27	102	0.1	1.14		
5-Feb-04	<l	255	6.2	6.08	100	0.1	6.46		
1-Jul-04	<l	252	6.6	4.2	86	0.3	9.15		
16-Sep-04	<1	139		3.2	66	0.1	3.40		

ARCADIS

Ocean Sands WWTP Groundwater Monitoring Wells

Monitoring Well Lab Analysis – MW8									
	Fecal Coliform Colonies/100ml	TDS mg/L	pH	TOC mg/L	Chloride mg/L	Ammonia Nitrogen mg/L	Nitrate mg/L	TSS mg/L	VOC mg/L
Limit	1 col./100/mL	500	6.5-8.5	10 mg/L	250 mg/L		10 mg/L		
							NH3		
MW8									
13-Jul-94	<1	206	6.4	3.14	80	0.5	0.10		
10-Sep-94	<2	46	6.3	5	150	0.5	0.10		
1-Dec-94	<2	192	6.3	6	44	0.7	0.99	118	<10
2-Feb-95	<2	193	6.7	4.5	52	1.97	0.37	54	<0.5
13-Jul-95	<2	218	6.2	5.9	32	4.2	0.10	21	
1-Sep-95	<2	168	6.8	2.4	64	0.5	4.91	3.5	
14-Dec-95	<2	264	6.1	2.8	34.5	4.6	0.93	43	<0.5
8-Feb-96	<2	198	5.9	1.2	68	4.14	0.22	32	BDL
25-Jul-96	<2	328	5.9	4.1	59	3.41	0.76	25	
12-Sep-96	<2	301	5.9	18.7	75	5.2	0.15	28	
5-Dec-96	<2	288	6.2	3.73	76	0.53	1.15	14	BDL
6-Feb-97	<2	170	6	3.4	65	4.97	0.55	20	BDL
2-Jul-97	<1	255	6.5	3.12	65	2.04	0.27	31	
17-Sep-97	<1	303	6.8	0.5	79	1.6	0.58	41	
3-Dec-97	<1	330	6.3	8.05	86	0.22	0.06	31	BDL
18-Feb-98	<1	294	6.5	5.87	76	1.76	0.04	64	BDL
22-Jul-98	<1	7		6	74	0.98	0.35	21	
2-Sep-98	<1	374	6	6.3	76	1.4	0.08		
2-Dec-98	<1	300	6.7	4.6	71	0.3	1.50	40	<.5
3-Feb-99	<1	326	6.6	8.3	71	0.8	1.50	60	<.5
13-Jul-99		24	6.7	4.2		0.7	0.04		
14-Sep-99	<1	318	6.1	3.9	76	0.09	0.23		
7-Dec-99	<1	341	6.2	3.4	69	0.25	0.95		<1
8-Feb-00	<1	247	6.5	2.8	90	0.58	0.44		<1
26-Sep-00	<1	252		4.4	40	0.35	<.04		
19-Jul-01	<1	103	6.9	7.08	25.41	0.1	0.33		
27-Sep-01	<1	122	6.9	2.98	35.92	0.1	<0.03		
20-Dec-01	<1	173	7	4	47.62	0.1	0.50		
14-Feb-02	<1	204	6.7	2.5	77.09	0.1	0.42		
18-Jul-02	<1	154	6.7	8.5	27.8	0.62	<0.03		
12-Sep-02	<1	227	6.7	3.04	44.5	0.1	0.15		
5-Dec-02	<1	477	6.8	3.9	175	0.1	0.95		
6-Feb-03	<1	<10	7.1	3.02	75	1	0.69		
3-Jul-03	<l	176	7.1	3	85.5	0.1	0.38		
11-Sep-03	<1	161	6.1	3.84	125	0.1	0.88		
4-Dec-03	<1	124	6.83	56.25	33.3	0.62	<0.03		
5-Feb-04	<1	199	7.1	5.02	46	0.1	4.71		
1-Jul-04	<1	304	6.6	4.8	74	0.1	8.50		
16-Sep-04	<1	75		3	21	<.08	<.1		

ARCADIS

Ocean Sands WWTP Groundwater Monitoring Wells

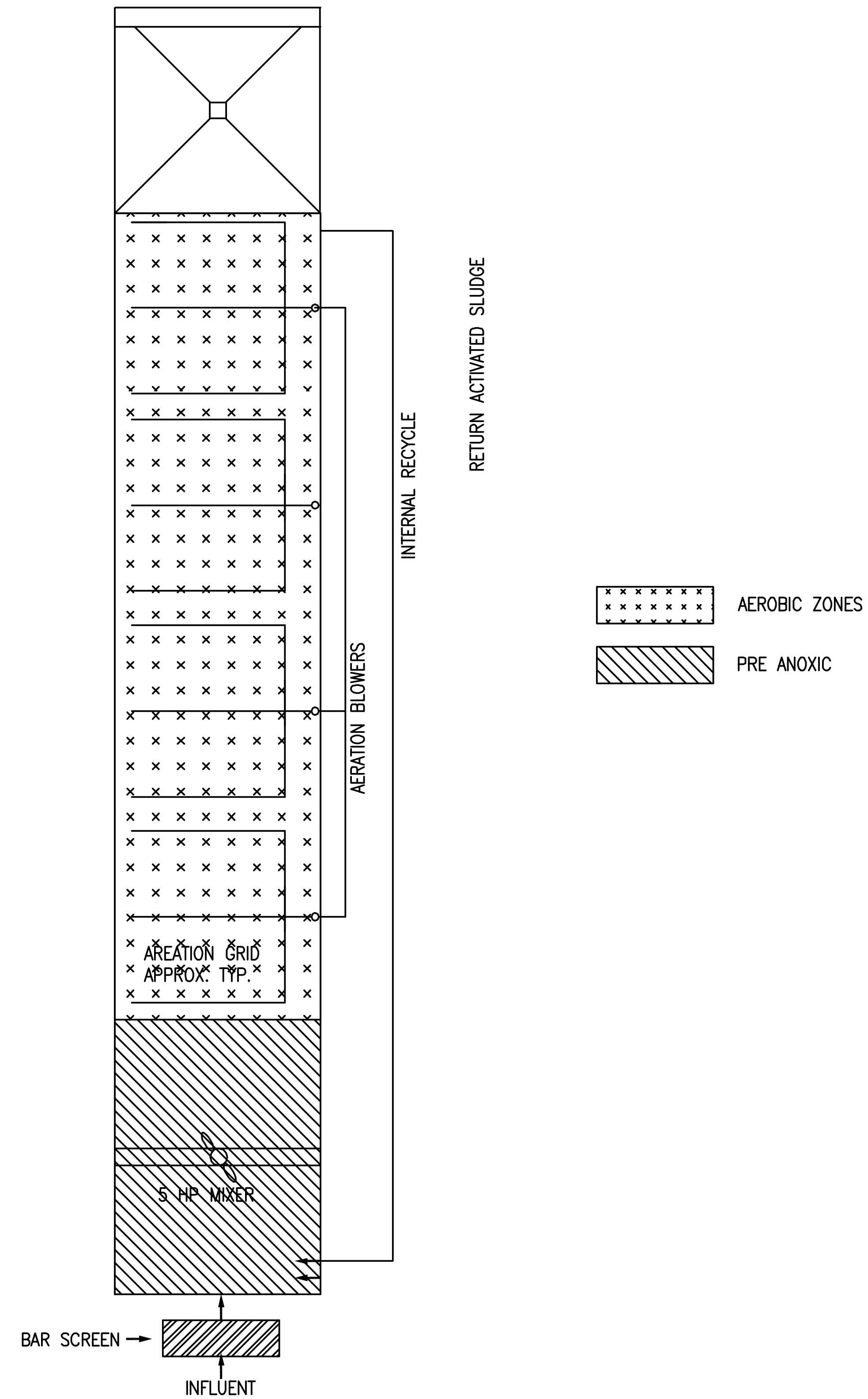
MONITORING WELL LAB ANALYSIS – SW1, SW2, SW3									
	SW1			SW2			SW3		
	FECAL	AMMONIA	NITRATE	FECAL	AMMONIA	NITRATE	FECAL	AMMONIA	NITRATE
	COLIFORM	NH3	NO3	COLIFORM	NH3	NO3	COLIFORM	NH3	NO3
Date	1		10MGL	1		10MGL	1		10MGL
2/10/1999	2	<.1	6.90	<1	<.1	4.50	<1	<.1	5.70
3/3/1999	<1	<.1	0.05	<1	<.1	0.05	<1	<.1	0.05
4/14/1999	10	0.03	0.25	7	0.03	0.04	15	0.03	0.11
4/21/1999	490	0.03	0.08	12	0.03	0.08	7	0.03	0.03
5/5/1999	1	0.03	0.03	1	0.03	0.03	22	0.03	0.03
5/19/1999	1	0.03	0.03	1	0.03	0.03	57	0.03	0.03
6/2/1999	50	0.03	0.03	28	0.03	0.03	140	0.03	0.18
6/9/1999	210	0.03	0.03	65	0.03	0.04	1100	0.03	0.03
7/21/1999	1	0.03	1.94	14	0.03	0.54	2	0.03	1.74
7/22/1999	30	0.18	0.04	7	0.05	0.47	11	0.04	0.04
8/10/1999	1	0.41	0.12	1	0.04	0.66	4	0.35	0.04
8/17/1999	1	0.16	0.04	3	0.04	0.78	1	0.04	0.04
9/14/1999	32	0.11	0.15	50	0.05	0.10	67	0.04	0.04
9/28/1999	44	0.04	0.83	75	0.04	0.66	83	0.04	0.21
10/05/00	660	0.04	0.04	73	0.04	0.09	49	0.04	0.04
10/12/00	6000	0.04	0.04	80	0.04	0.04	77	0.15	0.04
11/2/2000	57	0.12	0.08	48	0.19	0.04	19	0.04	0.04
12/7/2000	41	0.25	0.95	49	0.04	0.04	104	0.04	0.04
1/11/2000	18	0.04	0.04	23	0.04	0.04	26	0.04	0.04
2/1/2000	6	0.04	0.04	21	0.04	0.04	9	0.04	0.04
2/8/2000	1	0.04	0.04	1	0.04	0.04	1	0.04	0.04
3/7/2000	4	0.04	0.04	8	0.04	0.04	<1	0.04	0.04
4/4/2000	21	0.04	0.04	370	0.04	0.04	340	0.04	0.04
4/11/2000	10	0.04	0.04	96	0.04	0.04	7	0.04	0.04
5/2/2000	1	0.04	0.04	320	0.04	0.04	220	0.04	0.04
5/9/2000	79	0.04	0.04	18	0.04	0.04	18	0.04	0.04
6/6/2000	17	0.15	0.04	26	0.04	0.47	9	0.04	0.36
6/13/2000	44	0.04	0.04	26	0.04	0.04	24	0.04	0.04
7/18/2000	370	0.04	0.12	200	0.04	0.64	>6000	0.04	0.69
7/25/2000	24	0.34	0.59	18	0.04	0.7	17	0.04	0.68
8/14/2000	24	0.04	0.05	9	0.04	0.35	9	0.04	0.31
8/21/2000	31	0.04	0.11	28	0.04	0.46	32	0.04	0.28
9/13/2000	14	0.04	0.04	44	0.04	0.04	189	0.04	0.04
9/26/2000	52	0.18	0.04	61	0.13	0.04	19	0.04	0.04
10/3/2000	16	<.04	0.11	22	<0.04	<0.04	13	<0.04	<0.14
10/10/2000	6	<0.04	<0.04	148	0.05	0.25	36	<0.04	0.24
11/16/2000	4	<0.04	<0.04	16	<0.04	<0.04	16	<0.04	<0.04
1/18/2001	8	<0.04	<0.04	<2	<0.04	<0.04	12	<0.04	<0.04
2/15/2001	76	<0.04	<0.04	>6000	<0.04	<0.04	18	<0.04	<0.04
3/8/2001	2	<0.04	0.13	10	<0.04	0.06	4	<0.04	<0.04
4/10/2001	2	<0.04	<0.04	600	<0.04	<0.04	1200	<0.04	<0.04

4/24/2001	2	<0.04	<0.04	1620	<0.04	<0.04	10	<0.04	<0.04
5/2/2001	<1	<0.04	<0.04	320	<0.04	<0.04	220	<0.04	<0.04
5/9/2001	79	<0.04	<0.04	18	<0.04	<0.04	18	<0.04	<0.04
6/5/2001	44	<0.04	<0.04	44	<0.04	<0.04	48	<0.04	<0.04
6/12/2001	290	<0.04	<0.04	22	<0.04	0.18	24	<0.04	0.17
7/19/2001	55	<0.04	<0.04	10	<0.04	1.2	10	<0.04	0.86
7/24/2001	30	<0.04	0.25	6	<0.04	1.06	15	<0.04	0.98
8/9/2001	190	<0.1	<0.3	>600	<0.1	0.51	9	<0.1	0.5
8/21/2001	32	<0.1	1.34	6	<0.1	2.5	19	0.28	3.84
9/6/2001	21	<0.1	0.2	20	<0.1	0.33	13	<0.1	0.13
9/27/2001	3	<0.1	0.42	2	<0.1	<0.03	1	<0.1	<0.03
10/4/2001	20	<0.1	0.13	1	<0.1	0.57	2	<0.1	0.76
10/11/2001	3	<0.1	0.06	2	<0.1	0.48	1	<0.1	<.03
11/1/2001	42	<0.1	<0.03	47	<0.1	0.35	<1	<0.1	0.08
12/20/2001	22	<0.1	0.06	15	<0.1	0.22	<1	<0.1	0.06
1/10/2002	22	<0.1	0.59	2	<0.1	0.84	<1	0.25	0.22
2/14/2002	<1	<0.1	<0.01	<1	<0.1	0.17	<1	<0.1	0.06
3/7/2002	<1	<0.1	<0.03	<1	<0.1	0.07	5	<0.1	<0.03
4/11/2002	4	<0.1	0.09	8	<0.1	0.1	<1	<0.1	<0.03
4/18/2002	110	<0.1	0.03	5	<0.1	0.11	1	<0.1	0.16
5/2/2002	16	<0.1	<0.03	10	<0.1	0.62	360	<0.1	0.15
5/9/2002	12	<0.1	<0.03	4	<0.1	<0.03	<1	<0.1	<0.03
6/6/2002	100	0.14	<0.03	70	<0.1	<0.03	7	<0.1	<0.03
6/13/2002	160	<0.1	0.05	1300	<0.1	<0.03	5	<0.1	<0.03
7/11/2002	60	<0.1	0.51	100	<0.1	0.82	48	<0.1	0.7
7/18/2002	27	<0.1	<0.03	51	<0.1	0.68	15	0.28	<0.03
8/1/2002	42	<0.1	0.01	57	<0.1	0.32	17	<0.1	0.36
8/8/2002	180	0.28	0.06	38	<0.1	0.43	4	<0.1	<0.03
9/5/2002	100	<0.1	1.33	63	<0.1	<0.03	150	<0.1	0.22
9/12/2002	70	1.28	0.86	90	1.01	0.1	30	1.15	0.4
10/3/2002	12	<0.1	0.12	23	<0.1	0.2	1	<0.1	0.15
10/10/2002	8	<0.1	0.11	42	<0.1	0.14	2	<0.1	<.03
11/7/2002	10	<0.1	<0.03	63	<0.1	0.31	60	<0.1	0.16
12/3/2002	230	<0.1	<0.03	60	<0.1	0.95	30	<0.1	<0.03
1/10/2003	17	<0.1	<0.03	7	<0.1	0.11	100	<0.1	<0.03
2/6/2003	16	<0.03	<0.1	10	0.07	<0.1	14	0.04	<0.1
3/13/2003	39	<0.1	<0.03	<1	<0.1	0.15	56	<0.1	<0.03
4/4/2003	3	<0.1	0.04	41	<0.1	0.1	1	<0.1	<0.03
4/11/2003	160	<0.1	0.11	390	<0.1	0.19	410	<0.1	0.05
5/2/2003	11	<0.1	<0.03	31	<0.1	<0.03	220	<0.1	<0.03
5/9/2003	47	<0.1	<0.03	130	<0.01	0.1	23	<0.1	<0.03
6/5/2003	28	<0.1	<0.03	33	<0.1	0.03	22	<0.1	<0.03
6/12/2003	58	<0.1	<0.03	76	<0.1	<0.03	26	<0.1	<0.03
7/17/2003	<1	<0.1	0.04	82	<0.1	0.06	<1	<0.1	0.03
7/24/2003	<1	<0.1	0.06	8	<0.1	0.03	25	<0.1	0.08
8/14/2003	<1	<0.1	0.05	36	<0.1	0.08	20	<0.1	0.03
8/28/2003	15	<0.1	<0.03	40	<0.1	<0.03	28	<0.1	<0.03
9/4/2003	12	<0.1	<0.03	32	<0.1	0.34	35	<0.1	<0.03
9/11/2003	14	0.05	<0.03	130	<0.03	1.47	60	0.2	0.03
10/2/2003	9	<0.1	0.44	28	<0.1	3.02	36	<0.1	0.03
10/9/2003	9	<0.1	<0.3	46	<0.1	0.25	4	<0.1	0.05
11/13/2003	56	0.09	3.19	90	0.02	2.07	90	0.03	1.15

ARCADIS

12/5/2003	38	27	0.14	23	0.25	0.88	2	<.1	<.03
1/9/2004	39	0.31	<.03	63	<.1	1.06	21	<.1	0.38
2/6/2004	4	<0.1	0.09	14	<0.1	0.39	8	<0.1	<0.03
3/5/2004	7	0.11	0.22	20	0.25	0.24	19	<0.1	0.66
4/9/2004	210	0.17	0.09	28	0.17	0.82	13	<0.1	0.34
4/16/2004	500	0.25	0.18	220	<0.1	0.46	370	<0.1	0.64
5/7/2004	120	<0.1	<0.03	155	<0.1	1.09	26	<0.1	26
5/14/04	84	0.2	0.03	105	0.17	0.24	25	0.2	0.1
6/5/04	360	0.2	<0.03	5	0.2	0.07	2	<0.1	0.06
6/11/2004	114	0.2	0.04	81	0.58	<0.03	49	<0.1	0.05
7/2/2004	65	0.1	<0.3	440	<0.1	0.79	210	<0.1	0.03
7/9/2004	90	<0.1	0.12	210	0.2	0.63	220	0.2	0.72
8/6/2004	1300	0.2	<.1	280	0.2	0.14	520	<.1	<.1
8/13/2004	340	<.1	0.14	60	<.1	0.42	<1	<.1	<.1
9/10/2004		<.1	<.1		<.1	0.4		<.1	0.6
9/17/2004	190	<.1	0.1	2900	<.1	1.2	70	<.1	0.7
9/23/2004	8600			2000			8500		

50,000 GPD TREATMENT UNIT



2 W-2 MLE MODIFICATIONS
NOT TO SCALE

KEYNOTES:

1. 400 GPM NITRATE RECYCLE PUMP
2. MIXER FOR ANOXIC ZONE
3. ALKALINTY ADDITION POINTS
4. CARBON METHANOL FEED

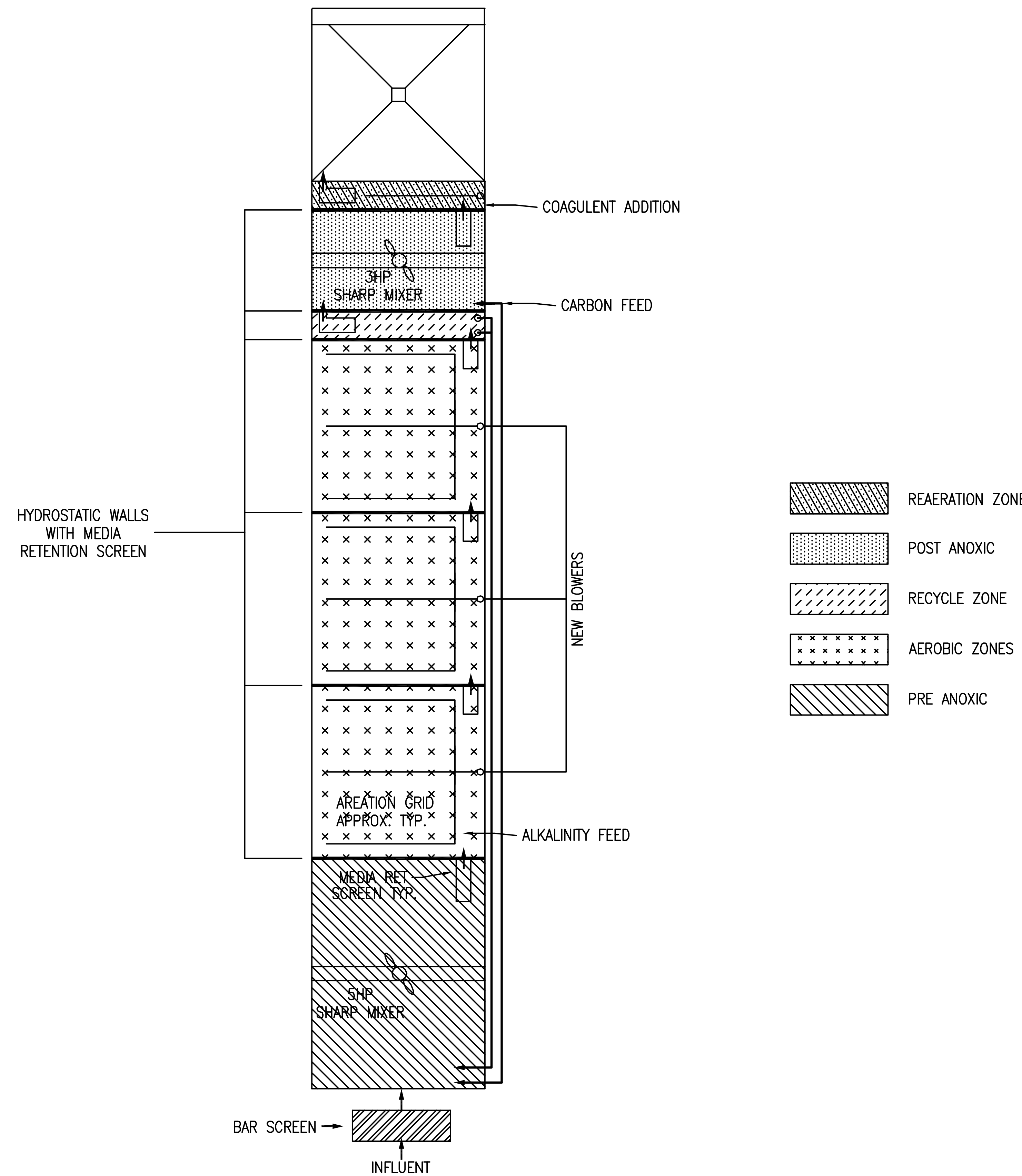
NO.	DATE	REVISION DESCRIPTION	BY / CKD

MLE PROPOSED PROCESS MODIFICATIONS OCEAN SANDS WASTEWATER TREATMENT PLANT

ARCADIS
801 Corporate Center Drive, Suite 300
Raleigh, NC 27607-5073
Tel: 919/854-1282 Fax: 919/854-5448

PROJECT MANAGER: D. BRILEY	DEPARTMENT MANAGER: R. WYCHE
LEAD DESIGN PROF.: A. GHORPADE	CHECKED: W. WHEELER
DRAWN: D. SARAMOSING	DATE: 01-18-08
PROJECT NUMBER: NCCURR01	DRAWING NUMBER: W-2

50,000 GPD TREATMENT UNIT



3 W-3 MBBR MODIFICATIONS
NOT TO SCALE

NO.	DATE	REVISION DESCRIPTION	BY / CKD

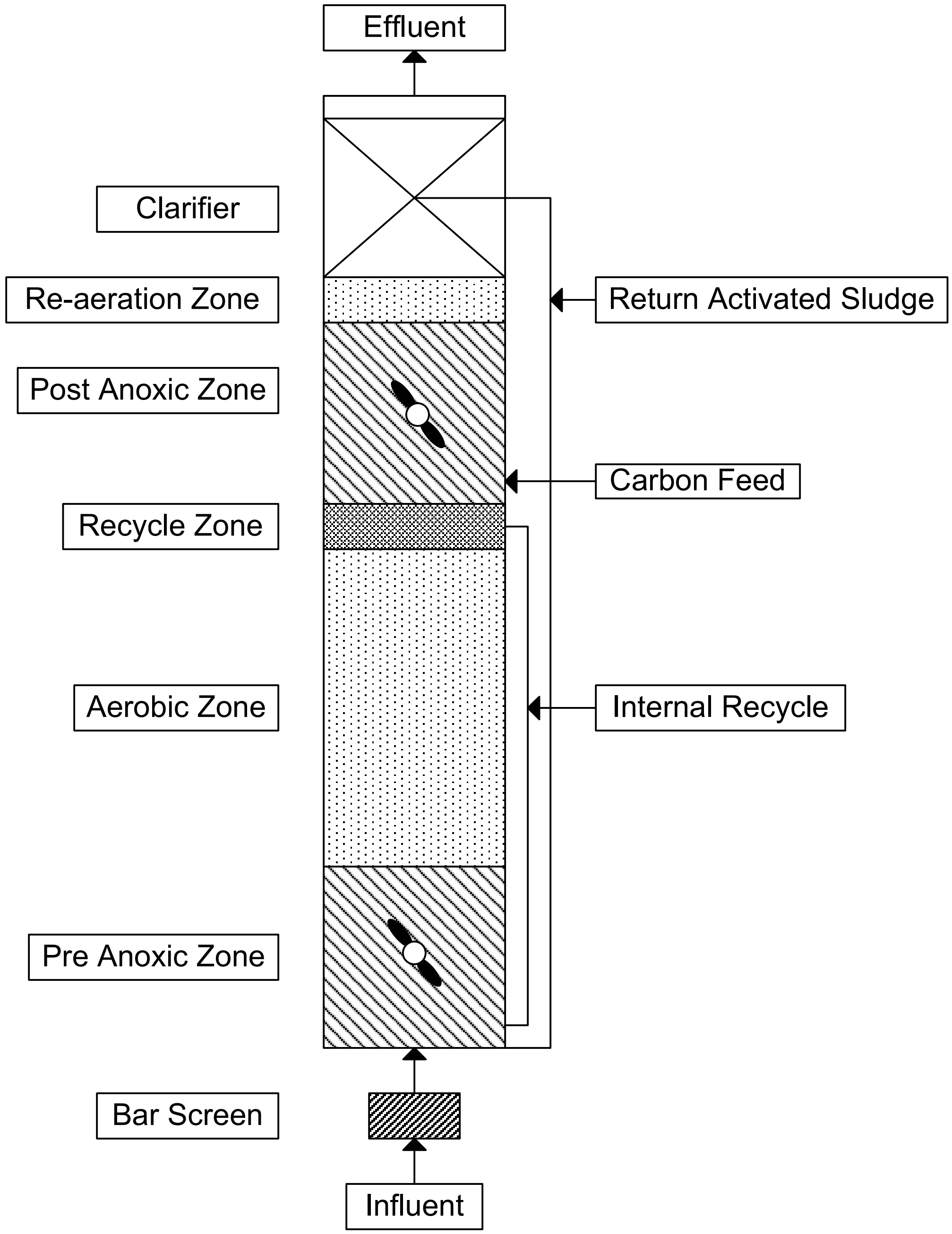
MBRR PROPOSED
PROCESS MODIFICATIONS
OCEAN SANDS
WASTEWATER TREATMENT PLANT

ARCADIS

801 Corporate Center Drive, Suite 300
Raleigh, NC 27607-5073
Tel: 919/854-1282 Fax: 919/854-5448

PROJECT MANAGER D. BRILEY	DEPARTMENT MANAGER R. WYCHE
LEAD DESIGN PROF. A. GHORPADE	CHECKED W. WHEELER
DRAWN D. SARAMOSING	DATE 01-18-08
PROJECT NUMBER NCCURR01	DRAWING NUMBER W-3

50,000 GPD Enhanced MLE Treatment Unit



MLE

Wastewater Characteristics	
Constituent	Concentration
BOD (mg/L)	308.75
COD (mg/L)	671.1956522
bCOD (mg/L)	494
nbCOD	177.1956522
sCOD	333.9978261
TSS (mg/L)	309
TKN (mg/L)	40

Estimated COD = BOD/.45

Ne 5.966019

Design Conditions		
Parameter	Unit	Value
Flowrate	m3/d	189
Temperature	•C	12
MLSS	mg/L	3000
MLVSS	mg/L	2400
Volume	m3	189

Kinetic Coefficients Hetertrophic Bacteria (20• C)			
Coefficient	Unit	Typical Value	• Values
•m	g VSS/ g VSS*d	6	1.07
Ks	g bCOD/m3	20	1
Y	v VSS/g bCOD	0.4	-
kd	g VSS/ g VSS*d	0.12	1.04
fd	Unitless	0.15	-

Kinetic Coefficients Nitrification (20• C)			
Coefficient	Unit	Typical Value	• Values
•mn	g VSS/ g VSS*d	0.75	1.07
Kn	g NH4-N/m3	0.74	1.053
Yn	g VSS/ g NH4-N	0.12	-
kdn	v VSS/ g VSS*d	0.08	1.04
K0	g/m3	0.5	-

Design

Temperature Conversions	
Temperature (•C)	12
$\bullet_m$	3.492054627
k_d	0.087682825
$\bullet_{mn}$	0.436506828
K_n	0.489558675
k_{dn}	0.058455216

Define Basin Volumes	
Anoxic V (m^3)	37.8
Aerobic V (m^3)	151.2

Assume Recycle Values	
X_R (mg/L)	6000
Q_{RAS} (m^3/d)	189
Q_{IR} (m^3/d)	756

Assume MLSS Concentration	
MLSS (mg/L)	3000

Determine Aerobic SRT		SOLVER	Diff
Aerobic Solids (kg)	453.6	453.6	0.0
Aerobic SRT (d)	4.869518702		

Composition of MLSS & MLVSS	
Daily Biomass Production (kg)	30.86573662
Daily Wasting (kg/d)	6.338560032
N Used for Synthesis (kg/d)	3.703888394
NO_X (mg/L)	35.79611161
Mass Biomass (kg VSS)	257.9835597
Mass Nitrifiers (kg VSS)	3.077375817

Summary Table	
MLSS (mg/L)	3000
MLVSS (mg/L)	2250
Nitrifiers (mg/L)	15.26476099
Biomass (mg/L)	1279.680355

Nitrification

Nitrification Rates		
Previous Flow (m^3/d)	945	
Influent (m^3/d)	189	
Total Flow (m^3/d)	1134	
Nitrification Rate (g/d)	5995.74	
NH4-N (mg/L)	4.072604209	
Rn	5995.742898	
Rn	5995.742898	0.00

Denitrification

Nitrate Removal Capacity	
F/M Ratio	6.031779707
SDNR	0.3
SDNR (10• C)	0.244310633
NO_3-N Removed (g/d)	11817.77376

Nitrate Mass Balance		SOLVER	Diff
Total NO_3-N to Pass (g/d)	9703.384764	10.27	0.00
Anoxic Revoval Capacity (g/d)	11817.77376		
NO_3-N Produced (g/d)	5995.74		
Effluent NO_3-N (g/d)	3881.35		

		Required Capacity (g/d)	Required Active Cell + 25% (m3)
NO3-N (mg/L)	10.27	1940.7	4.4
NH4-N	4.07	769.7	2.4

Enhanced MLE

Wastewater Characteristics		
Constituent	Concentration	
BOD (mg/L)	308.75	
COD (mg/L)	671.1956522	Estimated COD = BOD/.45
bCOD (mg/L)	494	
nbCOD	177.1956522	
sCOD	333.9978261	
TSS (mg/L)	309	
TKN (mg/L)	100	Ne 15.91331

Design Conditions		
Parameter	Unit	Value
Flowrate	m3/d	189
Temperature	•C	12
MLSS	mg/L	3000
MLVSS	mg/L	2250
Volume	m3	189

Kinetic Coefficients Hetertrophic Bacteria (20• C)			
Coefficient	Unit	Typical Value	• Values
•m	g VSS/ g VSS*d	6	1.07
Ks	g bCOD/m3	20	1
Y	v VSS/g bCOD	0.4	-
kd	g VSS/ g VSS*d	0.12	1.04
fd	Unitless	0.15	-

Kinetic Coefficients Nitrification (20• C)			
Coefficient	Unit	Typical Value	• Values
•mn	g VSS/ g VSS*d	0.75	1.07
Kn	g NH4-N/m3	0.74	1.053
Yn	g VSS/ g NH4-N	0.12	-
kdn	v VSS/ g VSS*d	0.08	1.04
K0	g/m3	0.5	-

Kinetic Coefficients Denitrification (10• C)		
Coefficient	Unit	Typical Value
•mn	g VSS/ g VSS*d	0.52
K	g NH4-N/m3	3.1
Y	g VSS/ g NH4-N	0.17
kd	v VSS/ g VSS*d	0.04
Ks	g/m3	12.6

Design

Temperature Conversions	
Temperature (•C)	12
$•_m$	3.492054627
k_d	0.087682825
$•_{mn}$	0.436506828
K_n	0.489558675
k_{dn}	0.058455216

Define Basin Volumes	
Anoxic V (m^3)	30.24
Aerobic V (m^3)	120.96

Assume Recycle Values	
X_R (mg/L)	6000
Q_{RAS} (m^3/d)	189
O_{IR} (m^3/d)	756

Assume MLSS Concentration	
MLSS (mg/L)	3000

Determine Aerobic SRT		Diff
Aerobic Solids (kg)	362.88	0.0
Aerobic Solids (kg)	362.88	
Aerobic SRT (d)	3.348657613	

Composition of MLSS & MLVSS	
Daily Biomass Production (kg)	33.50095863
Daily Wasting (kg/d)	10.004295
N Used for Synthesis (kg/d)	4.020115035
NO_X (mg/L)	95.47988496
Mass Biomass (kg VSS)	195.6977806
Mass Nitrifiers (kg VSS)	6.064382166

Summary Table	
MLSS (mg/L)	3000
MLVSS (mg/L)	2250
Nitrifiers (mg/L)	37.60157593
Biomass (mg/L)	1213.403897

Nitrification

Nitrification Rates		
Previous Flow (m^3/d)	945	
Influent (m^3/d)	189	
Total Flow (m^3/d)	1134	
Nitrification Rate (g/d)	12997.50	
NH_4-N (mg/L)	26.71007012	
Rn (Mass Balance)	12997.49501	
Rn (Growth)	12997.49501	0.00

Denitrification

Nitrate Removal Capacity	
F/M Ratio	1.590309298
SDNR	0.22
SDNR (12• C)	0.179161131
NO_3-N Removed (g/d)	6574.019182

Nitrate Mass Balance		SOLVER	Diff
Total NO_3-N to Pass (g/d)	15114.95165	18.99	0.00
Anoxic Revoval Capacity (g/d)	6574.019182		
NO_3-N Produced (g/d)	12997.50		
Effluent NO_3-N (g/d)	21538.43		

	NO3-N	NH_3-N
Effluent Concentration (mg/L)	18.99	26.71
Required Removal (g/d)	3589.737912	5048.20
Required Dispersed Media (m3)	12.756709	11.41610867
Recommended Dispersed Media (m3)	0.0	14.3

Secondary Denitrification

Define Basin Volume	
Anoxic V (m^3)	20.34

Nitrite to Denitrify	
NO3-N Reduced (mg/L)	45.70

Carbon Dosing	
Methanol (mg/L)	137.11
Methanol (gal/d)	8.77
F/M Ratio	0.18
SDNR	0.07
SDNR (12• C)	0.057005814
NO_3-N Removed (g/d)	1406.939711

Effluent Nitrate	
Total NO_3-N to Pass (g/d)	8637.941164
Anoxic Revoval Capacity (g/d)	1406.939711
Effluent NO_3-N (g/d)	7231.00

	NO3-N
Effluent Concnetration (mg/L)	19.13
Required Removal (g/d)	5423.25
Required Dipersed Media (m3)	7.9
Recommended Dispersed Media (m3)	9.9