PREPARED FOR
MIAMI-DADE COUNTY
WATER AND SEWER
DEPARTMENT

Biscayne Bay Coastal Wetlands Rehydration Pilot Project

PILOT PLANT CLOSEOUT REPORT | SEPTEMBER 2011

MWH

BUILDING A BETTER WORLD

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Section 1
Introduction

1.1 INTRODUCTION

Miami-Dade Water and Sewer Department (MDWASD), was tasked with implementing the Biscayne Bay Coastal Wetlands Rehydration Project (BBCWRP) to determine its feasibility for enhancing or restoring estuarine ecosystems. The BBCWRP forms part of the South Florida Water Management District (SFWMD) Water Use Permit (WUP) No. RE-ISSUE 13-00017-W limiting condition 43.

The purpose of the BBCWRP is to evaluate the potential effects of rehydrating the Biscayne Bay Coastal Wetlands with highly treated reclaimed water. This would involve evaluating options for treating secondary effluent from the South District Wastewater Treatment Plant (SDWWTP) to produce reclaimed water and investigate potential impacts to the ecosystem. The feasibility of the BBCWRP would be determined by MDWASD in consideration and coordination with the project stakeholders formed by SFWMD, Florida Department of Environmental Protection (FDEP) and Biscayne National Park (BNP). Important milestones undertaken were development of a pilot testing program including the design and implementation of a pilot treatment plant. Following the pilot testing program including results of toxicity studies, it is anticipated that the parties shall define and agree on the water quality criteria required and the feasibility of this project.

1.2 PROJECT BACKGROUND

The MDWASD tasked MWH Americas, Inc. (MWH) with engineering services for the planning, design, construction oversight, and operation of an advanced wastewater treatment pilot plant and the evaluation of the achieved water quality. This pilot plant is also referred as Biscayne Bay Coastal Wetlands Rehydration Pilot Plant (BBCWRPP).

Completed milestones through the end of operations of the pilot plant include:

- Technical Memorandum 1 - Water Quality Evaluation, May 2009
- Technical Memorandum 2 – Process Technology Assessment, May 2009
- Technical Memorandum 3 – Preliminary Engineering Report Rev1 June 2010
- Pilot Plant Testing and Water Quality Monitoring – August 2010
- Pilot Design, Permitting, Construction and Startup – October 2010
- Pilot Plant Operations, Sampling and Laboratory Tests – November 1, 2010 through April 7, 2011

The pilot plant processes were designed and constructed for providing water quality data prior and after treatment for comparison to proposed water quality targets defined in technical memorandum 1 and for establishing trends and variations. The pilot was anticipated to contain three process treatment trains A, B, and C described in Section 2. These treatment trains were intended to provide highly treated water for laboratory testing of parameters listed in the monitoring plan and for aquatic toxicity tests to be performed by Florida International

University. The resulting water quality data is intended to be part of supporting data for MDWASD and its Stakeholder to determine the feasibility of the BBCWRP.

The pilot plant initiated its official operations on November 1, 2010, after the startup and training process of approximately three weeks. The operations and monitoring of the pilot plant were continued through April 7, 2011. Water samples were collected and analyzed for Trains A and C during the time of operation.

The original project design called for 12 months operation for the pilot plant; however, initial water quality results after 5 months of operation, in combination with revenue constraints within MDWASD budget, caused pilot plant operations to cease after 5 months.

The data generated substantiated the need for reverse osmosis (RO) as part of a treatment system to reclaim wastewater in the event that water quality requirements call for low numerical nutrient removal as proposed in Class III/ Outstanding Florida Water (OFW) standards. The need for RO represents an important verification from earlier studies that were part of the Comprehensive Everglades Restoration Program (CERP). This data would be useful in future alternative analyses that may be undertaken to achieve the objective of coastal wetlands rehydration, should funding for full scale implementation becomes available. This pilot close out report is intended to provide a summary of water qualities achieved based on operational criteria throughout the five month period of operations.

Section 2
Configuration and Water Quality Targets

2.1 PROCESS CONFIGURATION

As a result of a technology evaluation, along with a comprehensive literature and process review, a number of treatment processes were identified as viable for pilot testing. The additional treatment, also referred as tertiary treatment, of the SDWWTP secondary effluent was designed to further reduce concentrations of biochemical oxygen demand (BOD_5), total suspended solids (TSS), total nitrogen (TN), total phosphorus (TP), emerging contaminants and microconstituents.

The pilot plant was designed to receive un-chlorinated secondary clarifier effluent to produce highly treated effluent water at a design flow of 25 gallons per minute. A process flow diagram (PFD) and process and instrumentation diagrams (P&IDs) were prepared to illustrate the process configuration of the pilot plant. The PFD is shown in **Figure 2-1** illustrating the main line process train and the bypass trains.

Secondary effluent from the SDWWTP was obtained from the secondary clarifier effluent channels and pumped to an equalization tank at the pilot site. This effluent was then pumped through the MBR system, which performed nitrification/denitrification, chemical phosphorus removal, and microfiltration/ultrafiltration (MF/UF). Depending on the treatment train being tested, the MBR permeate was pumped directly through the advanced oxidation process (AOP) for Train A or through the RO and AOP processes for Train C. Samples were taken throughout the process trains to assist in the evaluation of the treatment processes.

2.2 INSTALLATION, STARTUP, AND DECOMMISSIONING

The pilot plant was installed within the SDWWTP. MDWASD staff made available the conveyance of the secondary effluent to the pilot site, as well as the installation of service connections for power, potable water and other ancillary requirements. Vendors for the different treatment units provided installation, startup and training requirements for proper operation of their systems. Pall Corporation was the vendor providing the membrane bioreactor (MBR) system. The Advanced Oxidation Processes (AOP) was provided by Trojan Technologies (UV/peroxide reactor) and APTWater (Ozone/peroxide also known as HiPOx). MDWASD provided the RO unit, which was rehabilitated and reconfigured for this project. **Figure 2-2** shows the pilot site after installation was completed.

The BBCWRPP startup was initiated by "seeding" the membrane bioreactor (MBR) pilot unit with nitrified mixed liquor from Marathon, FL MBR package plant. After seeding the system, the MBR pilot unit was operated for three consecutive weeks required to achieve the steady state of the bioreactor and to determine optimum chemical dosing rates.

The BBCWRPP was operated for five months through April 8, 2011. Decommissioning activities were initiated on April 11, 2011 concluding with the vendors removing the corresponding treatment units on April 28, 2011. MDWASD disconnected and removed services and other features as required for closure of the permit filed with the Building Department. Inventory of instruments, equipment and remaining chemicals was taken, and property belonging to MDWASD was turned over.

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Figure 2-1 BBCWRPP Process Flow Diagram

SAMPLE POINTS:

- SP 1 Membrane Bioreactor (MBR) Influent
- SP Ae MBR Aeration Tank
- SP Ax MBR Anoxic Tank
- SP Mem MBR Membrane Tank
- SP 2 MBR Permeate
- SP 3 Reverse Osmosis (RO) Permeate
- SP 4 Advanced Oxidation Process (AOP) - UV/H2O2 Effluent
- SP 5 Advanced Oxidation Process (AOP) - O3/H2O2 Effluent

PROCESS UNITS:

A *Equalization Tank* Ensures that pilot plant receives constant flow from SDWWTP secondary clarifiers.

B *Screening* Preserves integrity of the membranes by removing debris, making it an important preliminary treatment step.

C *Nitrification Tank (Aeration Tank)* Single sludge two-step activated sludge process that converts ammonia to nitrite and then to nitrate under aerobic conditions.

D *Post Anoxic Tank (Anoxic Tank)* Unaerated tank to promote biological denitrification – the conversion of nitrate to nitrogen gas. A carbon source (MicroCg™) is added to augment the denitrification process. Polyaluminum Chloride (PACl) is added to promote the transformation of soluble phosphorus to a particulate form.

E *Membrane Bioreactor (MBR) Tank* Membranes are submerged in the mixed liquor. Coarse bubble aeration controls membrane fouling by scouring mixed liquor solids cake from the membrane surface.

F *Return Activated Sludge (RAS)* This line moves concentrated mixed liquor from the membrane tank back to the start of the biological process, to maintain a sufficient concentration of activated sludge in the aeration tank so that the required degree of treatment can be attained.

G *Waste Activated Sludge (WAS)* The SRT of the biological process is controlled by the waste sludge rate.

H *Advanced Oxidation Process (AOP) – UV/H_2O_2* A type of AOP that is used to oxidize complex organic constituents found in wastewater that are difficult to degrade biologically. This process includes hydrogen peroxide (H_2O_2) injection and mixing followed by UV light.

I *Advanced Oxidation Process (AOP) – O_3/H_2O_2* A type of AOP that is used to oxidize complex organic constituents found in wastewater that are difficult to degrade biologically. This process involves the injection of and mixing of H_2O_2 followed by the injection of ozone (O_3).

J *Cartridge Filter* A cartridge filter is included to protect the membranes from damage, and is used to remove any solids that remain in the MBR effluent, similar to the screening process for the biological process.

K *Reverse Osmosis (RO)* RO is a pressure-driven and diffusion controlled membrane process, and is used to remove dissolved constituents from wastewater remaining after advanced treatment.

L *RO Concentrate* The concentrate is the wastestream of constituents that are removed from the feed water during the RO process. The concentrate volume typically ranges from 15% to 25%, and mostly made of Na^+ and Cl^- ions with substantial amounts of divalent ions.

M *RO Permeate* is then sent to the AOPs for the further oxidation treatment. RO is used when testing experimental trains C and B.

N *Stabilization Tanks* will stabilize the treated effluent, prior to discharge.

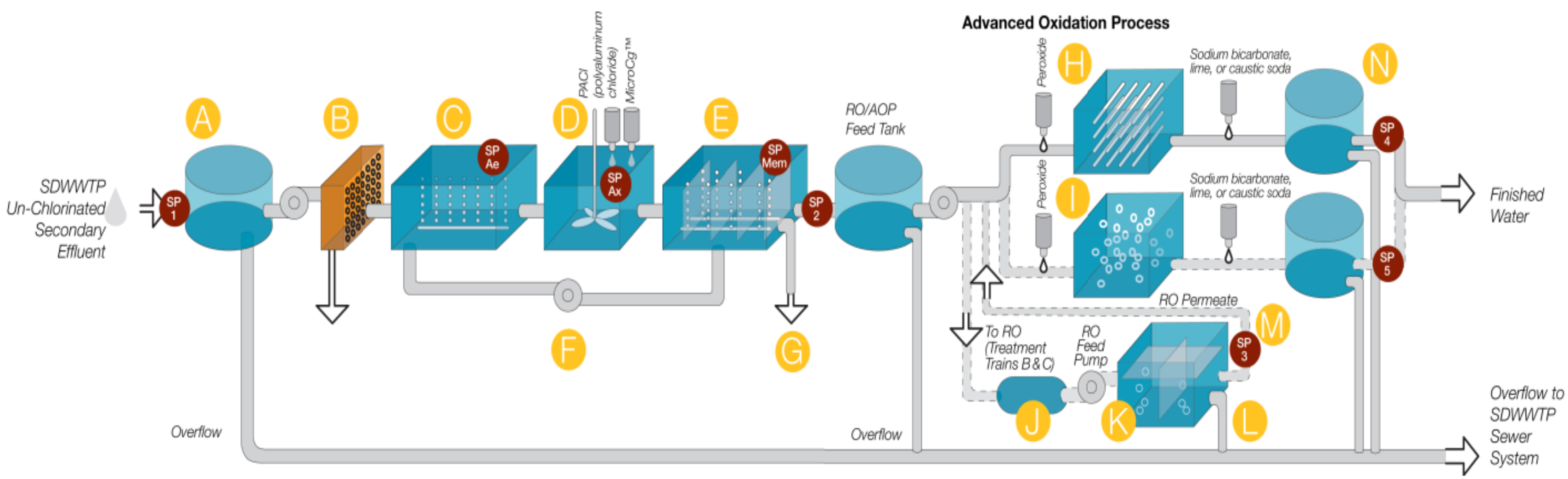

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Figure 2-2 BBCWRP Pilot

2.3 EXPERIMENTAL TRAINS

The pilot plant treatment trains sampled and tested during the five month operations were Trains A and Train C. Train B was not tested. Train A was comprised of a MBR sequential process for nitrification, denitrification, chemical addition for phosphorus removal and microfiltration/ ultrafiltration (within the MBR system) followed by the AOP side streams of UV/Peroxide and Ozone/Peroxide as shown in **Figure 2-3**. Train B included the MBR sequential process for nitrification, denitrification, and microfiltration/ultrafiltration followed by RO and the AOP side streams as shown in **Figure 2-4**. Train C included the MBR system as described for Train A, followed by the RO unit and the AOP side streams as shown in **Figure 2-5**.

Figure 2-3 Train A – Process Configuration

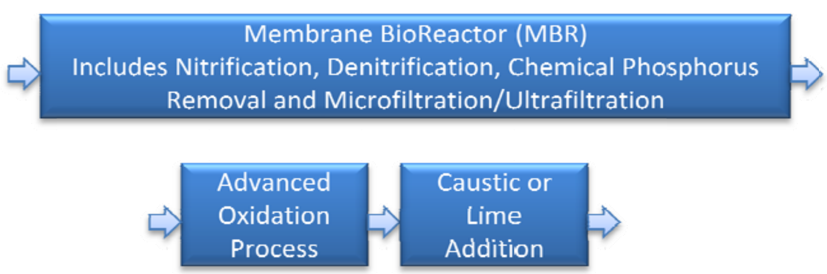


Figure 2-4 Train B – Proposed Process Configuration

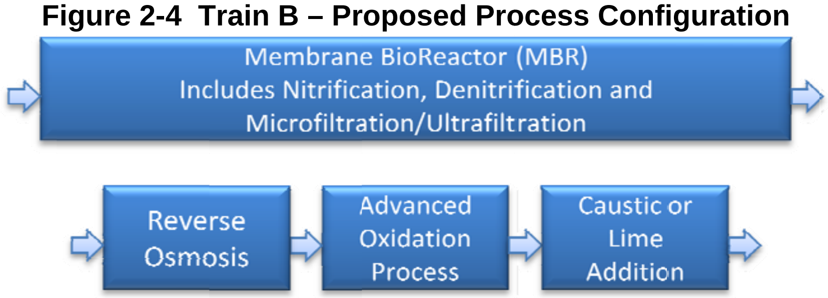
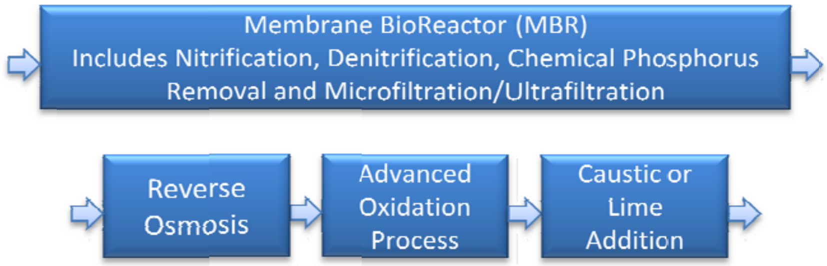


Figure 2-5 Train C – Process Configuration



2.4 WATER QUALITY TARGET

Water quality targets were based on four primary regulatory guidelines for effluent water quality. These regulatory guidelines were used as the baseline for the evaluation of water quality achieved by the pilot plant and further toxicity tests and studies:

1. Reuse Water Quality – dictated by Chapter 62-610, FAC for the irrigation of landscaped areas, edible crops, golf courses and parks.

2. Wetlands Application Standards – dictated by Chapter 62-611, FAC which vary depending on the type of wetlands or site specific limitations of receiving waters; these variations dictate the loading and application rates.

3. Miami-Dade County Code – dictated by Miami-Dade County Code Article III 24-42 which regulates environmental issues within Miami-Dade County, including groundwater and surface water quality.

4. Class III/ Outstanding Florida Water (OFW) – requires that discharges must not degrade the ambient water quality at the discharge site.

Water quality targets are proposed to, coincide with the Wetlands Application Standards (Chapter 62-611, FAC), and previously proposed Class III/OFW (Chapter 62-302, FAC), respectively. It was anticipated that results from the ecological tests tasked to FIU would ultimately provide the supporting data for Stakeholders and MDWASD to define the final water quality targets; however, these test were not completed due to the project budgetary restrictions.

Table 2-1 provides the parameters and the targeted water quality used for evaluating the results of this pilot project.

Table 2-1
BBCWRPP Treated Water Targets for Data Evaluation

Parameter	**Units**	**Reuse / Wetlands Application**[1]	**Class III / OFW**
TSS	mg/L	5	3.5
$CBOD_5$	mg/L	5	N/A
Total Nitrogen as N	mg/L	3	0.27
Total Phosphorous as P	mg/L	1	0.005
Fecal Coliform	#/100 ml	<1.0	<1.0
Total Ammonia as N	mg/L	2[1]	0.02 – 0.05[2]
Nitrate/Nitrite as N	mg/L	N/A	0.01
TKN	mg/L	N/A	0.22
Ortho-Phosphate as P	mg/L	N/A	0.002
Dissolved Oxygen	mg/L	N/A	5.0 – 7.3
Turbidity	NTU	N/A	0.5
Salinity	mg/L	N/A	Note 3
pH range	SU	N/A	6.5-7.5
Microconstituents	ng/L	N/A	Note 4
Cryptosporidium and Giardia	Note 5	N/A	Note 4

1. Effluent requirements are based on annual average conditions except for Ammonia as N which is based on monthly averages. Numerical nutrient criteria for reuse and wetland application would depend on site specific location of wetland application.
2. Treated water targets would depend on the method of sample collection and analysis.
3. Background salinity shall not change by more than 5 parts per thousand.
4. There are no established numerical criteria or anti-degradation data.
5. Reporting units for Cryptosporidium is ocysts/L and for Giardia is cysts/L.

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Section 3
Operational Performance

3.1 MEMBRANE BIOREACTOR SYSTEM

The MBR pilot system was operated for a period of approximately 4,500 hours as part of Train A and Train C. **Table 3-1** presents the operational parameters for the MBR system. The target gross membrane flux was 14.3 gallons per square foot per day (gfd), although the system was operated between 11 to 15 gfd depending on the operational conditions at the site. The system was operated at a target solid retention time (SRT) of 16 days, total hydraulic retention time (HRT) of 5.3 hours and the anoxic volume constituted 28% of the total volume. The specific air demand for the membrane system was calculated at 12 scfm/1000 ft^2 of membrane area.

Table 3-1
Operational Parameters for the MBR Pilot System

Parameter	Value
Manufacturer	Pall
Model	Aria MBR
Bioreactor	
SRT (days)	16
Active tank volumes	
Aerobic	4,130
Anoxic	2,550
Membrane	2,500
HRT, total (hours)	5.3
Aerobic MLSS (mg/L)	8,000
Process air (scfm)	30 - 50
Membrane scouring air (scfm)	40
Membrane Filtration	
Active membrane area (ft^2)	3,228
Gross filtrate flow-rate (gpm)	32
Length of filtration cycle (minutes)	9
Length of relaxation cycle (seconds)	60
Length of backwash cycle (seconds)	0
Net filtrate flow-rate (gpm)	28.8
Gross membrane flux (gfd)	14.3
Feed water recovery (%)	90

Figure 3-1 presents the trans-membrane pressure (TMP) and temperature, whereas **Figure 3-2** presents the membrane flux and temperature corrected specific flux for the MBR system. During the start-up, the system was operated at a flux of 11.2 gfd for the first 270 hours of operation. Following that, the flux was increased to 14.2 gfd and was maintained at that rate for most of the study period. The maintenance cleanings, also referred to enhanced flux maintenance (EFM), on the membranes were scheduled to occur on a weekly basis or if the TMP

exceeded 7 pounds per square inch (psi), whichever occurred first. As shown in **Figure 3-1**, the TMP for the pilot system varied from 2.2 to 8.7 psi during the study period and the weekly maintenance cleanings combined with quarterly clean-in-place (CIP) recovery cleanings were effective in controlling the TMP of the system. The temperature corrected specific flux (membrane permeability) varied from 5.4 to 1.7 gfd/psi but was mostly below 4.0 gfd/psi for the period of operations. **Attachment A** contains the Monthly Operational Reports and Water Quality and Operational Data for the MBR system collected throughout the life of the pilot.

Figure 3-1 Trans-membrane Pressure and Temperature for the MBR Pilot System.

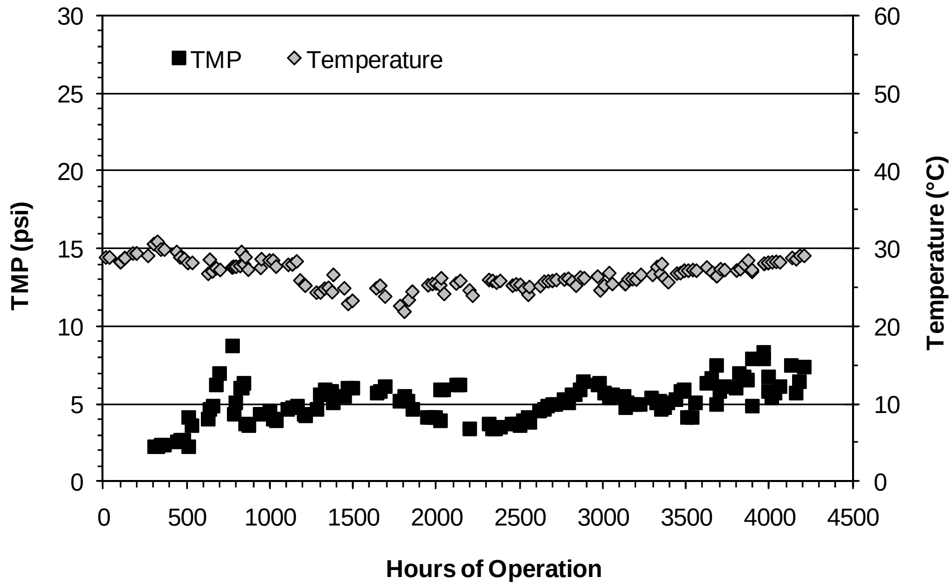
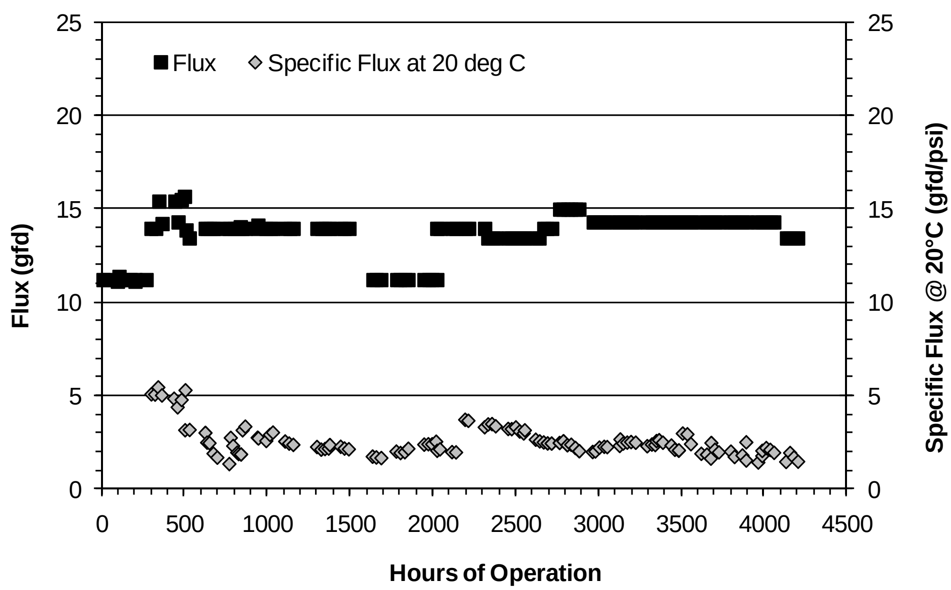


Figure 3-2 Flux and Temperature Corrected Specific Flux of the MBR Pilot System



3.2 REVERSE OSMOSIS SYSTEM

The RO pilot system was operated intermittently based on project needs to collect samples for Train C. The operational parameters for the RO system are presented in **Table 3-2**. The system was operated as a two-stage system with total feed water recovery of 75%. The pilot system consisted of five vessels, each of which contained seven RO membrane elements. Anti-scalant (at a dose of 3 mg/L) was added to the MBR effluent before being fed to the RO system. Concentrate from Stage 1 (three vessels) was fed to the second stage (two vessels) and combined permeate (from Stage 1 and Stage 2) was utilized as a feed to the advanced oxidation pilot systems.

Figure 3-3 presents the net operating pressure and temperature, whereas **Figure 3-4** presents the flux and the temperature corrected specific flux for the RO system. The net operating pressure for the RO system varied from 74 to 141 psi during the study period. While operating at the target flux, the net operating pressure stayed between 96 to 103 psi, which is typical of RO systems operating on municipal wastewater. The temperature corrected specific flux for the RO system was observed to be fairly stable at 0.08 gfd/psi throughout the study period. **Attachment A** contains the Monthly Operational Reports and Water Quality and Operational Data for the RO system collected throughout the life of the pilot.

Table 3-2 Operational Parameters for the RO System

Parameter	Value
Manufacturer	Dow
Model	FilmTec
Total number of RO vessels	5
Number of elements per vessel	7
Number of elements in first stage	21
Number of elements in second stage	14
Membrane area per element (ft^2)	78
Total membrane area (ft^2)	2730
Array	3:2
1st Stage permeate flux (gfd)	12.5
Total system recovery (%)	75

Figure 3-3 Net Operating Pressure and Temperature for the RO System

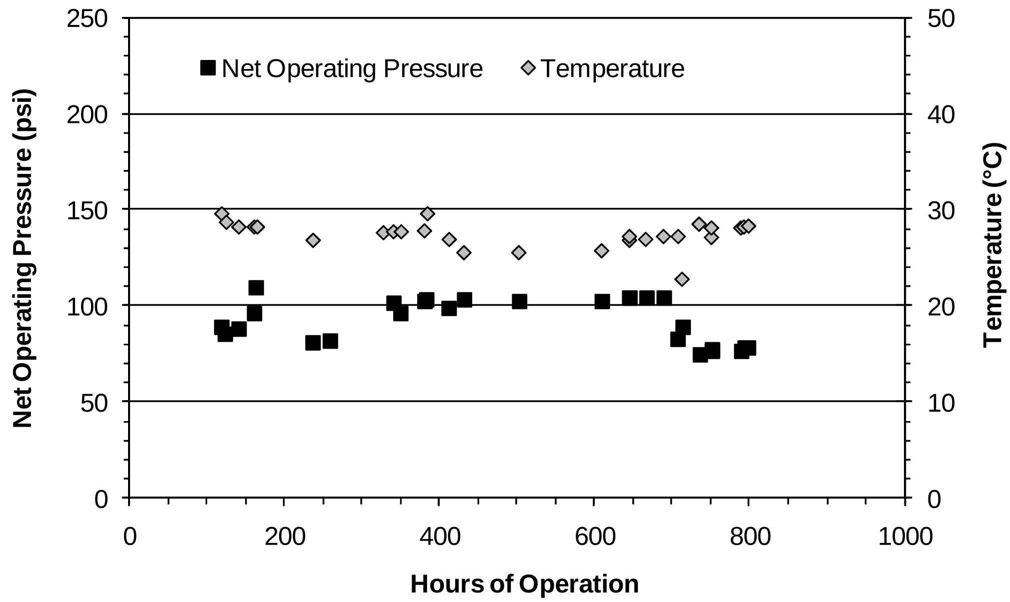
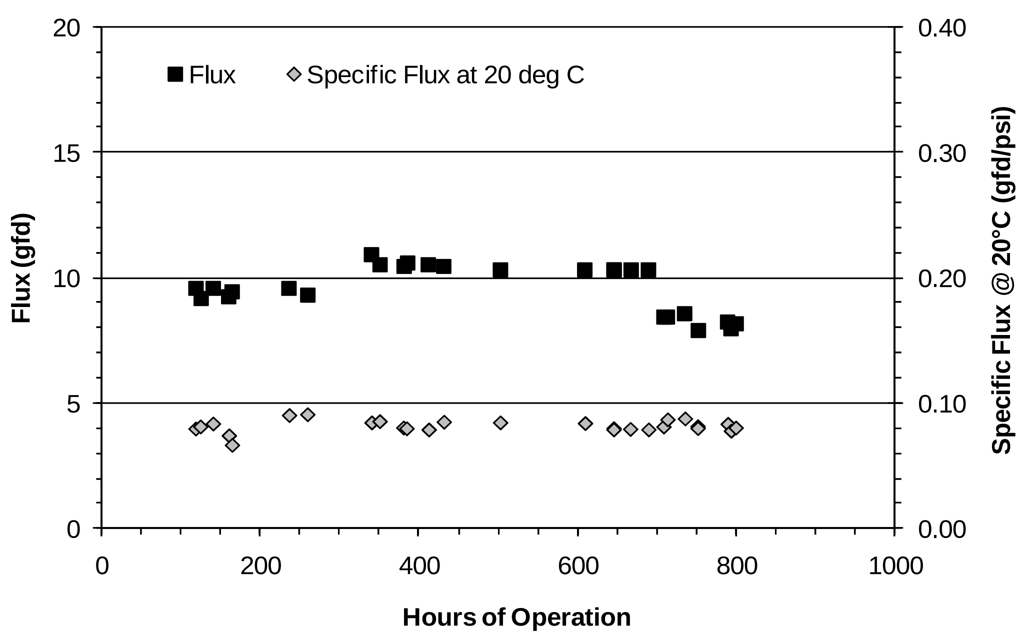


Figure 3-4 Flux and Temperature Corrected Specific Flux of the RO System



Section 4
Water Quality Results

4.1 CONCENTRATION BALANCE

A design concentration balance of the proposed treatment process was developed based on the secondary effluent characteristics of the SDWWTP and on typical removal rates evaluated as part of this project. **Table 4-1** provides anticipated concentration balance for nutrient removal based on SDWWTP effluent quality historical averages per grab samples from 2004-2008. The actual treatment performance for each process as result of this study is presented in further sections.

Table 4-1
Pilot Plant – Concentration Balance at Feed Flow and Projected Nutrient Removal

Treatment Process	Ammonia (NH_3-N) (mg/L)	Nitrate/Nitrite (NO_x-N) (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
SDWWTP Secondary Effluent (2004-2008)	25	0.75	27	2.7
MBR System				
Designed with Chem-P Removal	0.5	0.5	3	0.07
Designed without Chem-P Removal	0.5	0.5	3	<1
Designed Reverse Osmosis	0.05	0.02	0.3 – 0.15	0.005
Designed Advanced Oxidation Process (anticipates no further nutrient removal)	-	-	-	-

4.2 PILOT INFLUENT WATER QUALITY

Pilot influent water was piped directly from the SDWWTP Secondary Effluent. Water Quality of this source is presented in **Table 4-2**.

Table 4-2
SDWWTP Secondary Effluent Water Quality

Parameter	Unit	Number of Samples	Median Concentration ± Standard Deviation
cBOD	mg/L	83	4 ± 1
TSS	mg/L	78	5 ± 2
NH3	mg/L - N	99	29 ± 7
NO3	mg/L - N	95	0.1 ± 1.4
TP	mg/L - P	100	2.8 ± 1.3
Alkalinity	mg/L as CaCO3	33	247 ± 35
pH	-	90	6.7 ± 0.3

4.3 NUTRIENT REMOVAL

Nutrient removal of ammonia, nitrate, and total phosphorus occurred due to MBR and RO processes. As it was anticipated, the AOP systems, UV/H2O2 and O3/H2O2, did not provide additional nutrient removal thus results for only MBR and RO systems are presented in this section. Water quality results that coincided with mechanical and/or electrical failure of critical pilot equipment, such as chemical feed pumps, blowers, or power failure, were considered as "outlier" results, as a statistical value that is outside other values in a set of data, and they were not included in determining removal performance. For instance, failure of chemical dosing pump for the carbon source (MicroCg) would impact nitrate removal.

4.3.1 MBR Nutrient Removal Results

Ammonia was consistently reduced by the MBR system throughout the time frame of the pilot operations. MBR effluent ammonia concentrations ranged from 0.01 to 0.068 mg/L-N when outliers were removed. Median ammonia results out of the MBR were 0.011 mg/L–N while median influent concentrations were 29 mg/L-N. **Figure 4-1** presents influent and effluent ammonia concentrations in and out of the MBR system throughout the course of pilot operations. The few spikes of ammonia concentrations can be attributed to mechanical and power failures of the air blowers, resulting in lower than desired dissolved oxygen concentrations in the aeration tank, thus resulting in incomplete nitrification.

Figure 4-1 Ammonia Removal by MBR System

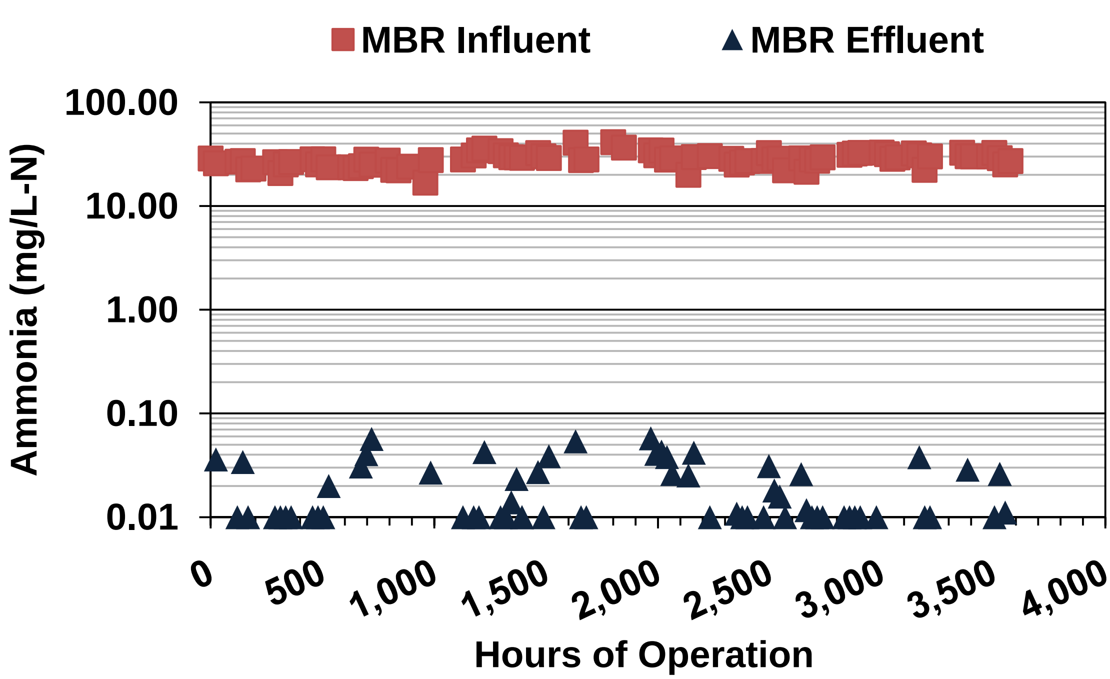


Figure 4-2 presents MBR influent ammonia concentrations versus MBR effluent nitrate concentrations. MBR effluent nitrate concentrations during the time span of the pilot operations ranged from 0.02 to 6.2 mg/L-N while the median nitrate concentration was 0.1 mg/L-N when outliers are removed. Several spikes did occur, however, between 1,000 and 1,500 hours as well as between 2,000 and 3,000 hours of operations. These spikes are attributed to insufficient MicroCg dosing that occurred during those periods. Other operational and maintenance upsets did occur, however, more stable operations where MBR effluent nitrate concentrations remained consistently below 1 mg/L-N occurred after 3,000 hours of operation. **Figure 4-3** illustrates this stability of operations after 3,000 hours with the exception of only one minor spike which occurred at 3,216 hours.

Figure 4-2 Nitrate Removal by MBR System

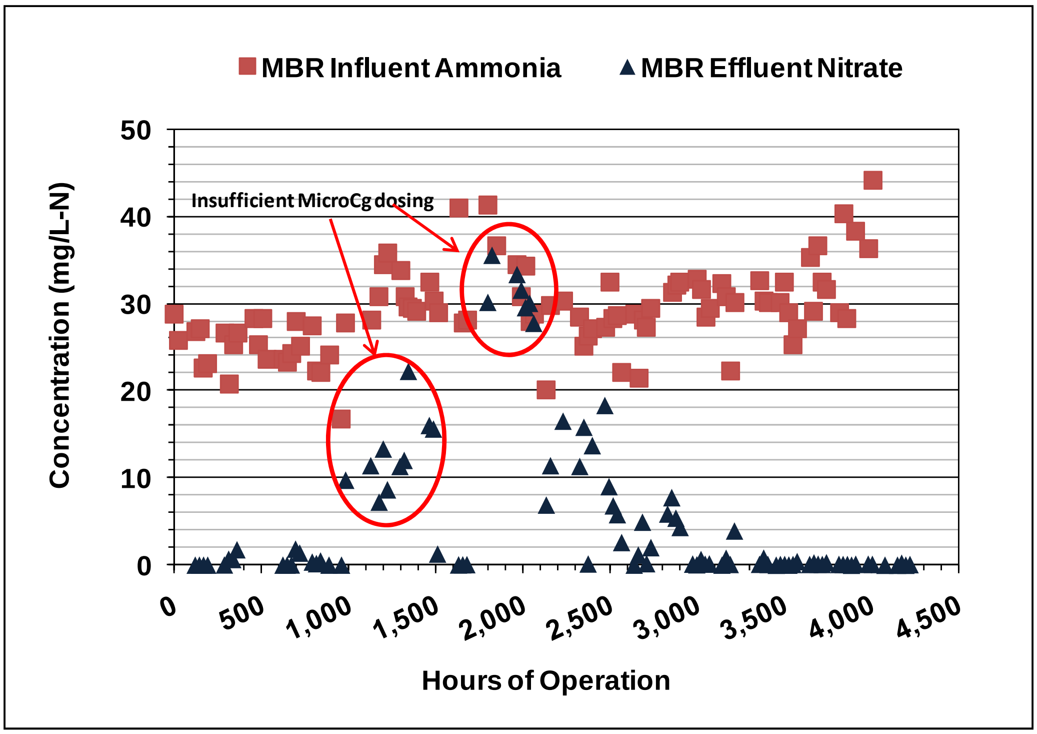
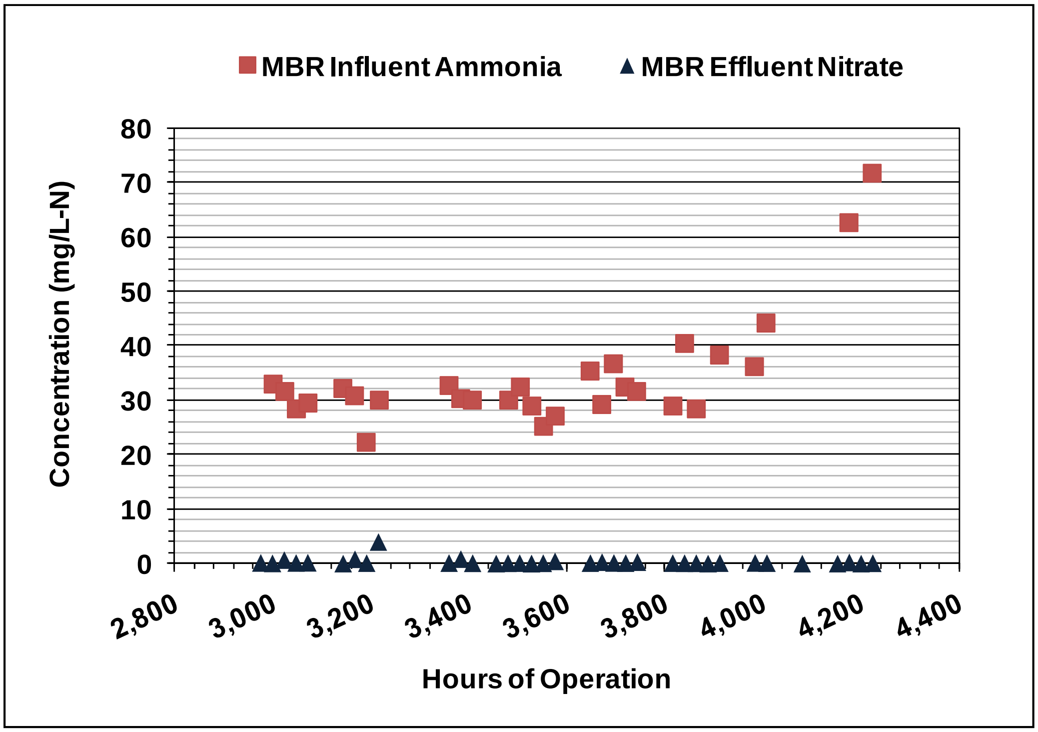


Figure 4-3 Nitrate Removal by MBR System After 3,000 Hours



Phosphorus removal was obtained by MBR treatment with majority of samples occurring below the reuse/wetlands application goal of 1 mg/L-P. MBR effluent total phosphorus concentrations ranged from 0.01 to 13.1 mg/L-P with the median concentration of 0.09 mg/L-P when outliers were removed. Few spikes occurred over the course of the pilot study; however, these spikes were attributed to insufficient dosing of Poly-aluminum Chloride (PACl). Overall phosphorous results for MBR influent and effluent are presented in **Figure 4-4.** More consistent operations were achieved after 3,000 hours of operations and **Figure 4-5** illustrates influent and effluent concentrations on a logarithmic scale over this period.

Figure 4-4 Phosphorus Removal by MBR System

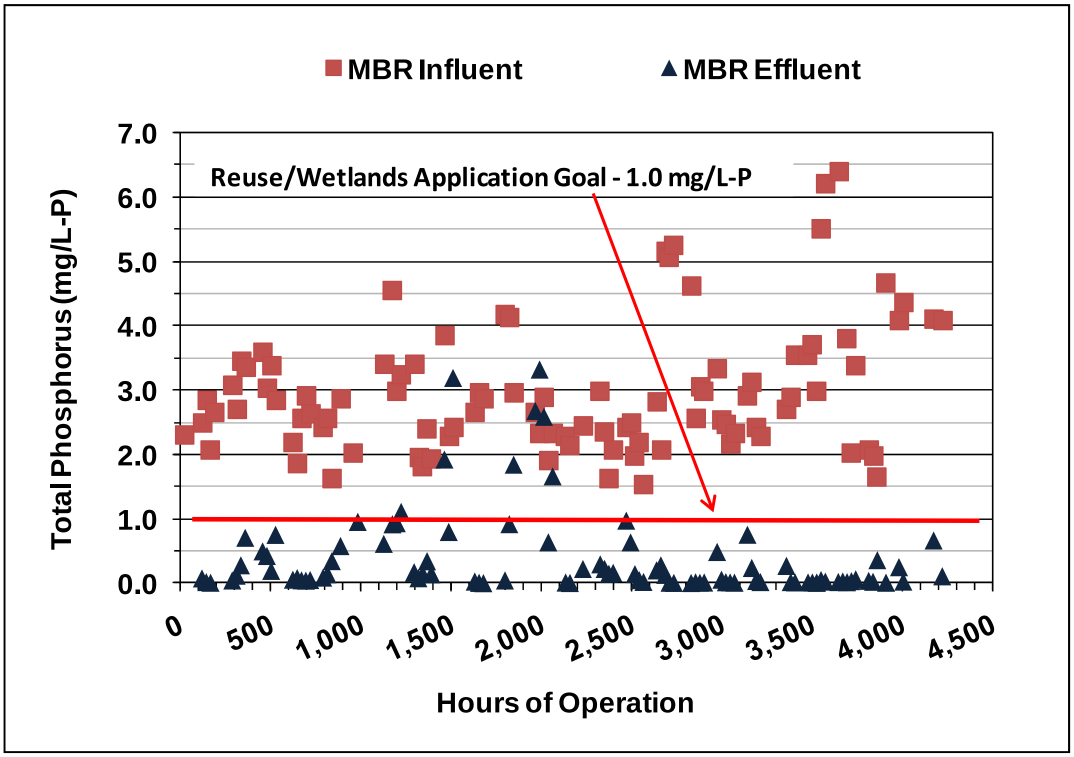
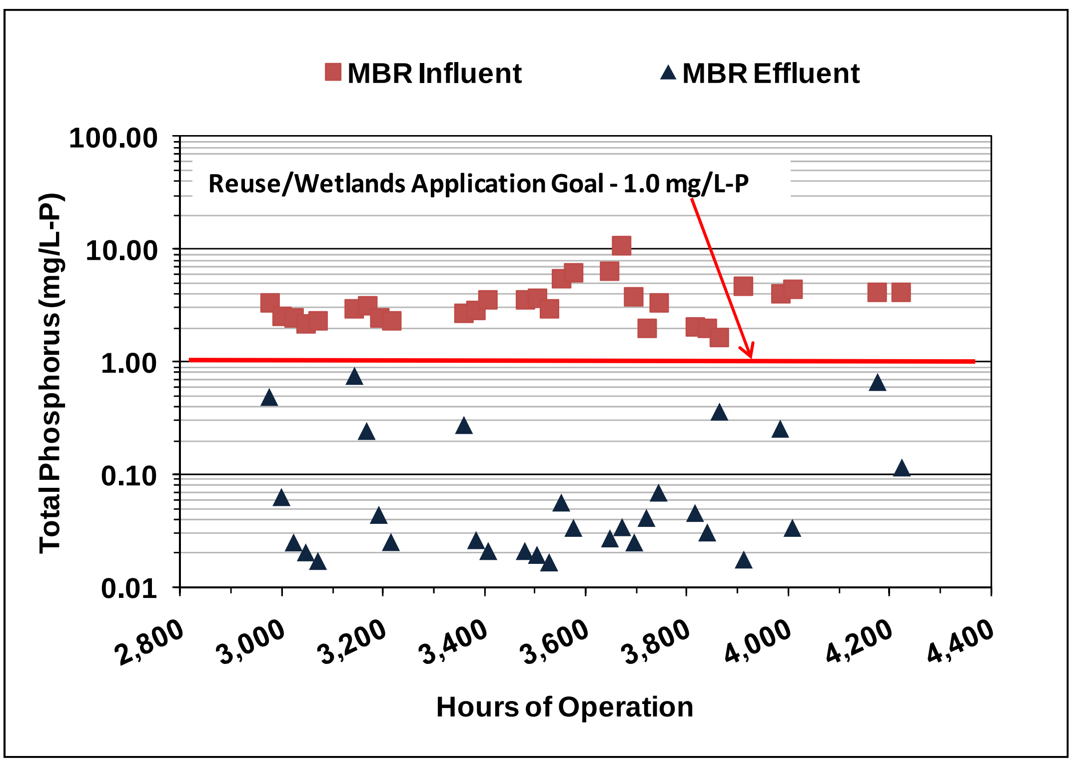


Figure 4-5 Phosphorus Removal by MBR System after 3,000 Hours of Operations



4.3.2 RO Nutrient Removal Results

The RO system consistently reduced nitrogen out of the MBR system to levels below the reuse/wetlands application goal of 3.0 mg/L-N. RO effluent total nitrogen (TN) concentrations ranged from 0.2 to 1.3 mg/L-N with a median concentration of 0.42 mg/L-N. There were a total of six incidences where samples reduced nitrogen levels to below the Class III/OFW goal of 0.27 mg/L-N. Refer to **Figure 4-6** for an illustration of total nitrogen concentrations in MBR and RO system effluents.

Total phosphorus (TP) concentrations were also further reduced by RO treatment. RO effluent TP concentrations ranged from 0.002 to 0.003 mg/L-N with a median effluent concentration of 0.002 mg/L-P. RO system TP results consistently exceeded the Class III/OFW treatment goal of 0.005 mg/L-P. **Figure 4-7** depicts total phosphorus concentrations of MBR and RO system effluents.

Figure 4-6 Total Nitrogen Removal by RO System

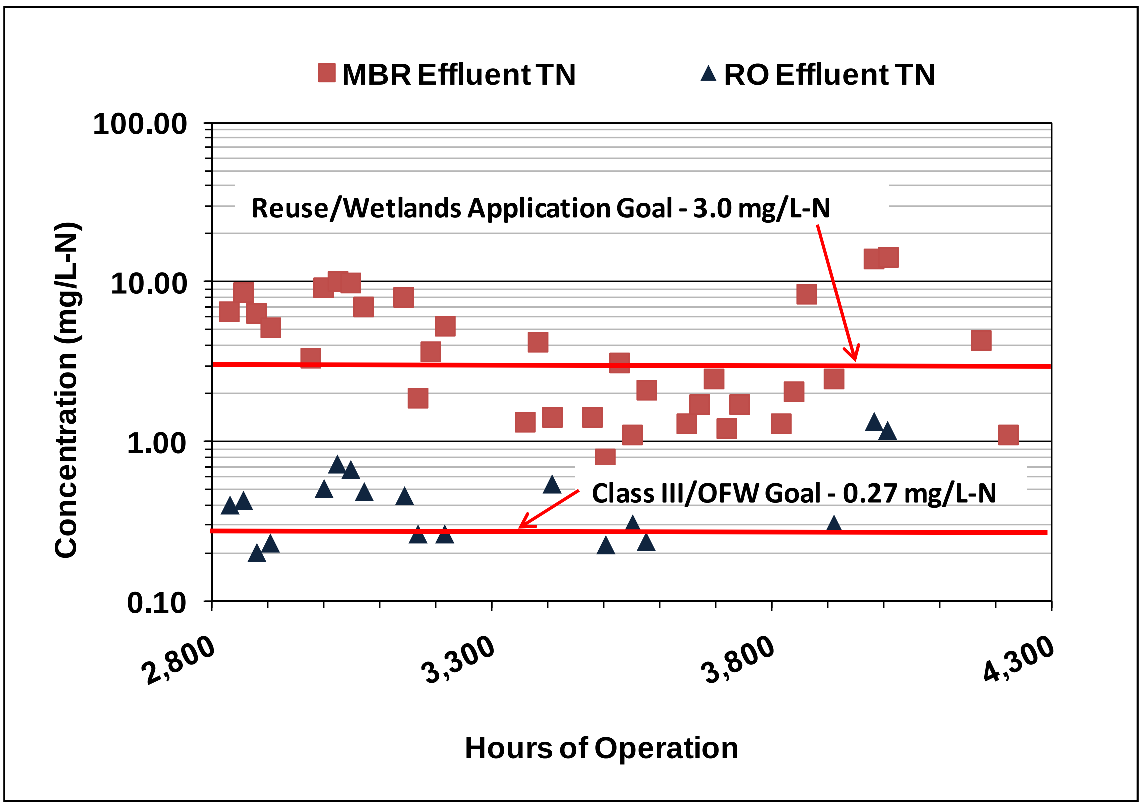
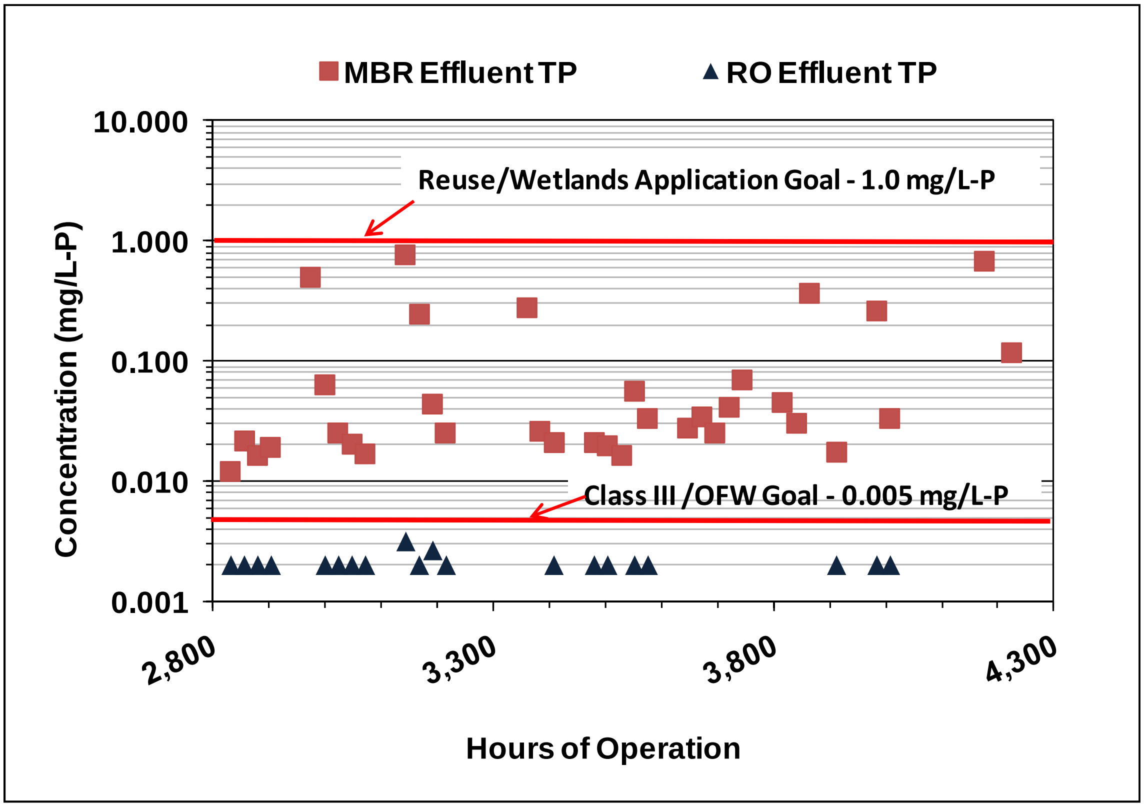


Figure 4-7 Total Phosphorus Removal by RO System



4.4 MICROCONSTITUENT RESULTS

A total of six microconstituent sampling events took place throughout the five and a half months of pilot testing. Each sampling event consisted of sampling for either Train A (MBR, AOP) or Train C (MBR, RO, AOP). **Table 4-3** shows the dates and specific sample points (refer to **Figure 2-1** for location) where samples were collected for testing.

Table 4-3 Microconstituent Sampling Events for Duration of Pilot

Sample Date	Sample Point 1	Sample Point 2	Sample Point 3	Sample Point 4	Sample Point 5	Train Equivalency
Wednesday, November 17, 2010	X	X		X	X	A
Tuesday, December 21, 2010	X	X		X	X	A
Monday, February 07, 2011	X	X		X	X	A
Tuesday, February 09, 2010			X	X	X	C
Monday, March 07, 2011	X	X	X	X	X	C
Wednesday, March 09, 2011				X	X	A

Four sampling events were performed for Train A while two sample events (February 9th and March 7th) for Train C. As laboratory results were showing consistency on daily operational water quality results from sample points 1 and 2; it was decided that, on weeks where two sampling events occurred within days of each other, sample points 1 and 2 would not be collected as these were common to both experimental Trains A and C.

Due to limited data points on microconstituents, a detailed analysis of results could not be achieved. However, the data does present information that was used to determine some over arching differences between Train A and Train C. Refer to **Tables 4-4** and **4-5** for microconstituent data for specific categories of microconstituents along with representative parameters of each category for Train A and Train C, respectively. **Table 4-4** shows that for Train A, the MBR is capable of reducing microconstituents, although the AOP systems further reduced majority of parameters. Train C, on the other hand (refer to **Table 4-5**), indicates that the majority of parameters were fully reduced to non detectable levels by the RO process. The only exceptions shown in **Table 4-5** are 4-methylphenol, bis phenol A, and gemfibrozil where hits were detected in RO effluent but where fully reduced to levels of non-detect by the AOP systems.

For the complete list of reported parameters for each sampling event refer to **Attachment A – Monthly Microconstituent Water Quality Results** for both Trains A and C. **Attachment B** contains the certified laboratory reports for all tests performed during the life of the pilot. It should be noted that constituents reported as non-detect (ND) reflect that the constituent was analyzed but not detected.

Table 4-4 Train A Microconstituent Removal

Parameter	Method	Minimum Reporting Limit	Units	Membrane BioReactor (MBR) Influent			MBR Permeate			AOP Effluent (UV/H_2O_2)			AOP Effluent (Ozone/H_2O_2)		
				SP1			SP2			SP4			SP5		
				Min Reported	Median Reported	Max Reported	Min Reported	Median Reported	Max Reported	Min Reported	Median Reported	Max Reported	Min Reported	Median Reported	Max Reported
Chlorination By Products															
1,4-Dioxane	EPA 522	0.50	ug/L	0.72	0.81	0.89	0.61	0.64	0.67	-	ND	-	0.53	0.53	0.53
Industrial By Products															
2,6-di-tert-butylphenol	USGS 4MOD	25.0	ng/L	44	46	62	-	ND	-	-	ND	-	-	ND	-
4-Methylphenol	EPA 625	5.0	ug/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-
4-Methylphenol	USGS 4MOD	25.0	ng/L	100	160	410	58	440	2800	71	316	560	45	45	45
Bis Phenol A (BPA)	USGS 4MOD	25.0	ng/L	260	380	420	26	61	96	29	31	33	31	31	31
BPA	LC-MS-MS	10.0	ng/L	110	420	580	21	80.5	140	12	12	12	130	130	130
Phenol	EPA 625	3.0	ug/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Phenol	USGS 4MOD	50.0	ng/L	160	170	260	320	760	1200	130	185	240	-	ND	-
Antibiotics															
Amoxicillin (semi-quantitative)	LC-MS-MS	20.0	ng/L	230	780	820	460	525	590	66	368	670	43	127	210
Sulfamethoxazole	LC-MS-MS	5.0	ng/L	310	490	820	82	92	180	7.2	15	130	100	215	330
Trimethoprim	LC-MS-MS	5.0	ng/L	180	300	760	20	160	640	19	22	25	9	59	110
Pharmaceuticals															
Acetaminophen	LC-MS-MS	5.0	ng/L	85	98	110	-	ND	-	-	ND	-	18	18	18
Caffeine	LC-MS-MS	10.0	ng/L	520	1900	8100	6.4	14	800	6.9	26	35	13	24	370
Caffeine by GCMS LLE	LC-MS-MS	25.0	ng/L	450	540	2500	200	200	200	-	ND	-	61	61	61
Caffeine by method 525mod	EPA 525.2	0.05	ug/L	0.6	0.67	2.5	0.23	0.23	0.23	0.06	0.06	0.06	0.07	0.07	0.07
Carbamazepine	LC-MS-MS	5.0	ng/L	100	120	150	87	120	250	25	56	87	48	48	48
Fluoxetine	LC-MS-MS	10.0	ng/L	44	68	92	27	41.5	56	24	24	24	22	176	330
Gemfibrozil	LC-MS-MS	5.0	ng/L	590	1900	2000	480	540	780	12	74	450	7.3	189	370
Ibuprofen	LC-MS-MS	20.0	ng/L	79	2340	4600	16	158	300	69	69	69	30	31.5	33
Iopromide	LC-MS-MS	5.0	ng/L	200	200	200	150	150	150	150	150	150	6.2	78	150
Hormones															
Estradiol	LC-MS-MS	1.0	ng/L	24	24	24	-	ND	-	-	ND	-	-	ND	-
Estrone	LC-MS-MS	1.0	ng/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Progesterone	LC-MS-MS	1.0	ng/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Pesticides															
4-Nonyl Phenol	USGS 4MOD	25.0	ng/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-
4-nonylphenol - semi quantitative	LC-MS-MS	100	ng/L	570	2235	3900	130	565	1000	-	ND	-	140	140	140
Alpha-Chlordane	EPA 525.2	0.05	ug/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Alpha Chlordane	USGS 4MOD	25.0	ng/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Carbaryl	EPA 531.2	0.50	ug/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Carbaryl	USGS 4MOD	50.0	ng/L	210	210	210	-	ND	-	-	ND	-	-	ND	-
Chlorpyrifos	EPA 531.2	25.0	ng/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Chlorpyrifos (Dursban)	EPA 525.2	0.05	ug/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-
DEET	LC-MS-MS	2.00	ng/L	17	69	120	5	28	51	2.5	33	64	7.9	8.8	28
DEET	USGS 4MOD	2.00	ng/L	83	100	320	81	130	190	30	70	110	29	62	62
Diazinon	USGS 4MOD	25.0	ng/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Diazinon (Qualitative)	EPA 525.2	0.10	ug/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Dieldrin	EPA 608	0.10	ug/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Dieldrin	EPA 505	0.01	ug/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Dieldrin	EPA 525.2	0.20	ug/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Dieldrin	USGS 4MOD	0.01	ng/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Methyl Parathion	USGS 4MOD	25.0	ug/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Personal Care Product															
Triclosan	LC-MS-MS	10.0	ng/L	140	260	380	26	78	130	22	22	22	22	22	22
Triclosan	USGS 4MOD	10.0	ng/L	280	360	620	69	90	110	67	67	67	-	ND	-
Flame Retardant															
TDCPP	USGS 4MOD	50.0	ng/L	310	320	620	330	370	380	340	365	400	200	295	420
Triphenylphosphate	USGS 4MOD	25.0	ng/L	86	100	150	25	31.5	38	-	ND	-	-	ND	-
Tris (2-chloroethyl) phosphate	USGS 4MOD	50.0	ng/L	130	160	390	150	170	190	130	175	240	84	140	230
Tris (2-butoxyethyl) phosphate	USGS 4MOD	200	ng/L	940	1600	5800	230	1565	2900	1500	1500	1500	830	830	830

* Based on data obtained from sample events held on November 17, December 21, 2010 and February 7, March 9, 2011.

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Table 4-5 Train C Microconstituent Removal

Parameter	Method	Minimum Reporting Limit	Units	Membrane BioReactor (MBR) Influent			MBR Permeate			Reverse Osmosis Permeate			AOP Effluent (UV/H_2O_2)			AOP Effluent ($Ozone/H_2O_2$)		
				SP1			SP2			SP3			SP4			SP5		
				Min Reported	Median Reported	Max Reported	Min Reported	Median Reported	Max Reported	Min Reported	Median Reported	Max Reported	Min Reported	Median Reported	Max Reported	Min Reported	Median Reported	Max Reported
Chlorination By Products																		
1,4-Dioxane	EPA 522	0.50	ug/L	1.2	1.2	1.2	1.1	1.1	1.1	-	ND	-	-	ND	-	-	ND	-
Industrial By Products																		
2,6-di-tert-butylphenol	USGS 4MOD	25.0	ng/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
4-Methylphenol	EPA 625	5.0	ug/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
4-Methylphenol	USGS 4MOD	25.0	ug/L	240	240	240	250	250	250	63	63	63	-	ND	-	-	ND	-
Bis Phenol A (BPA)	USGS 4MOD	25.0	ng/L	400	400	400	340	340	340	28	28	28	-	ND	-	-	ND	-
BPA	LC-MS-MS	10.0	ng/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Phenol	EPA 625	3.0	ug/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Phenol	USGS 4MOD	50.0	ng/L	180	180	180	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Antibiotics																		
Amoxicillin (semi-quantitative)	LC-MS-MS	20.0	ng/L	450	450	450	1100	1100	1100	-	ND	-	-	ND	-	-	ND	-
Sulfamethoxazole	LC-MS-MS	5.0	ng/L	550	550	550	510	510	510	-	ND	-	-	ND	-	-	ND	-
Trimethoprim	LC-MS-MS	5.0	ng/L	470	470	470	340	340	340	-	ND	-	-	ND	-	-	ND	-
Pharmaceuticals																		
Acetaminophen	LC-MS-MS	5.0	ng/L	83	83	83	-	ND	-	-	ND	-	-	ND	-	11	11	
Caffeine	LC-MS-MS	10.0	ng/L	6600	6600	6600	5800	5800	5800	-	ND	-	9.1	9.1	9.1	6.2	6.2	6.2
Caffeine by GCMS LLE	LC-MS-MS	25.0	ng/L	6400	6400	6400	1400	1400	1400	-	ND	-	-	ND	-	-	ND	-
Caffeine by method 525mod	EPA 525.2	0.05	ug/L	7.1	7.1	7.1	1.7	1.7	1.7	-	ND	-	-	ND	-	-	ND	-
Carbamazepine	LC-MS-MS	5.0	ng/L	110	110	110	110	110	110	-	ND	-	-	ND	-	-	ND	-
Fluoxetine	LC-MS-MS	10.0	ng/L	71	71	71	52	52	52	-	ND	-	-	ND	-	-	ND	-
Gemfibrozil	LC-MS-MS	5.0	ng/L	3000	3000	3000	1400	1400	1400	18	18	18	-	ND	-	-	ND	-
Ibuprofen	LC-MS-MS	20.0	ng/L	310	310	310	150	150	150	-	ND	-	-	ND	-	-	ND	-
Iopromide	LC-MS-MS	5.0	ng/L	11	11	11	13	13	13	-	ND	-	-	ND	-	-	ND	-
Hormones																		
Estradiol	LC-MS-MS	1.0	ng/L	25	25	25	4.3	4.3	4.3	-	ND	-	-	ND	-	-	ND	-
Estrone	LC-MS-MS	1.0	ng/L	17	17	17	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Progesterone	LC-MS-MS	1.0	ng/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Pesticides																		
4-Nonyl Phenol	USGS 4MOD	25.0	ng/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
4-Nonylphenol - semi quantitative	LC-MS-MS	100	ng/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Alpha-Chlordane	EPA 525.2	0.05	ug/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Alpha Chlordane	USGS 4MOD	25.0	ng/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Carbaryl	EPA 531.2	0.50	ug/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Carbaryl	USGS 4MOD	50.0	ng/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Chlorpyrifos	EPA 531.2	25.0	ng/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Chlorpyrifos (Dursban)	EPA 525.2	0.05	ug/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
DEET	LC-MS-MS	2.00	ng/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
DEET	USGS 4MOD	2.00	ng/L	300	300	300	240	240	240	-	ND	-	-	ND	-	-	ND	-
Diazinon	USGS 4MOD	25.0	ng/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Diazinon (Qualitative)	EPA 525.2	0.10	ug/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Dieldrin	EPA 608	0.10	ug/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Dieldrin	EPA 505	0.01	ug/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Dieldrin	EPA 525.2	0.20	ug/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Dieldrin	USGS 4MOD	0.01	ng/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Methyl Parathion	USGS 4MOD	25.0	ug/L	-	ND	-	-	ND	-	-	ND	-	-	ND	-	-	ND	-
Personal Care Product																		
Triclosan	LC-MS-MS	10.0	ng/L	450	450	450	160	160	160	-	ND	-	-	ND	-	-	ND	-
Triclosan	USGS 4MOD	10.0	ng/L	340	340	340	160	160	160	-	ND	-	-	ND	-	-	ND	-
Flame Retardant																		
TDCPP	USGS 4MOD	50.0	ng/L	330	330	330	390	390	390	-	ND	-	-	ND	-	-	ND	-
Triphenylphosphate	USGS 4MOD	25.0	ng/L	82	82	82	59	59	59	-	ND	-	-	ND	-	-	ND	-
Tris (2-chloroethyl) phosphate	USGS 4MOD	50.0	ng/L	190	190	190	190	190	190	-	ND	-	-	ND	-	-	ND	-
Tris (2-butoxyethyl) phosphate	USGS 4MOD	200	ng/L	4100	4100	4100	2800	2800	2800	-	ND	-	-	ND	-	-	ND	-

* Based on data obtained from sample events held on February 9 and March 7, 2011.

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Section 5
Conclusions

The goal of this pilot project was to evaluate the performance of various advanced treatment technologies for the purpose of determining the technical feasibility of reclaiming wastewater to rehydrate coastal wetlands. The data collected during the five months of pilot plant operations demonstrate the relative effectiveness of the two treatment trains tested.

Based on the pilot test results it was demonstrated that for the duration of the study, all the treatment processes tested could be viable options for implementation. Testing during this short period indicated that Train C (MBR, RO, AOP) would likely achieve removal to low level of nutrients that would potentially comply with proposed water quality targets for direct discharge.

Based on the data collected during the period of operations the following can be concluded:

- MBR achieved median effluent ammonia, nitrate and total phosphorus concentrations of 0.03 mg/L-N, 1.3 mg/L-N and 0.15 mg/L-P respectively. Based on these results, Train A achieved nutrient removal level for meeting the Reuse/Wetlands application per Chapter 62-611.420 Discharge Limits to Treatment and Receiving Wetlands.

- RO achieved median effluent total nitrogen and total phosphorous concentrations of 0.35 mg/L-N and 0.002 mg/L respectively. These results show that the Class III/OFW water quality targets were achieved consistently for total phosphorous, however not achieved consistently for total nitrogen.

Water quality results for microconstituents show that Train A and Train C were successful at reducing microconstituent levels. Train A showed some reduction by the MBR process followed by further reduction by APO systems. Train C, however, showed that with the application of RO process, further reduction of most of these compounds to non-detect levels was achieved. The AOP processes further reduced levels to non-detects for those parameters that showed hits in RO effluent. It should be noted that investigation of the potential effects of microconstituent to the natural environment was not included as part of this evaluation.

Discussion among stakeholders supported the conclusion that RO would likely be necessary as a treatment element in any treatment train to reclaim wastewater for enhancing or restoring the coastal wetlands. Further evaluation, testing, and cost benefit analyses, would likely be needed prior to determining the feasibility of this project.

The data produced from this study should support further alternatives analyses that will be necessary when full scale implementation of a system to rehydrate the coastal wetlands becomes more financially feasible as part of the Comprehensive Everglades Restoration Program. It is anticipated that at that time there may be additional technologies available that could improve performance and/or reduce considerably the cost associated with for meeting this objective.

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Attachment A

Monthly Pilot Operations, Sampling, Water Quality Report

Attachment A

Attachment A

Monthly Water Quality and Operations Report

MWH

BUILDING A BETTER WORLD

December 20, 2010

Mr. James Ferguson, P.E.
Miami-Dade Water and Sewer Department
23200 SW 97th Avenue, Suite 1
Miami, Florida 33190

Subject: Agreement No. 08MWHA007
OCI Project No. E08-WASD-02A
Work Order No. 4 BBCWRPP - Pilot Operations, Water Quality Reports, Laboratory and Stakeholder Management and Coordination
Monthly Pilot Operations and Water Quality Report

Dear Mr. Ferguson:

MWH Americas, Inc. (MWH) is pleased to submit the first monthly Summary Report for the Biscayne Bay Coastal Wetlands Rehydration Pilot Project (BBCWRPP) Operations and Water Quality Monitoring. This summary report covers the reporting period from November 1, 2010, at 07:30 hours through December 13, 2010, at 17:00 hours.

I. DAILY OPERATIONS SUMMARY

The BBCWRPP startup was initiated by "seeding" the membrane bioreactor (MBR) pilot unit with nitrified mixed liquor from the Marathon MBR package plant. After seeding the system, the MBR pilot unit was operated for three weeks to achieve the steady state for the bioreactor and to determine optimum chemical dosing rates.

Once the steady-state was achieved, the pilot plant initiated official operations starting November 1, 2010. Chemical phosphorous removal started November 8th, by dosing poly-aluminum chloride (PACl) to the MBR Anoxic tank. Trains C was initially operated from November 2 through November 8, however a switch to Train A was made due to reduced production of the MBR filtrate. Train A has been operated since November 8, through the end of this reporting period. It should be noted that, on November 22, the MBR pilot system experienced mechanical problems with the Aeration Tank #1 blower. A temporary bypass was piped to run the MBR pilot with Aeration Tank #2 blower until a replacement blower arrives. Refer to the enclosed daily operations summaries prepared by the field operator. The pilot site was not manned on Thanksgiving Day. Replacement blower was installed the first week of December.

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II. DAILY AND WEEKLY WATER QUALITY SAMPLING SUMMARY

Figures 1 and **2** show removal of ammonia, nitrate and total phosphorus achieved during the start-up period for the MBR system. As shown, the MBR pilot system achieved complete nitrification and almost complete denitrification with effluent ammonia and nitrate concentrations below 0.1 and 0.5 mg/L-N respectively. The effluent total phosphorus concentration was measured below 0.5 mg/L-P during this period. Following the start-up period, the RO, ozone and the UV systems were brought into operation and additional planned water quality sampling was initiated.

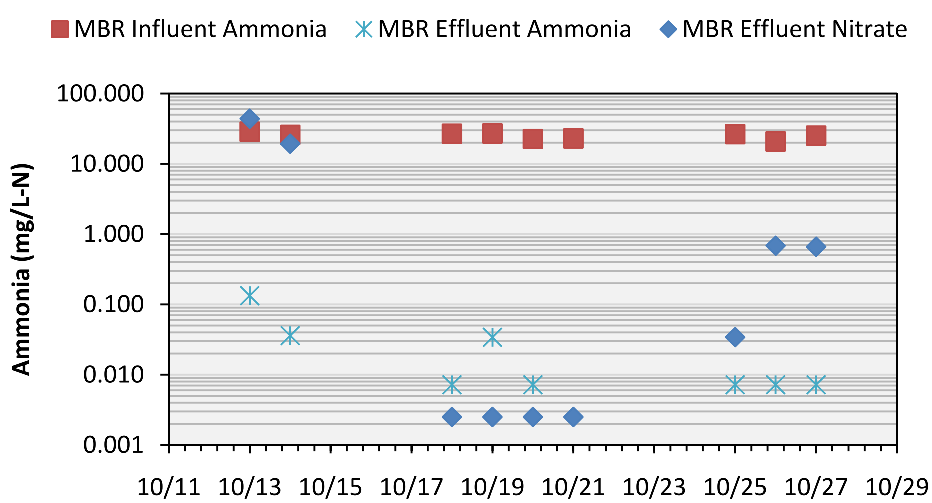

Figure 1 – Ammonia and Nitrate removal during the Start-Up Period

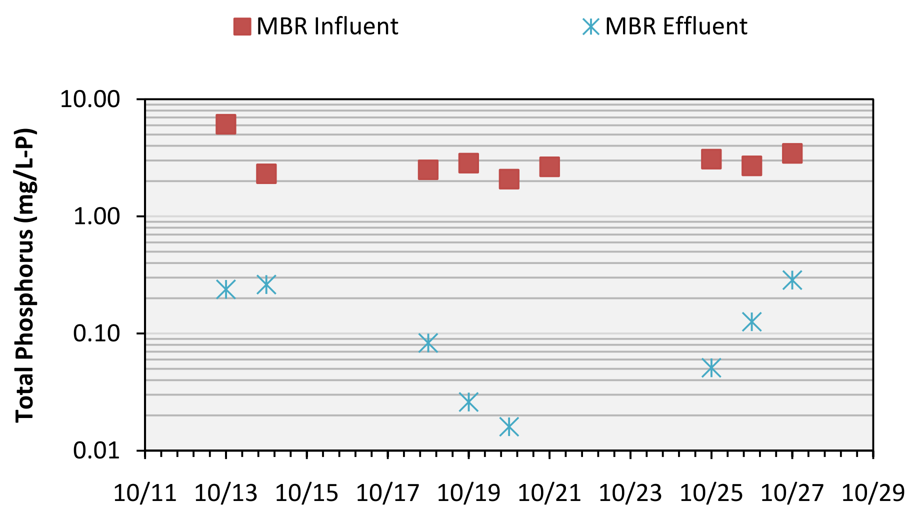

Figure 2 – Total Phosphorus removal during the Start-Up Period

During this reporting period, water quality was monitored through online instruments, field testing with handheld instrument and laboratory tests. The daily and weekly water quality monitoring provides a direct correlation of the performance of the pilot treatment units as well as the level of treatment that can be achieved during different operational conditions. A tabulated spreadsheet was prepared to record and analyze this data (refer to electronic spreadsheet BBCWRPP Water Quality Operations Data_12292010_KEH.xlsx). Please note that the latest version of this electronic file will be submitted with these reports, thus water quality data will extend further than this progress report.

The graphical representations of key water quality parameters are shown in the figures below. **Figures 3** and **4** show the ammonia removal observed in the MBR, RO, ozone and the UV systems. As shown in **Figure 3**, the MBR pilot unit achieved complete nitrification for most of the reporting period with the exception of few spikes observed in effluent ammonia concentration when the mechanical and power failures of the process air blower resulted in lower than desired dissolved oxygen concentration in the aeration tank. As shown in **Figure 4**, the effluent ammonia concentration observed in the ozone and UV system effluents were similar to that observed in the MBR system effluent as expected, since these systems are not expected to provide any significant ammonia removal.

Figures 5 and **6** demonstrate nitrate removal observed in the pilot systems evaluated during operation of Train A. As shown in **Figure 5**, the effluent nitrate concentrations for the MBR systems were observed mostly below 1 mg/L-N until November 22nd as expected. But from November 23rd to December 13th, the MBR effluent nitrate concentration spiked above 10 mg/L-N. The project team inspected the MicroCg dosing system and found that the chemical was not being dosed at sufficient rate. The project team adjusted the MicroCg dosing and since December 15th, the effluent nitrate concentration has reduced to below 0.1 mg/L-N as desired.

Figures 7 and **8** present the total phosphorus removal observed in the pilot systems during the reporting period. As shown, the MBR system was able to achieve good phosphorus removal with effluent total phosphorus concentrations observed below 0.5 mg/L-P for most of the samples. Insufficient dosing of PACl in some instances resulted in spikes in effluent phosphorus concentration but the issue with the chemical dosing was resolved as soon as the project staff noticed it.

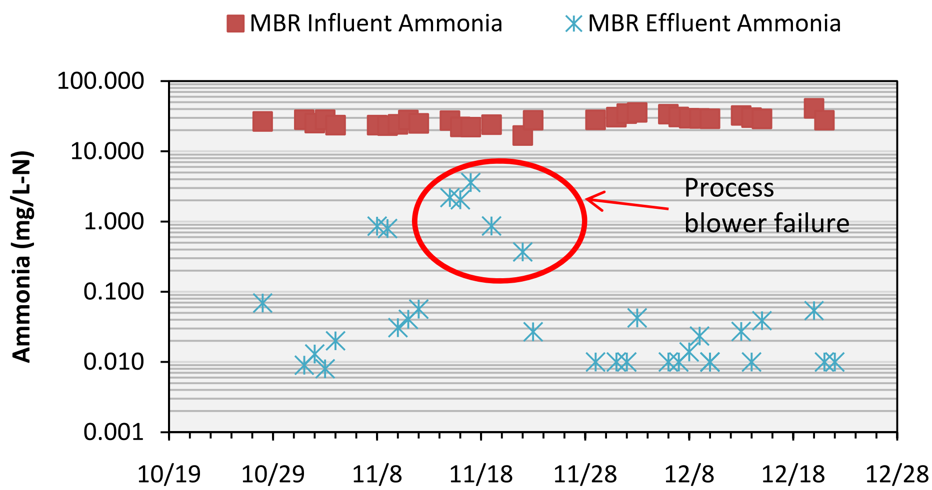

Figure 3 – Influent and Effluent Ammonia Concentrations for the MBR System

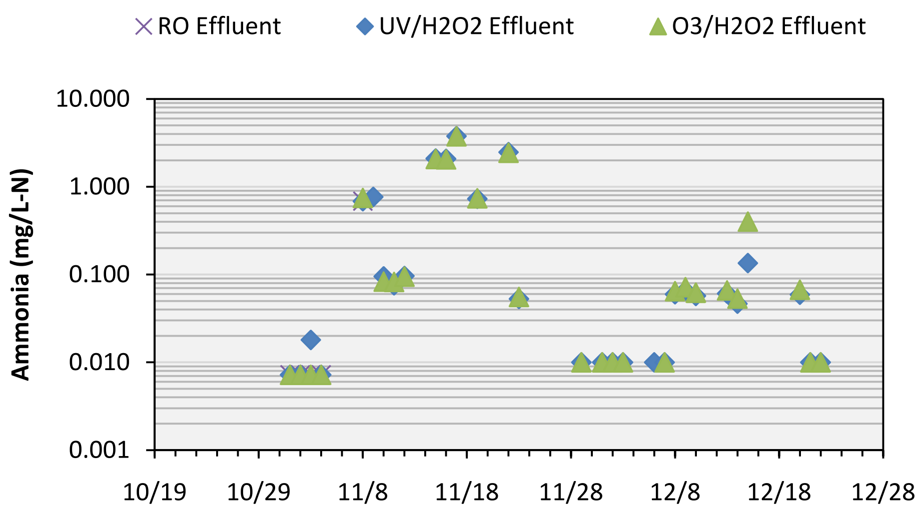

Figure 4 – Ammonia Concentrations in the RO, UV and Ozone System Effluents

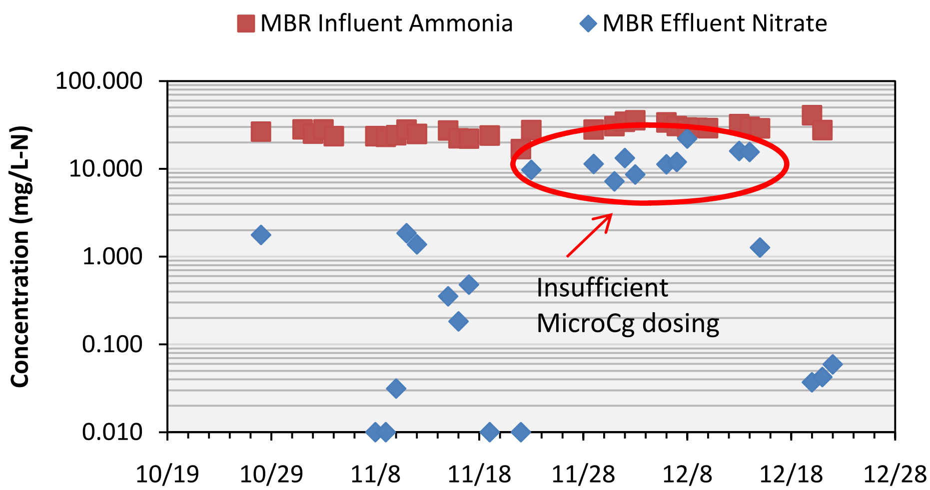

Figure 5 – Influent Ammonia and Effluent Nitrate Concentrations for the MBR System

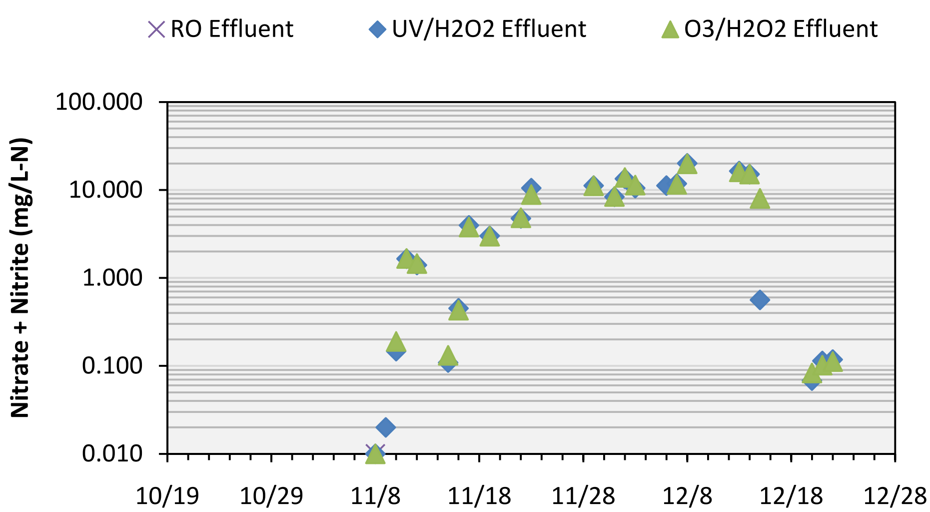

Figure 6 – Effluent Nitrate+Nitrite Concentrations for the RO, Ozone and the UV Systems

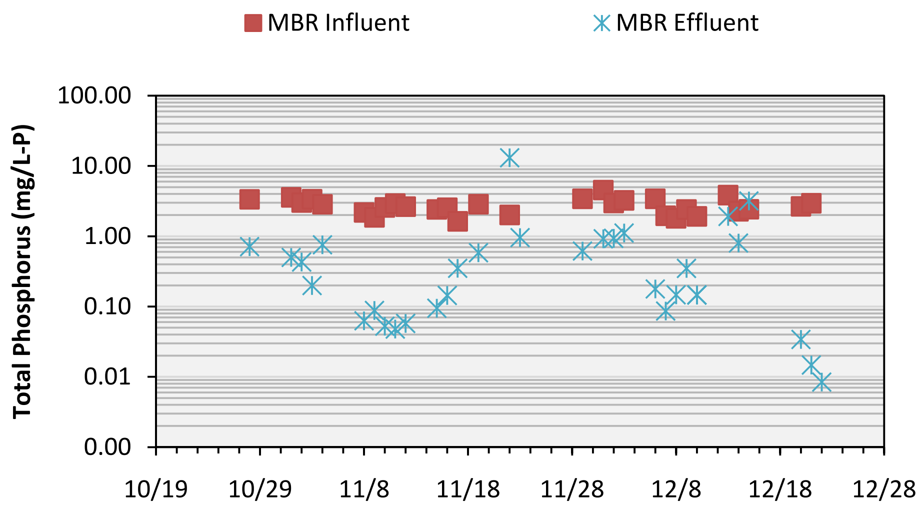

Figure 7- Influent and Effluent total Phosphorus Concentrations for the MBR System

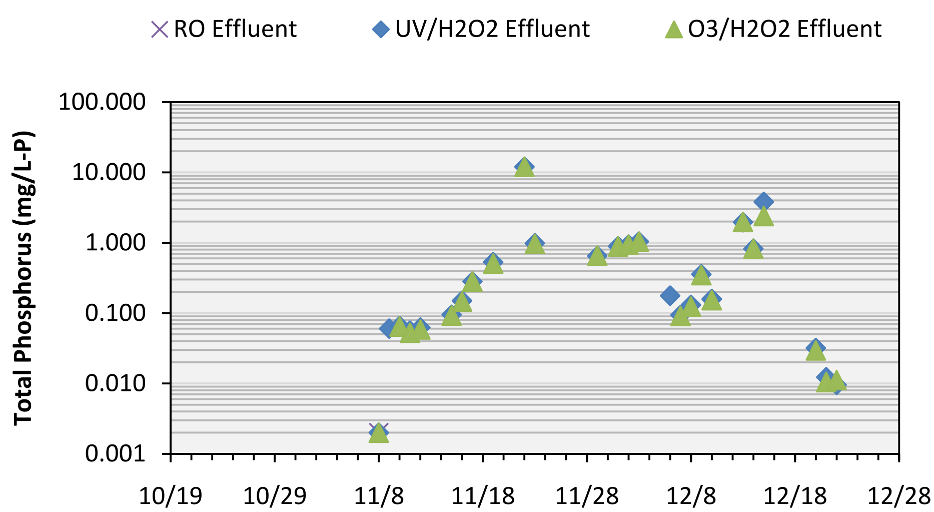

Figure 8 – Effluent Phosphorus Concentrations for the RO, Ozone and the UV Systems

III. MONTHLY WATER QUALITY SAMPLING SUMMARY

Monthly microconstituent sampling took place on November 16, 2010. This sampling event took place from 9:30 AM to 4:00 PM. Composites and grab samples for MBR influent (MBR in), MBR filtrate (MBR out), UV/Peroxide effluent (UV/H2O2), and Ozone/Peroxide (O3/H2O2) effluent were taken. Test results have three to four weeks turn around; therefore these results will be reported during next month.

If you should have any questions or require additional information, please do not hesitate to contact me at (954) 846-0401.

Respectfully submitted,

MWH Americas, Inc.

Yurfa Glenny
Project Manager

cc.

Attachments: Daily Operational Logs Month No.1
Provisional Daily and Weekly Water Quality Results

MWH

BUILDING A BETTER WORLD

January 20, 2011

Mr. James Ferguson, P.E.
Miami-Dade Water and Sewer Department
23200 SW 97th Avenue, Suite 1
Miami, Florida 33190

Subject: Agreement No. 08MWHA007
OCI Project No. E08-WASD-02A
Work Order No. 4 BBCWRPP - Pilot Operations, Water Quality Reports, Laboratory and Stakeholder Management and Coordination
Monthly Pilot Operations and Water Quality Report

Dear Mr. Ferguson:

MWH Americas, Inc. (MWH) is pleased to submit the second monthly Summary Report for the Biscayne Bay Coastal Wetlands Rehydration Pilot Project (BBCWRPP) Operations and Water Quality Monitoring. This summary report covers the reporting period from December 1, 2010, at 07:30 hours through December 31, 2010, at 17:00 hours.

I. DAILY OPERATIONS SUMMARY

During the reporting period, the operational performance of Train A was evaluated due to limited availability of the MBR filtrate flow. The MBR, Ozone and UV systems were operated at target net flow rates of 25, 11, and 10 gpm respectively for first half of the reporting period.

The MBR system experienced severe membrane fouling during the second half of the reporting period, following which the system flow rate was reduced to 20 gpm to ensure that the trans-membrane pressure does not exceed the maximum allowable pressure until a recovery clean is performed on the membranes. Reduced filtrate flow production from the MBR system also required reducing the flow-rate to the UV system from 10 to 8 gpm during the second half of the reporting period.

Two maintenance cleans or enhanced flux maintenance (EFM) cleans were performed on the MBR system (on 12/10 and 12/19) but the membrane permeability did not recover. Following this, the project team decided to conduct a recovery clean (CIP). Since the CIP required presence of Pall's staff on site, it was planned to be conducted in early January. The process air blower for the MBR system failed on December 15th, following which the system was operated on spare blower. The system is currently operating on a spare blower and the DO concentration in the aeration tank is maintained close to the set point of 2 mg/L.

The ozone system had few major downtimes including a power failure that was experienced at the plant on 8th December, which caused all pilot units to shut down. In addition, the ozone system went into recycling mode when the MBR system was not able to produce enough flow to feed the ozone and UV systems. This happened when the maintenance cleans was performed on the MBR system, and when the process air blower was replaced.

The UV system was operated at a target flow-rate of 10 gpm for the first half of the reporting period but the flow to the system was reduced to 8 gpm in the second half since the MBR system was operating at lower flow due to membrane fouling issues. The UV system did not have any mechanical issues during the reporting period.

II. DAILY AND WEEKLY WATER QUALITY SAMPLING SUMMARY

Figures 1 and **2** show removal of ammonia, nitrate and total phosphorus achieved during the first two months of testing for the MBR system.

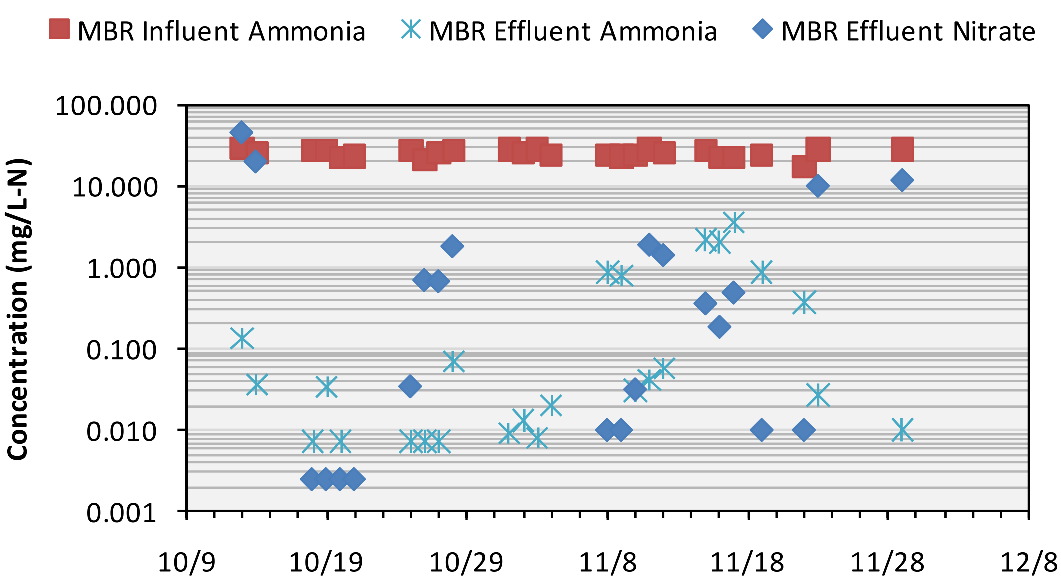

Figure 1 – Ammonia and Nitrate Removal during the First Two Months of Operation

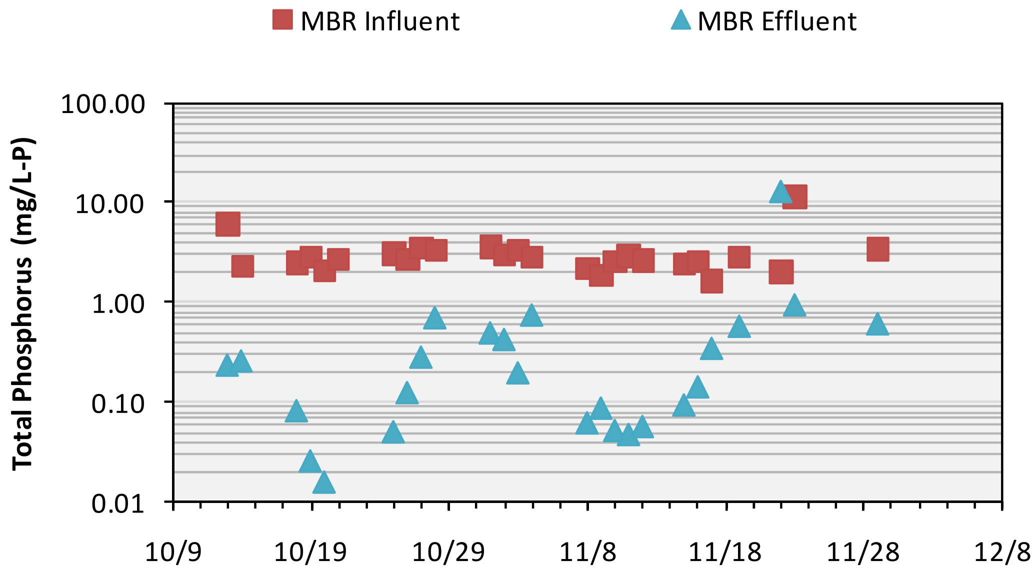

Figure 2 – Total Phosphorus Removal during the First Two Months of Operation

During this reporting period, water quality was monitored through online instruments, field testing with handheld instrument and laboratory tests. The daily and weekly water quality monitoring provides a direct correlation of the performance of the pilot treatment units as well as the level of treatment that can be achieved during different operational conditions. A tabulated spreadsheet was prepared to record and analyze this data. Please note that the latest version of this electronic file will be submitted with these reports, thus water quality data will extend further than this progress report.

The graphical representations of key water quality parameters are shown in the figures below. **Figures 3** and **4** show the ammonia removal observed in the MBR, ozone and UV systems. As shown in **Figure 3**, the MBR pilot system achieved complete nitrification during the reporting period with effluent ammonia concentration measured below 0.1 mg/L-N. The effluent ammonia concentrations on December 27th and 28th were measured above typical levels but returned to normal values on December 29th. As shown in **Figure 4**, the effluent ammonia concentration observed in the ozone and UV system effluents were similar to that observed in the MBR system effluent as expected, since these systems are not expected to provide any significant ammonia, nitrate or phosphorus removal.

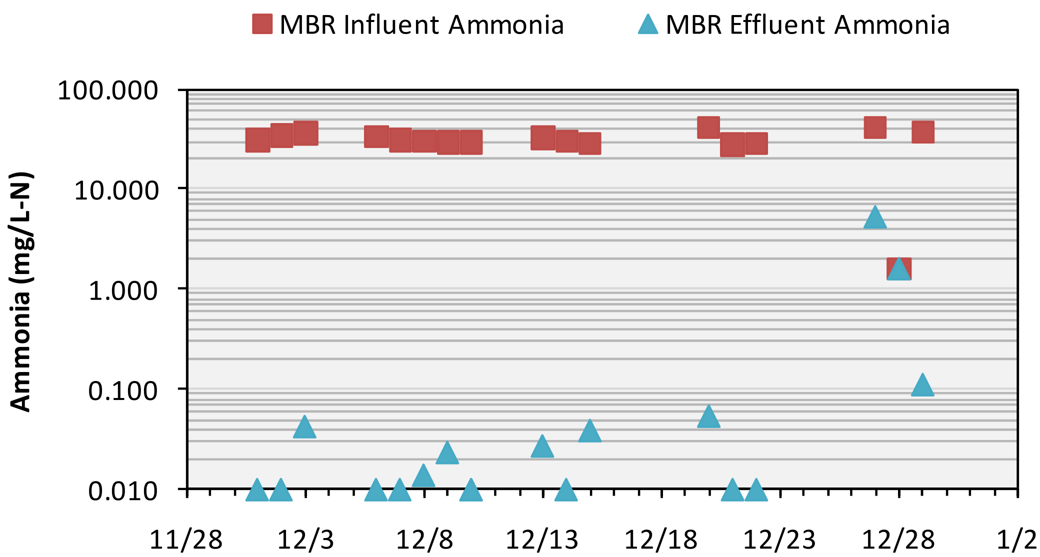

Figure 3 – Influent and Effluent Ammonia Concentrations for the MBR System

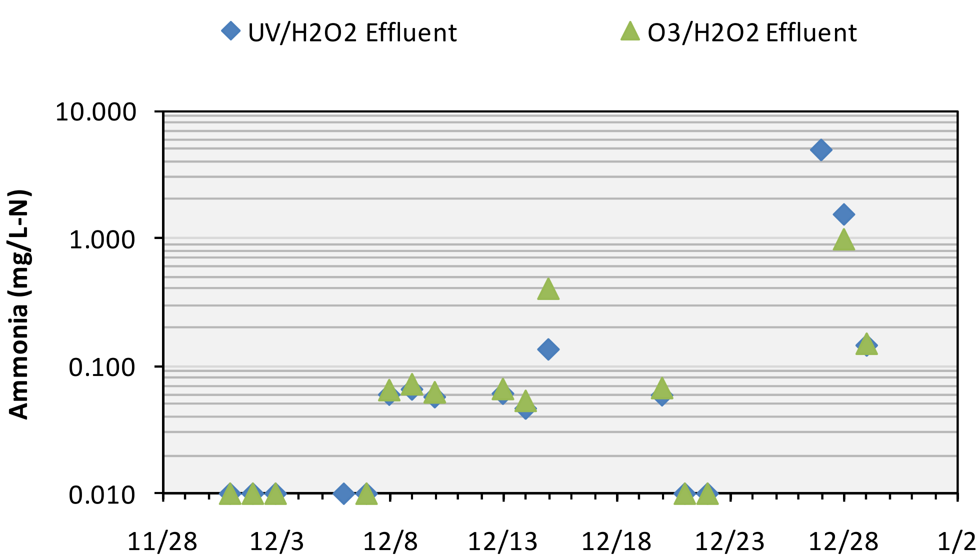

Figure 4 – Ammonia Concentrations in the RO, UV and Ozone System Effluents

Figures 5 and **6** demonstrate nitrate removal observed in the pilot systems evaluated during operation of Train A. As shown in **Figure 5**, the effluent nitrate concentrations were measured at much higher than expected levels for most of the reporting period. Once the project team received the lab results for ammonia and nitrate for the first week of the reporting period, the MicroCg dosing was increased on 14th December to account for higher feed ammonia concentration and to reduce the effluent nitrate concentrations to desired levels. The average ammonia concentration in the feed water during the first two months was observed at 25.1 mg/L-N whereas that during the reporting period was observed at 30.6 mg/L-N.

Following the increase in MicroCg dosing, the effluent nitrate concentration was lowered to desired level by 20th December, but it spiked again in few days. On 7th January, it was found that MicroCg pump was clogged and the chemical was not being dosed. This could explain spikes in effluent nitrate concentration observed at the end of the reporting period. The project team is now monitoring the MicroCg feed rate twice a week and will adjust the MicroCg dosing over next few weeks to achieve complete denitrification.

Figures 7 and 8 demonstrate phosphorus removal observed in the MBR, ozone and UV systems. As shown in Figure 7, the phosphorus removal by the MBR system varied significantly with phosphorus concentration in the MBR effluent samples measured below 0.5 mg/L-P for about half of the samples. During the reporting period, the phosphorus concentration in the feed water varied from 1.8 to 4.5 mg/L-P with average concentration of 2.9 mg/L-P.

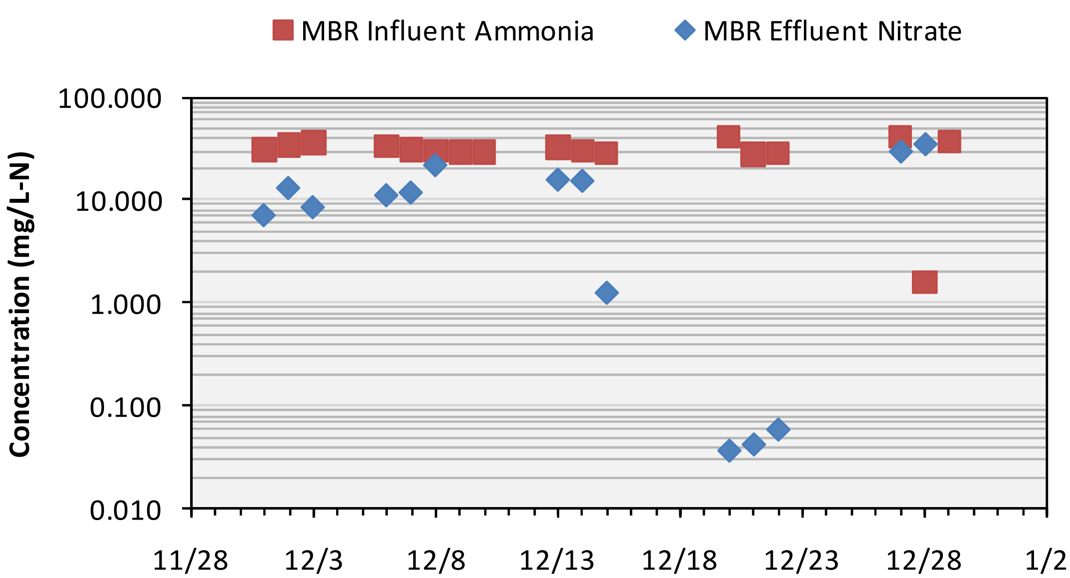

Figure 5 – Influent Ammonia and Effluent Nitrate Concentrations for the MBR System

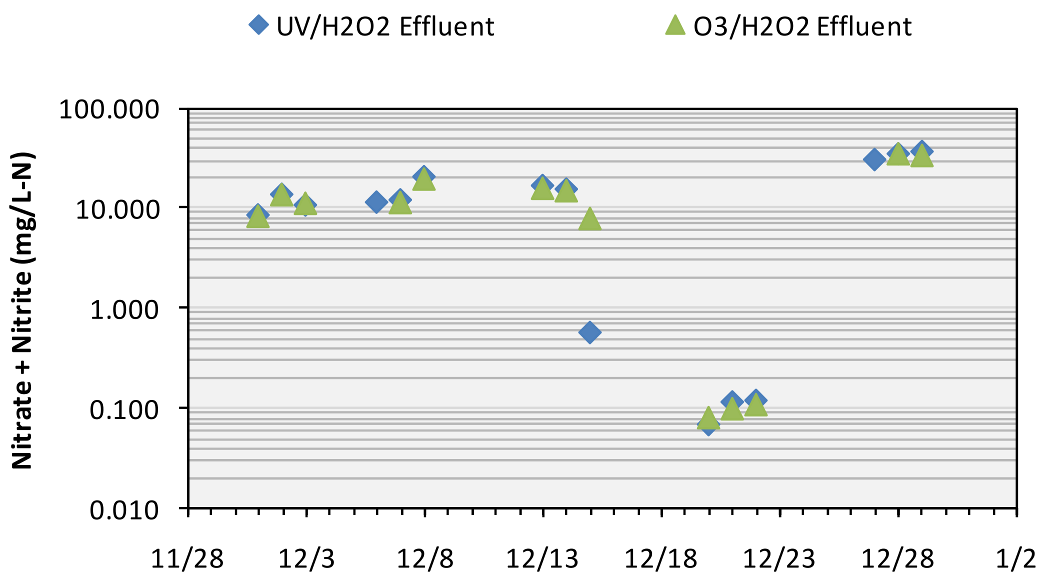

Figure 6 – Effluent Nitrate+Nitrite Concentrations for the RO, Ozone and the UV Systems

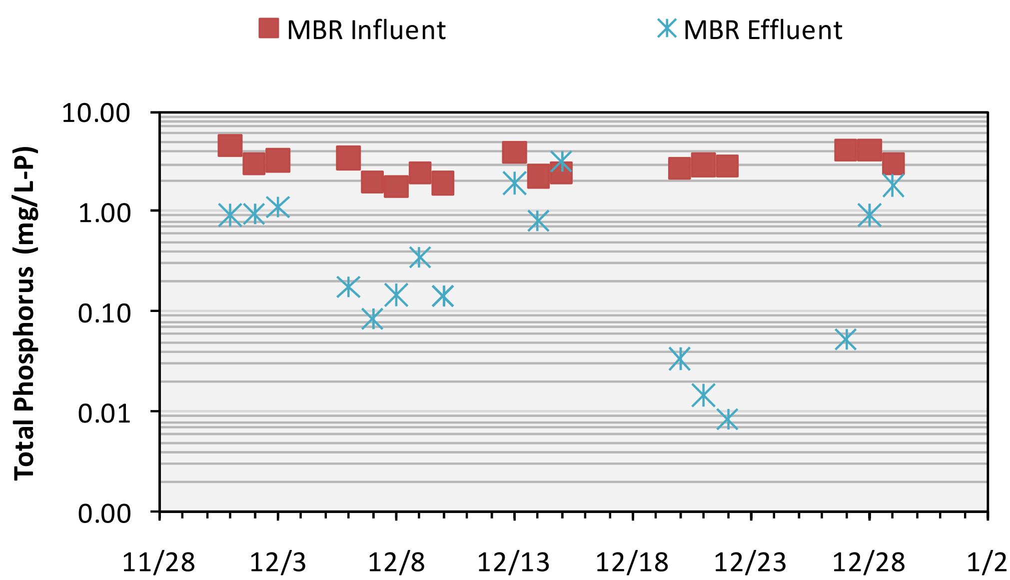

Figure 7 – Influent and Effluent Total Phosphorus Concentrations for the MBR System

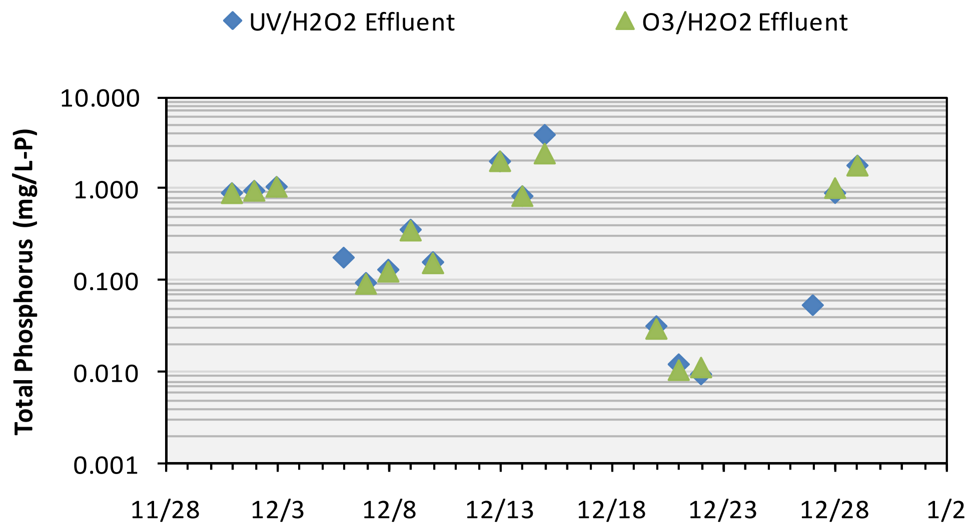

Figure 8 – Effluent phosphorus concentrations for the RO, ozone and the UV Systems

III. MONTHLY WATER QUALITY SAMPLING SUMMARY

Monthly microconstituent sampling took place on December 21, 2010. This sampling event took place from 9:30 AM to 4:00 PM. Composites and grab samples for MBR influent (MBR in), MBR filtrate (MBR out), UV/Peroxide effluent (UV/H2O2), and Ozone/Peroxide (O3/H2O2) effluent were taken. Provisional November sampling results were we submitted to the Stakeholders.

If you should have any questions or require additional information, please do not hesitate to contact me at (954) 846-0401.

Respectfully submitted,

MWH Americas, Inc.

Yurfa Glenny
Project Manager

cc.

Attachments: Daily Operational Logs Month No.2
Provisional Daily and Weekly Water Quality Results

MWH

BUILDING A BETTER WORLD

March 2, 2011

Mr. James Ferguson, P.E.
Miami-Dade Water and Sewer Department
23200 SW 97th Avenue, Suite 1
Miami, Florida 33190

Subject: Agreement No. 08MWHA007
OCI Project No. E08-WASD-02A
Work Order No. 4 BBCWRPP - Pilot Operations, Water Quality Reports, Laboratory and Stakeholder Management and Coordination
Monthly Pilot Operations and Water Quality Report

Dear Mr. Ferguson:

MWH Americas, Inc. (MWH) is pleased to submit the third monthly Summary Report for the Biscayne Bay Coastal Wetlands Rehydration Pilot Project (BBCWRPP) Operations and Water Quality Monitoring. This summary report covers the reporting period from January 1, 2011, at 07:30 hours through January 31, 2011, at 17:00 hours.

I. DAILY OPERATIONS SUMMARY

During the reporting period, the operational performance of only Train A was evaluated due to limited availability of the MBR filtrate flow. The MBR, Ozone and UV systems were operated at flow rates of 20-28, 11, and 10 gpm respectively for the reporting period.

The MBR system experienced severe membrane fouling during the second half of the previous reporting period, following which the system flow rate was reduced to 20 gpm to ensure that the trans-membrane pressure does not exceed the maximum allowable pressure until a recovery clean is performed on the membranes. Following the recovery clean, the system flow-rate was increased to 28.2 gpm.

The following operations and maintenance issues occurred during this reporting period:

1) 5th January 2011 – Ozone system shut down due to insufficient feed water available from the MBR system. System was restarted on the same day.

2) 7th January 2011 – Operator found out that MicroCg (carbon source) was not being dosed to the bioreactors due to clogging inside the chemical dosing pump.

Following this, the chemical dosing pump was cleaned and MicroCg dose (flow-rate) was measured and adjusted.

3) 11th January 2011 – A membrane recovery clean was conducted on the MBR system, which required the system to be shut down. During the recovery clean, mixed liquor from the membrane tank was drained accidentally, which reduced the mixed liquor concentration in the bioreactors to 3620 mg/L. To increase the MLSS concentration to desired levels, sludge wasting was temporarily discontinued. The desired MLSS concentration of 8,000 mg/L was achieved by 28th January 2011. The ozone and UV systems were also shutdown while the recovery cleaning was conducted on the MBR system.

4) 18th January 2011 – Feed water pump for the MBR system did not have enough capacity to produce required flow, which resulted in low water level in the anoxic tank level and subsequent shutdown of the pilot system. Feed water flow-rate to the MBR system was reduced to 27 gpm to avoid any further shutdown until the replacement pump arrives.

Figure 1 shows the TSS and VSS concentrations measured in the bioreactors of the MBR system. As shown, the MLSS concentrations as well as VSS (as % of TSS) concentrations in the bioreactor stabilized (at about 85%) by early November after the initial start-up period. But following that, the MBR system experienced several operational issues including process blower failure, clogging of coarse bubble diffusers (for membrane scour air) and, clogging of MicroCg dosing pump. These maintenance issues resulted in multiple shutdowns during the months of December and January causing upsets in the bioreactor, which is evident from VSS concentration (as % of TSS) measured in the bioreactors (**Figure 1**). As shown, the VSS concentration in the bioreactor varied from 50-90% during the months of December and January. The MLSS concentration also reduced dramatically during mid January, when mixed liquor from the membrane tank was drained accidentally.

The ozone and UV systems had few downtimes; once when the MBR system was not able to produce enough flow to feed these systems and second time when the recovery cleaning was conducted on the MBR system. The RO system was not utilized during this reporting period.

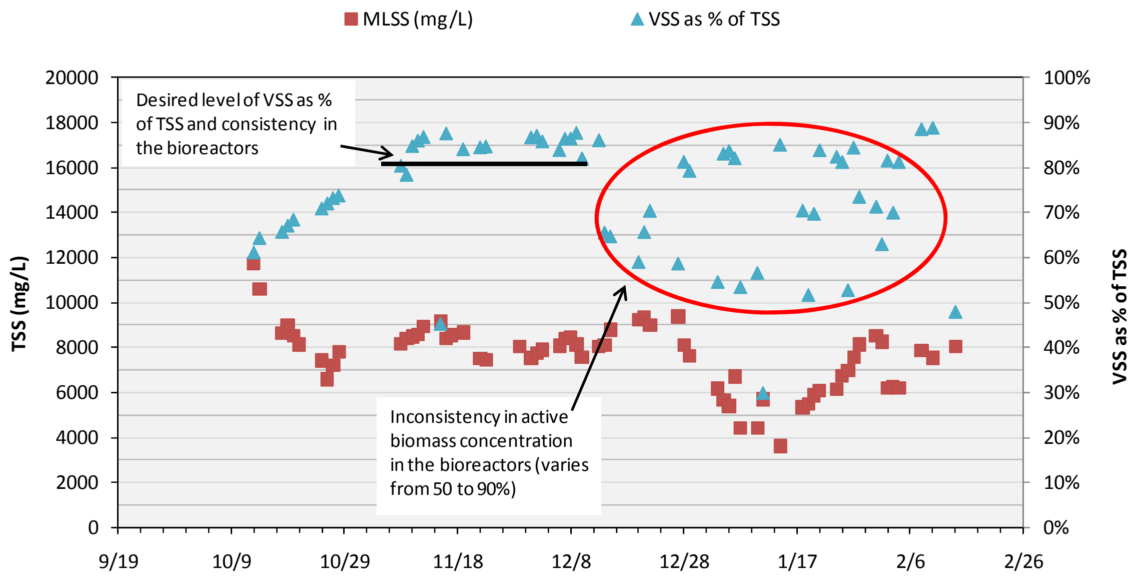

Figure 1 – TSS and VSS Concentrations in the Mixed Liquor of the MBR System

II. DAILY AND WEEKLY WATER QUALITY SAMPLING SUMMARY

During this reporting period, water quality was monitored through online instruments, field testing with handheld instrument and laboratory tests. The daily and weekly water quality monitoring provides a direct correlation of the performance of the pilot treatment units as well as the level of treatment that can be achieved during different operational conditions. A tabulated spreadsheet was prepared to record and analyze this data (refer to electronic spreadsheet BBCWRPP Water Quality Operations Data_12292010_KEH.xlsx). Please note that the latest version of this electronic file will be submitted with these reports, thus water quality data will extend further than this progress report.

The graphical representations of key water quality parameters are shown in the figures below. **Figures 2** and **3** show the ammonia removal observed in the MBR, Ozone and UV systems. As shown in **Figure 2**, the MBR pilot system achieved complete nitrification during the reporting period with effluent ammonia concentration measured below 0.1 mg/L-N, with the exception of sample on 18th January when it was measured at unusually high concentration. As shown in **Figure 3**, the effluent ammonia concentration observed in the ozone and UV system effluents were similar to that observed in the MBR system effluent since these systems are not expected to provide any significant ammonia, nitrate or phosphorus removal.

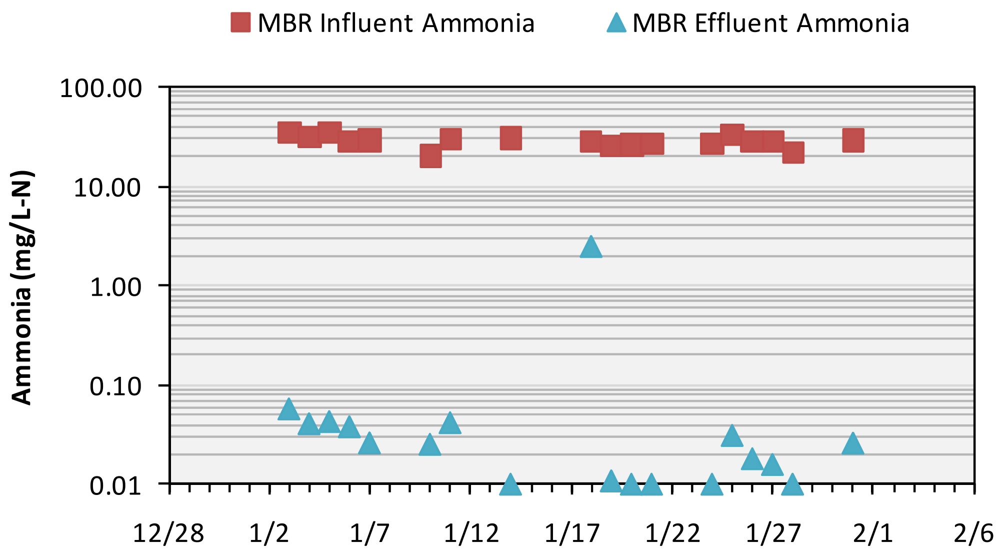

Figure 2 – Influent and Effluent Ammonia Concentrations for the MBR System

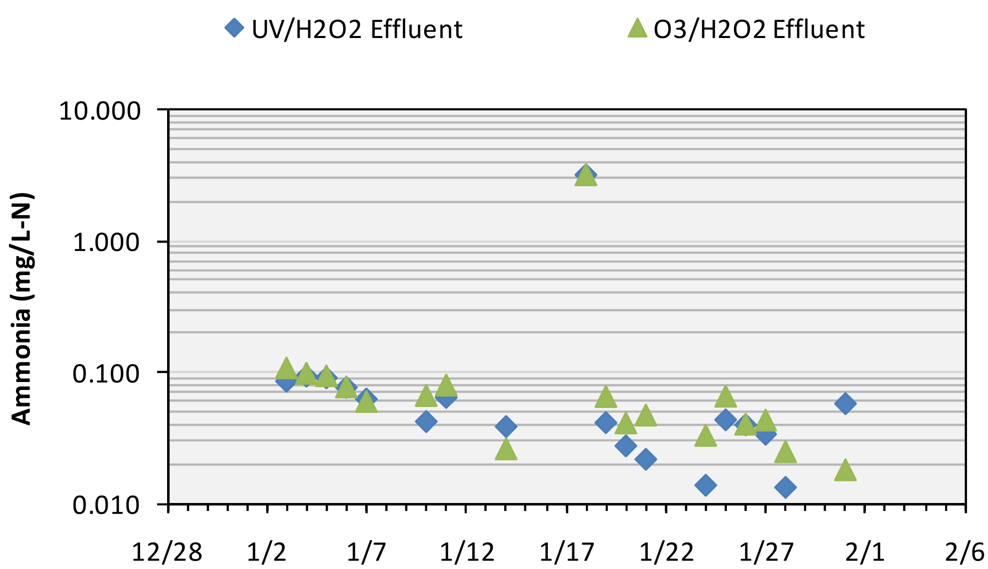

Figure 3 – Ammonia Concentrations in the UV and Ozone System Effluents

Figures 4 and **5** demonstrate the nitrate removal observed in the pilot systems evaluated during operation of Train A. As shown in **Figure 4**, the effluent nitrate concentrations were measured at much higher than expected levels for most of the reporting period, primarily due to upsets caused during the operational and maintenance issues experienced during most of the reporting period. As mentioned in the operations summary, MicroCg (carbon source for denitrifiers) was not being dosed in early January due to clogging of the chemical dosing pump. Following that, a recovery clean was performed, during which a significant volume of mixed liquor was accidentally drained and mixed liquor concentration was reduced dramatically. It took two weeks to achieve the desired MLSS concentration in the bioreactors. Once these issues were resolved, denitrification efficiency of the MBR system increased gradually and the effluent nitrate concentration was reduced from peak concentration of 18.6 mg/L-N on 24th January to 2.6 mg/L-N on 28th January. The average ammonia concentration in the feed water during the reporting period was measured at 28.4 mg/L-N.

Figures 6 and **7** demonstrate phosphorus removal observed in the MBR, ozone and UV systems. As shown in **Figure 6**, the phosphorus removal by the MBR system varied significantly with phosphorus concentration in the MBR effluent samples measured below 0.3 mg/L-P for about half of the samples. During the reporting period, the phosphorus concentration in the feed water varied from 1.6 to 3.0 mg/L-P with average concentration of 2.3 mg/L-P. It should be noted that the pilot system is not designed to automatically adjust the chemical dosing based on the influent water quality.

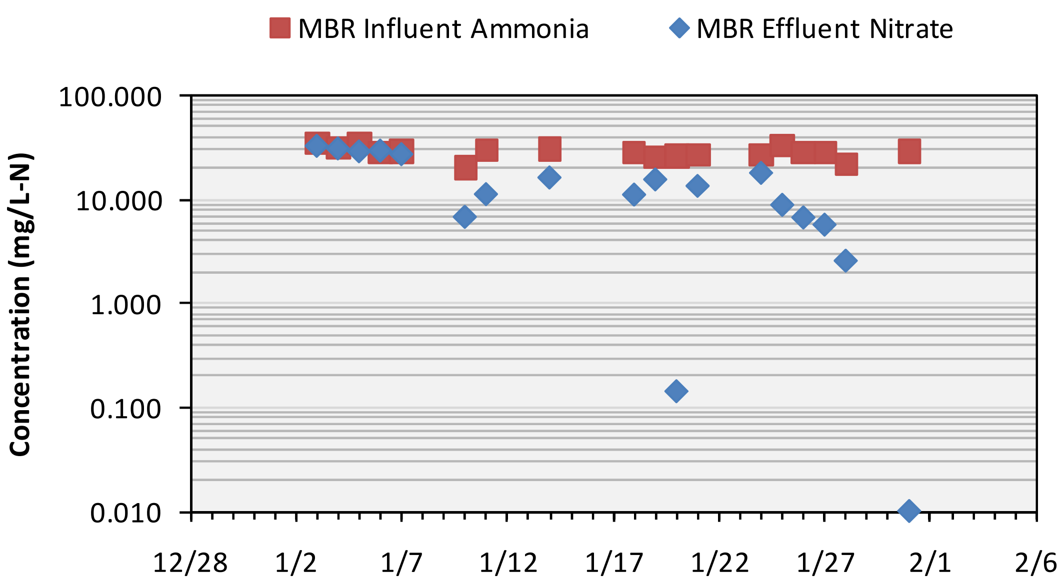

Figure 4 – Influent Ammonia and Effluent Nitrate Concentrations for the MBR System

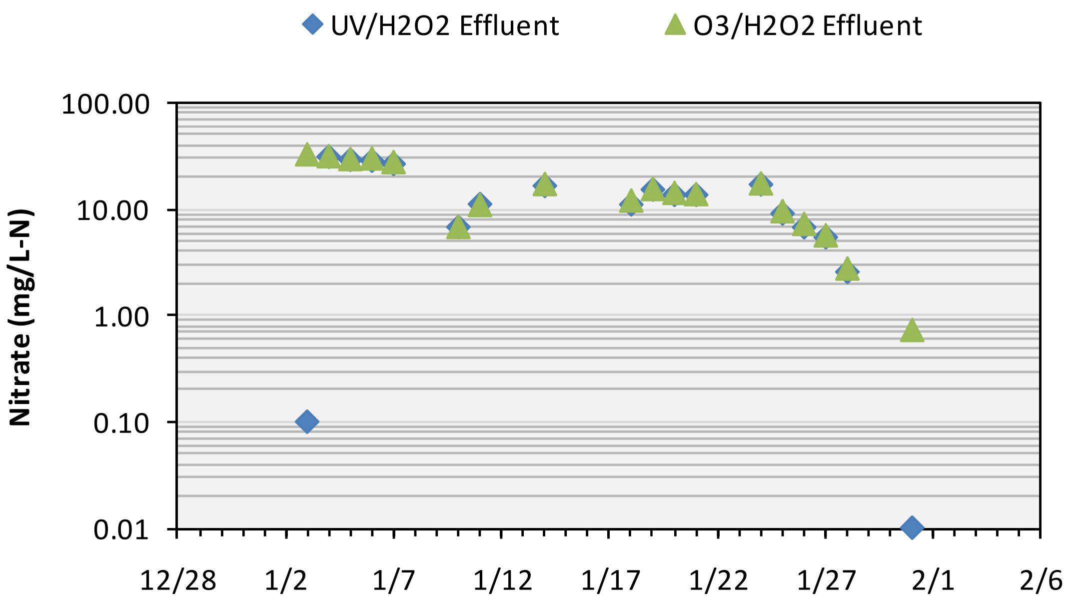

Figure 5 – Effluent Nitrate Concentrations for the Ozone and the UV Systems

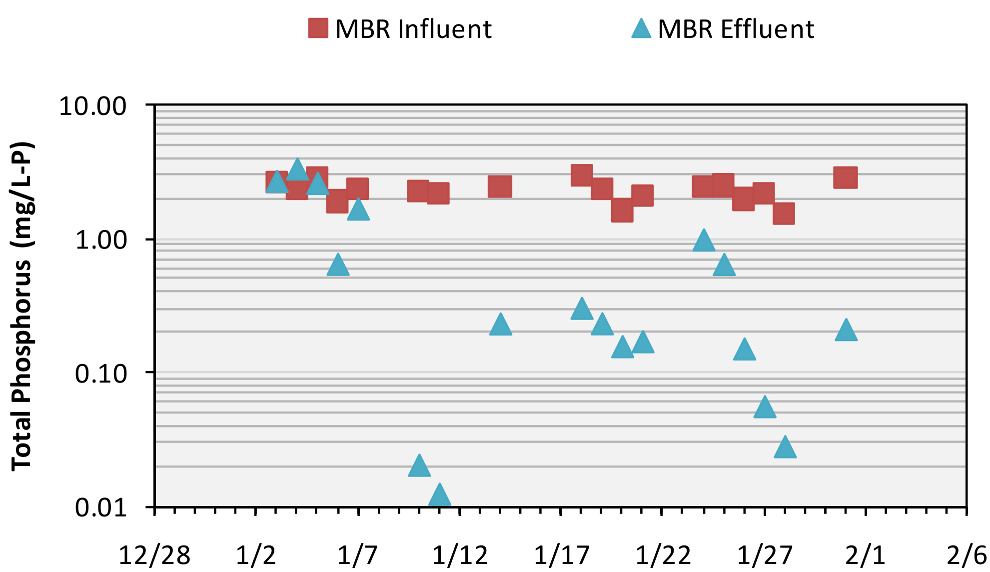

Figure 6 – Influent and Effluent Total Phosphorus Concentrations for the MBR System

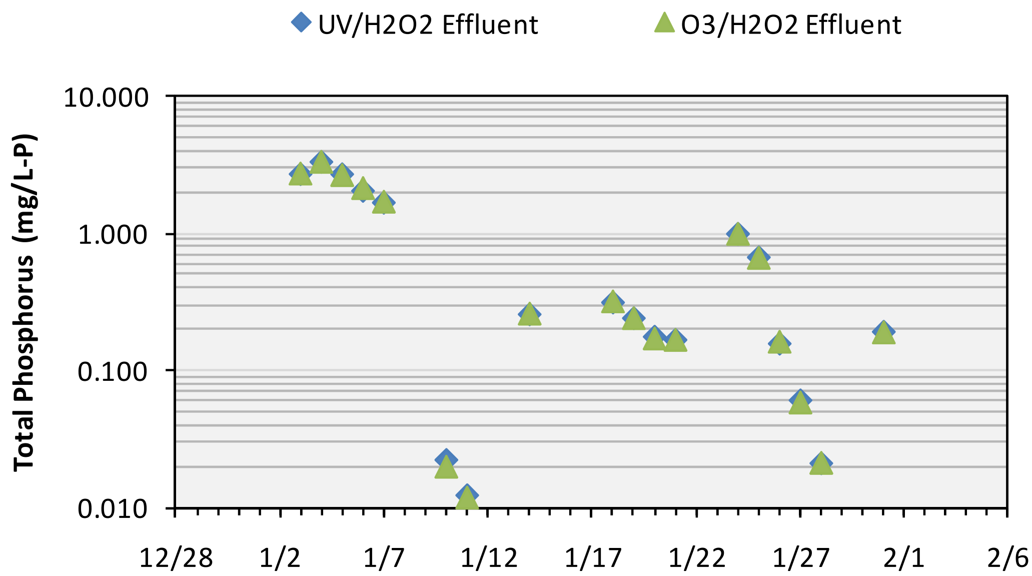

Figure 7 – Effluent Phosphorus Concentrations for the Ozone and the UV Systems

III. MONTHLY WATER QUALITY SAMPLING SUMMARY

Monthly microconstituent sampling took place on December 21, 2010. This sampling event took place from 9:30 AM to 4:00 PM. Composites and grab samples for MBR influent (MBR in), MBR filtrate (MBR out), UV/Peroxide effluent (UV/H2O2), and Ozone/Peroxide (O3/H2O2) effluent were taken. Test results have three to four weeks turn around and are shown on the Monthly_Data_Final April 2011.xlsx spreadsheet. These are also available on the project SharePoint site at https://fastplay.mwhtools.com/sites/miamidade/SitePages/Home.aspx

If you should have any questions or require additional information, please do not hesitate to contact me at (954) 846-0401.

Respectfully submitted,

MWH Americas, Inc.

Yurfa Glenny
Project Manager

cc.

Attachments: Daily Operational Logs Month No. 3

Provisional Daily and Weekly Water Quality Results Spreadsheet

MWH

BUILDING A BETTER WORLD

April 20, 2011

Mr. James Ferguson, P.E.
Miami-Dade Water and Sewer Department
23200 SW 97th Avenue, Suite 1
Miami, Florida 33190

Subject: Agreement No. 08MWHA007
OCI Project No. E08-WASD-02A
Work Order No. 4 BBCWRPP - Pilot Operations, Water Quality Reports, Laboratory and Stakeholder Management and Coordination
Monthly Pilot Operations and Water Quality Report

Dear Mr. Ferguson:

MWH Americas, Inc. (MWH) is pleased to submit the third monthly Summary Report for the Biscayne Bay Coastal Wetlands Rehydration Pilot Project (BBCWRPP) Operations and Water Quality Monitoring. This summary report covers the reporting period from February 1, 2011, at 07:30 hours through February 28, 2011, at 17:00 hours.

I. DAILY OPERATIONS SUMMARY

During the reporting period, the operational performance of Train A and Train C was evaluated. Train C, with RO in operation, was continually tested from February 8th to February 24th while Train A was tested during the beginning and end of the month. The MBR, RO, Ozone and UV systems were operated at flow rates of 28-29, 21-22, 10-11 and 10 gpm respectively for the reporting period.

The following operations and maintenance issues occurred during this reporting period:

1) The UV system was shut down temporarily on 4th February to clean the lamps.

2) Severe foaming was observed in the MBR system on 14th February which required shut down of the RO, ozone and UV systems.

3) The MBR system shut down multiple times from 28th February to 2nd March due to lack of feed water in the equalization tank. Due to maintenance issues at the South District WWTP, the pumps delivering water to the equalization tank were not able to draw sufficient secondary effluent.

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Figure 1 presents the TSS and VSS concentrations measured in the bioreactors of the MBR system. The MLSS concentration in the anoxic tank was maintained at the target concentration of 8,000 mg/L during the reporting period. Due to rise in trans-membrane pressure (TMP) of the MBR system, maintenance cleaning (EFM) was performed on 11th February. This required the MBR system to shut down temporarily but the maintenance clean was not found to be effective. As a result, a second maintenance clean was performed on 14th February, which helped recover the membrane permeability. These multiple cleaning events may have resulted in upset of biomass, which was evident from severe foaming observed in the bioreactor tanks on 14th February and a drop in active biomass concentration in the anoxic tanks (low volatile solids concentration). As a result of severe foaming, the RO, ozone and UV systems were shut down temporarily.

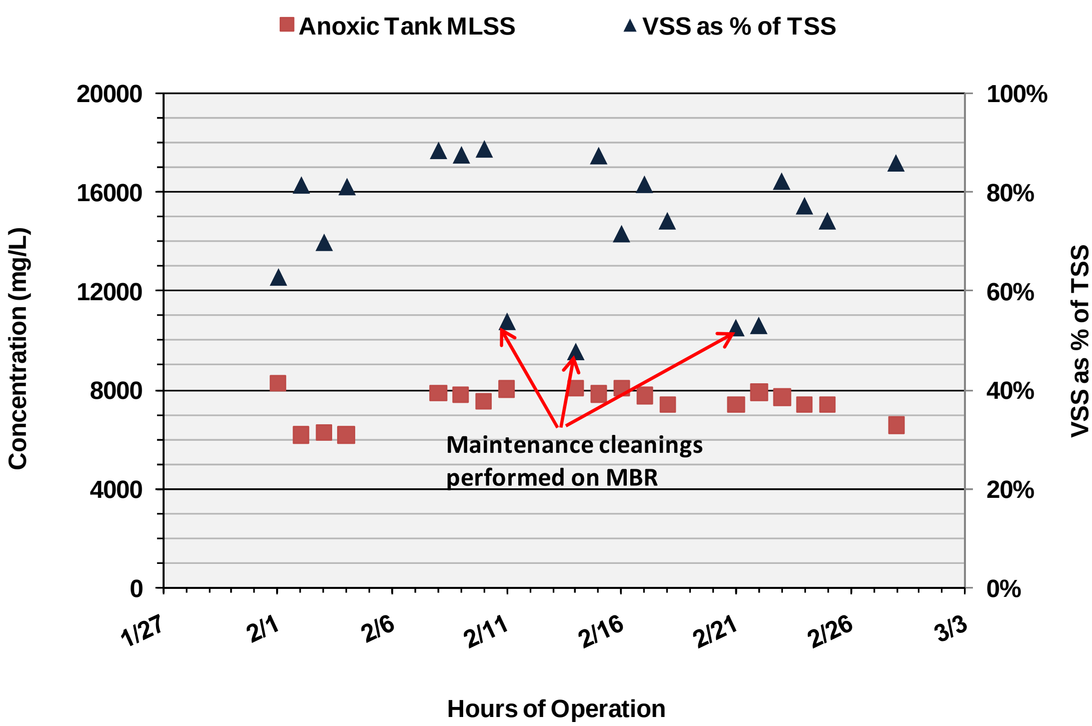


Figure 1 – TSS and VSS Concentrations in the Mixed Liquor of the MBR System

II. DAILY AND WEEKLY WATER QUALITY SAMPLING SUMMARY

During this reporting period, water quality was monitored through online instruments, field testing with handheld instrument and laboratory tests. The daily and weekly water quality monitoring provides a direct correlation of the performance of the pilot treatment units as well as the level of treatment that can be achieved during different operational conditions. A tabulated spreadsheet was prepared to record and analyze this data (refer to electronic spreadsheet BBCWRPP Water Quality Operations

Data_06072011_KEH.xlsx). Please note that the latest version of this electronic file will be submitted with these reports, thus water quality data will extend further than this progress report.

The graphical representations of key water quality parameters are shown in the figures below. **Figures 2** and **3** show the ammonia removal observed in the MBR, Ozone and UV systems. As shown in **Figure 2**, the MBR pilot system achieved complete nitrification from 1st February to 14th February but following the maintenance cleanings and foaming issues, effluent ammonia concentration spiked to 9 mg/L-N and gradually declined to normal levels on 22nd February. As shown in **Figure 3**, the effluent ammonia concentration observed in the reverse osmosis (RO) permeate were measured at the detection limit of 0.01 mg/L-N for most of the reporting period but slightly higher ammonia concentrations were observed for RO permeate when the feed (MBR filtrate) concentration increased from 14th to 21st February. For feed ammonia concentration varying from 2.7-8.7 mg/L-N, the RO system provided 94-99% rejection of ammonia (RO permeate ammonia concentration below 0.5 mg/L-N), indicating that RO could serve as a polishing step for meeting stringent total nitrogen limits in the event of upset in bioreactor basins of the MBR system. The ammonia concentration in the ozone and UV system effluents were similar to that observed in the RO system effluent since these systems are not expected to provide any significant ammonia, nitrate or phosphorus removal.

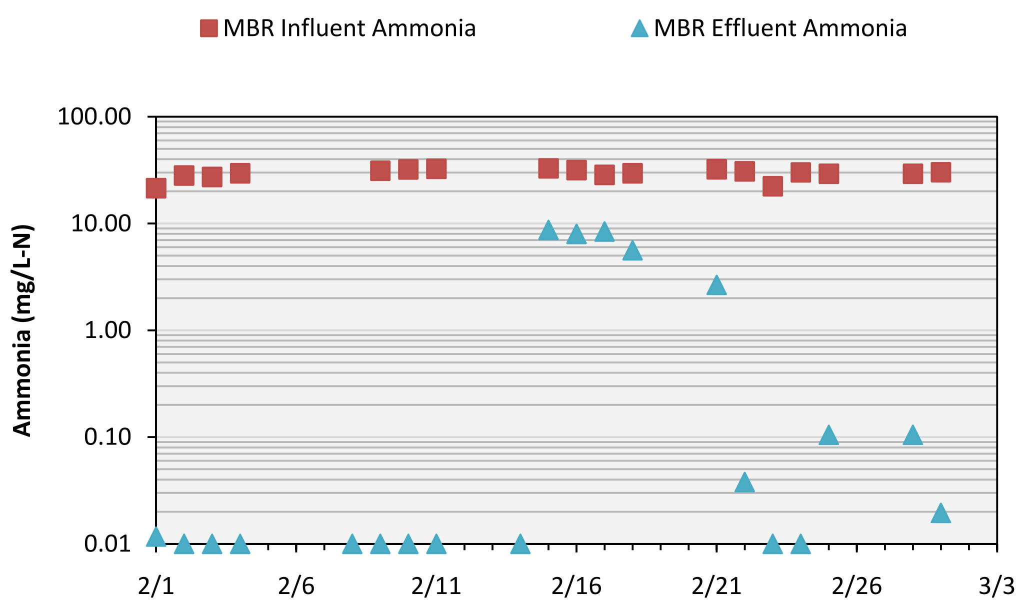


Figure 2 – Influent and Effluent Ammonia Concentrations for the MBR System

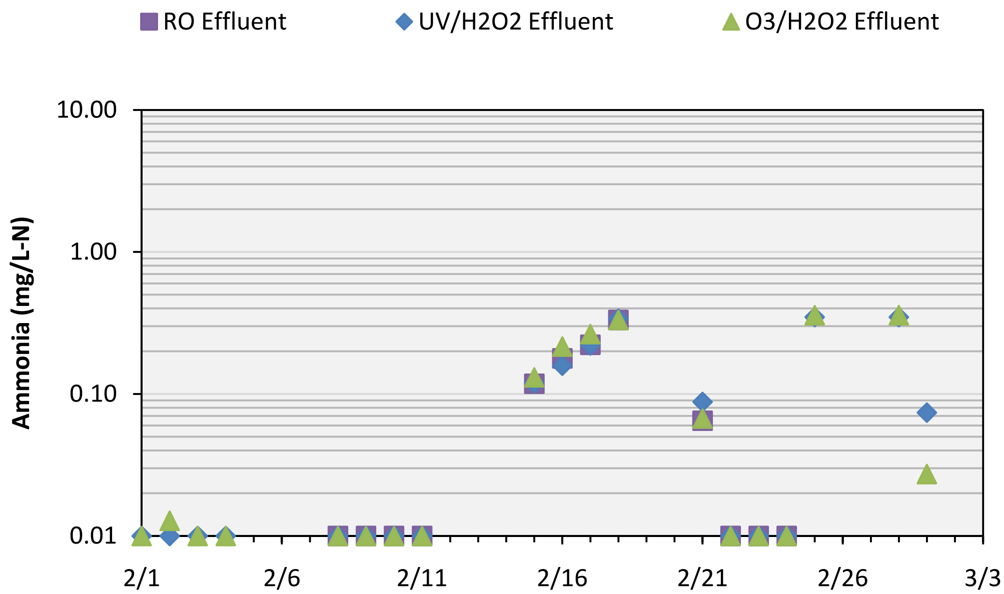


Figure 3 – Ammonia Concentrations in the RO, UV and Ozone System Effluents

Figures 4 and **5** demonstrate the nitrate removal observed in the pilot systems evaluated during operation of Train A and C. As shown in Figure 4, denitrification efficiency of the MBR system varied during the reporting period with effluent nitrate concentrations varying from 0.01 to 7.7 mg/L-N. Since MicroCg (external carbon source) was added a constant rate and the feed ammonia concentration stayed below 35 mg/L-N throughout the reporting period, it is likely that DO carryover from the aeration tank may have resulted in these fluctuations in the effluent nitrate concentrations. Effluent nitrate concentrations were measured mostly below 1 mg/L-N for the second half of the reporting period. The nitrate concentrations in the RO permeate were measured below 0.2 mg/L-N and when the feed (MBR filtrate) nitrate concentration varied from 4.3 to 7.7 mg/L-N, the RO system provided 97.5 to 99.8% rejection of nitrate.

Figures 6 and **7** demonstrate phosphorus removal observed in the MBR, RO, ozone and UV systems. As shown in **Figure 6**, MBR effluent phosphorus concentration was measured below 30 µg/L for majority of the samples collected during the reporting period but occasional spikes of up to 0.75 mg/L were observed. The influent total phosphorus concentration varied from 2.1 to 5.3 mg/L during this period. The RO effluent phosphorus concentrations were measured mostly at the detection limit of 2 µg/L while those for the effluents from the advanced oxidation processes were measured similar to MBR effluent or RO effluent depending on the feed to these processes.

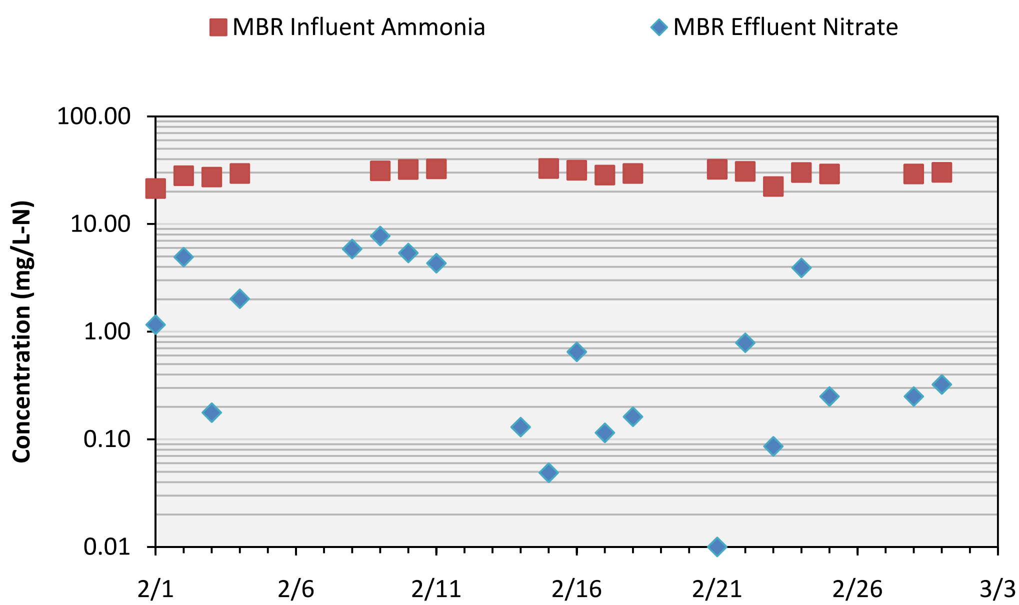


Figure 4 – Influent Ammonia and Effluent Nitrate Concentrations for the MBR System

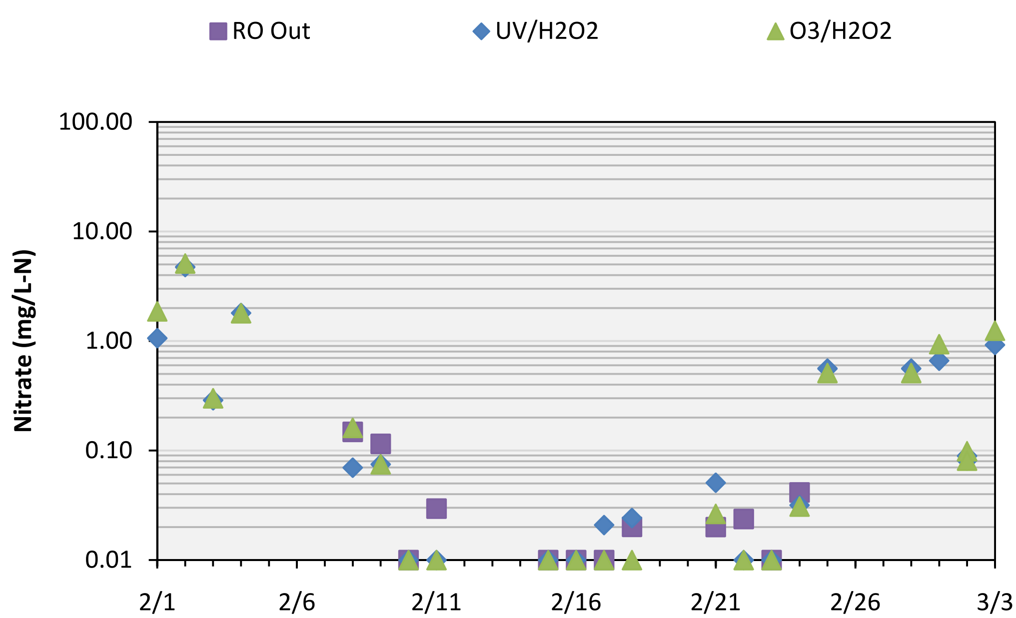


Figure 5 – Effluent Nitrate Concentrations for the RO, Ozone and the UV Systems

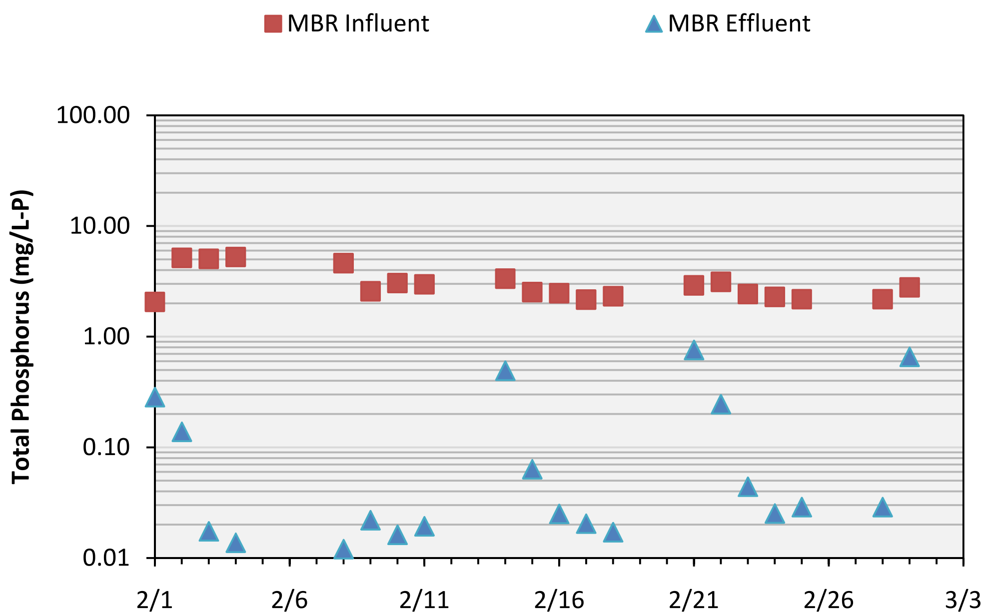


Figure 6 – Influent and Effluent Total Phosphorus Concentrations for the MBR System

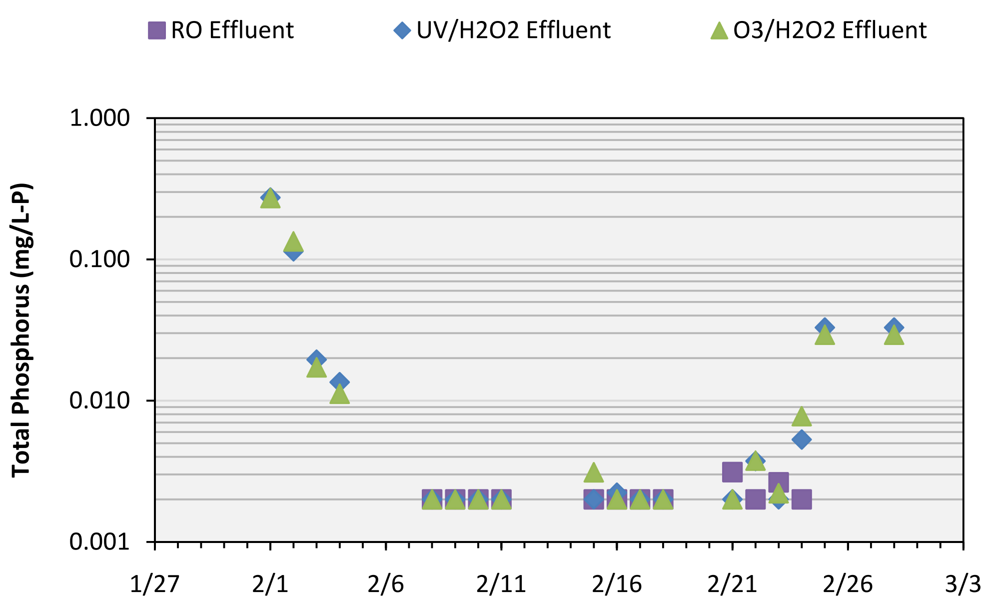


Figure 7 – Effluent Phosphorus Concentrations for the RO, Ozone and the UV Systems

III. MONTHLY WATER QUALITY SAMPLING SUMMARY

Monthly microconstituent samplings took place on February 7 and 9, 2011. Train A was sampled on February 7th and composites and grab samples for MBR influent (MBR in), MBR filtrate (MBR out), UV/Peroxide (UV/H2O2) effluent, and Ozone/Peroxide (O3/H2O2) effluent were taken. Train C was sampled on February 9th and composites and grab samples only for RO permeate (RO out), UV/Peroxide (UV/H2O2) effluent, and Ozone/Peroxide (O3/H2O2) effluent were taken while MBR influent and filtrate samples were assumed to have no change since sampled only 2 days prior during the sampling event on February 7th. The sampling events each took place from approximately 9:30 AM to 4:00 PM. Test results are shown on the Monthly_Data_Final April 2011.xlsx spreadsheet and are available on the SharePoint site at https://fastplay.mwhtools.com/sites/miamidade/SitePages/Home.aspx.

If you should have any questions or require additional information, please do not hesitate to contact me at (954) 846-0401.

Respectfully submitted,

MWH Americas, Inc.

Yurfa Glenny
Project Manager

cc:

Attachments: Daily Operational Logs Month No. 4
Provisional Daily and Weekly Water Quality Results

May 30, 2011

Mr. James Ferguson, P.E.
Miami-Dade Water and Sewer Department
23200 SW 97th Avenue, Suite 1
Miami, Florida 33190

Subject: Agreement No. 08MWHA007
OCI Project No. E08-WASD-02A
Work Order No. 4 BBCWRPP - Pilot Operations, Water Quality Reports, Laboratory and Stakeholder Management and Coordination
Monthly Pilot Operations and Water Quality Report

Dear Mr. Ferguson:

MWH Americas, Inc. (MWH) is pleased to submit the third monthly Summary Report for the Biscayne Bay Coastal Wetlands Rehydration Pilot Project (BBCWRPP) Operations and Water Quality Monitoring. This summary report covers the reporting period from March 1, 2011, at 07:30 hours through April 7, 2011, at 17:00 hours.

I. DAILY OPERATIONS SUMMARY

During the reporting period, the operational performance of Train A and Train C was evaluated. Train C, with RO in operation, was tested from 4th to 11th March and then from 24th March to 1st April while Train A was tested for the rest of the month. The MBR, RO, Ozone and UV systems were operated at flow rates of 27-29, 17-22, 10.8 and 10-15 gpm respectively for the reporting period. The ozone system was decommissioned on 9th March and later shipped back to the supplier. Following decommissioning of the ozone system, the UV system was operated at a higher flow rate (15 gpm) since excess RO effluent was available.

The following operations and maintenance issues occurred during this reporting period:

1) The MBR system shut down multiple times from 28th February to 2nd March due to lack of feed water in the equalization tank. Due to maintenance issues at the South District WWTP, the pumps delivering water to the equalization tank were not able to draw sufficient secondary effluent.

2) The UV system had an alarm on 3rd March stating that the auto wiping mechanism for the lamps was not functioning. Trojan Technologies was notified about this alarm, following which a technician from Trojan Technologies visited the site for troubleshooting.

Figure 1 presents the TSS and VSS concentrations measured in the bioreactors of the MBR system. The MLSS concentration in the anoxic tank of the MBR system was maintained close to the target concentration of 8,000 mg/L during the reporting period while the VSS as % of TSS was observed to vary from 70-90%.

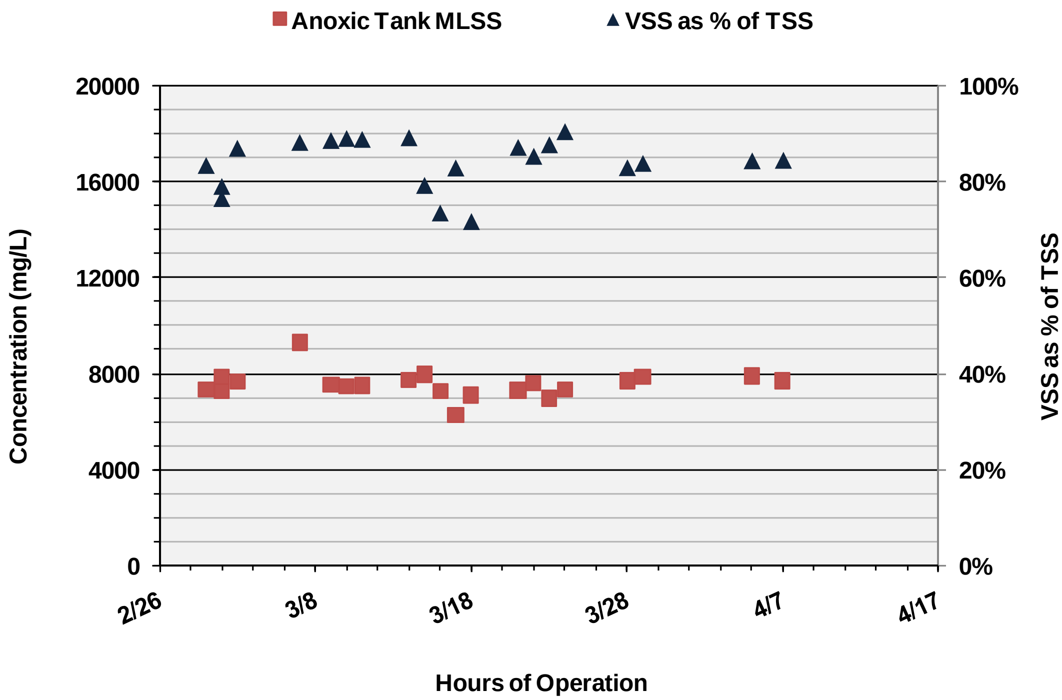


Figure 1 – TSS and VSS Concentrations in the Mixed Liquor of the MBR System

II. DAILY AND WEEKLY WATER QUALITY SAMPLING SUMMARY

During this reporting period, water quality was monitored through online instruments, field testing with handheld instrument and laboratory tests. The daily and weekly water quality monitoring provides a direct correlation of the performance of the pilot treatment units as well as the level of treatment that can be achieved during different operational conditions. A tabulated spreadsheet was prepared to record and analyze this data (refer to electronic spreadsheet BBCWRPP Water Quality Operations Data_06072011_KEH.xlsx). Please note that the latest version of this electronic file will be submitted with these reports, thus water quality data will extend further than this progress report.

The graphical representations of key water quality parameters are shown in the figures below. **Figures 2** and **3** show the ammonia removal observed in the MBR, RO, Ozone and UV systems. As shown in **Figure 2**, the MBR pilot system achieved complete nitrification for most of the reporting period with effluent ammonia concentrations below 1 mg/L-N. Due to high trans-membrane pressure (TMP), a maintenance cleaning was performed on MBR system on 25th March but the TMP reached 6.6 psi in next two days, which required another maintenance cleaning on 29th March. During this period, the system also lost nitrification and the effluent ammonia concentrations were measured at 19.7 and 20.4 mg/L-N on the samples collected on 28th and 29th March, respectively. The MBR system was able to achieve complete nitrification on 5th April.

As shown in **Figure 3**, the ammonia concentrations observed in the RO effluent were lower than MBR effluent, as expected and measured below 0.1 mg/L-N for most of the reporting period. When the MBR effluent ammonia concentrations increased to 19.7 and 20.4 mg/L-N on 28th and 29th March, respectively, the RO effluent ammonia concentrations were measured at 1.1 and 1.0 mg/L-N, respectively, indicating ammonia removal efficiency of 95%. The ammonia concentrations in the ozone and UV system effluents were similar to that observed in the MBR system effluent or RO system effluent (depending on the feed water to these systems) since these systems are not expected to provide any significant ammonia, nitrate or phosphorus removal.

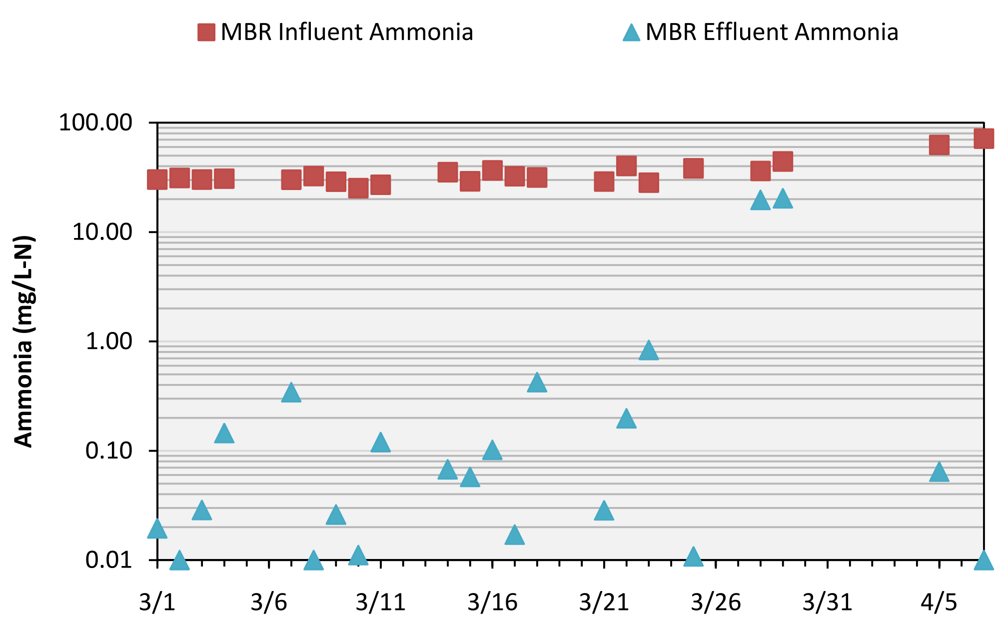


Figure 2 – Influent and Effluent Ammonia Concentrations for the MBR System

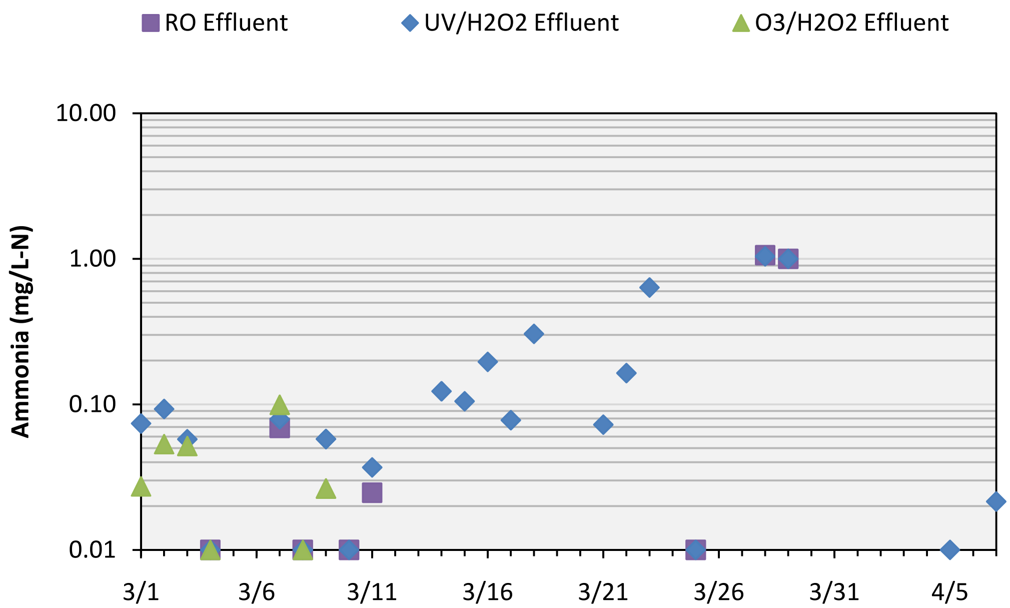


Figure 3 – Ammonia Concentrations in the RO, UV and Ozone System Effluents

Figures 4 and **5** demonstrate the nitrate removal observed in the pilot systems evaluated during operation of Train A and C. As shown in **Figure 4**, the MBR system achieved complete denitrification during most of the reporting period with effluent nitrate concentrations measured below 0.5 mg/L-N. Nitrate concentrations in the RO effluent were measured below those measured in the MBR effluent as the RO system is typically expected to provide greater than 80% rejection of nitrate.

Figures 6 and **7** demonstrate phosphorus removal observed in the MBR, RO, ozone and UV systems. As shown in **Figure 6**, phosphorus concentration in MBR effluent was measured below 100 µg/L for most of the reporting period while the influent concentration varied from 1.64 to 10.7 mg/L. The RO system was able to remove phosphorus to levels below the method's detection limit of 2 µg/L.

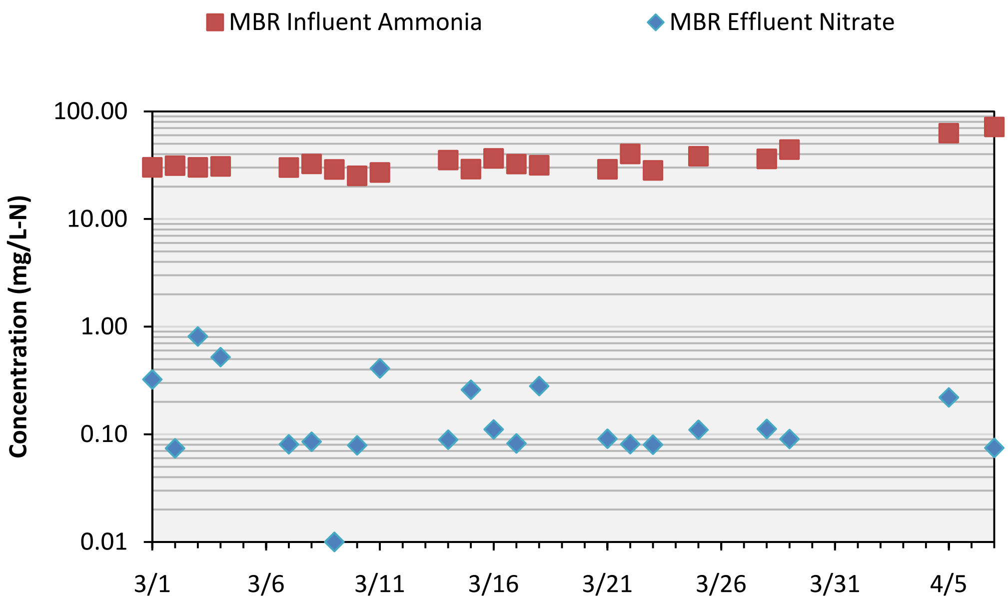


Figure 4 – Influent Ammonia and Effluent Nitrate Concentrations for the MBR System

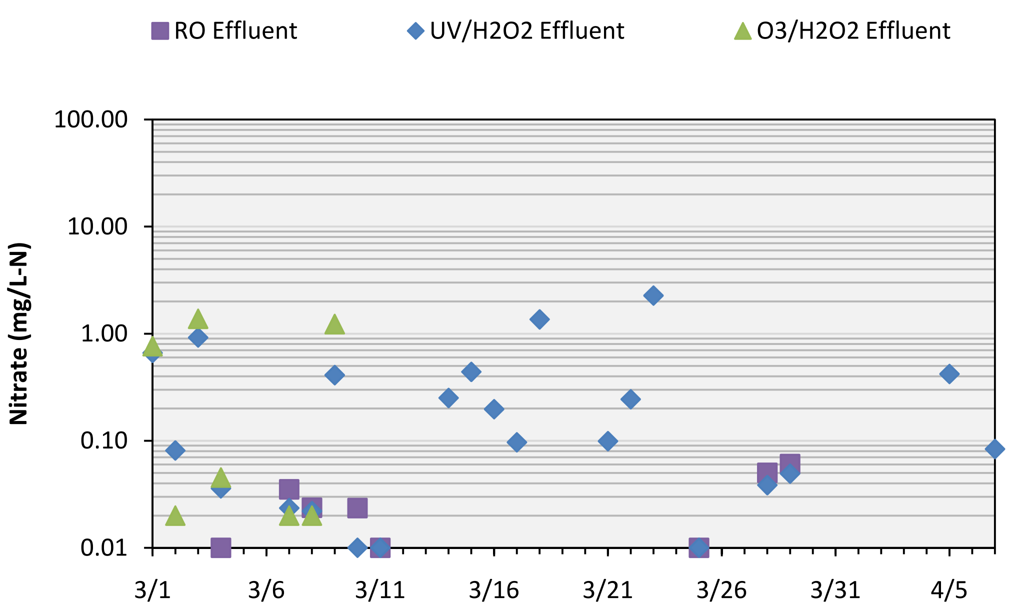


Figure 5 – Effluent Nitrate Concentrations for the RO, Ozone and the UV Systems

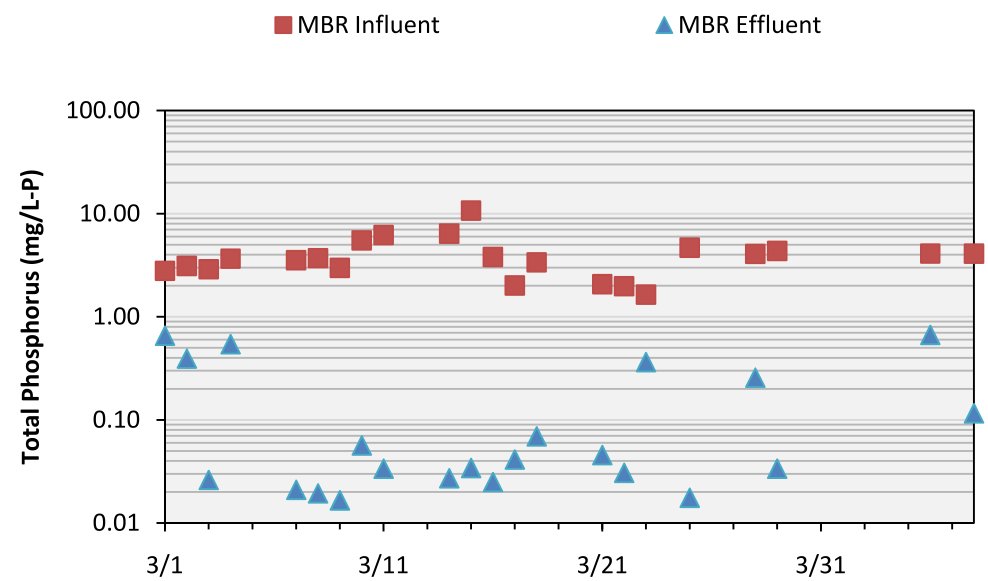
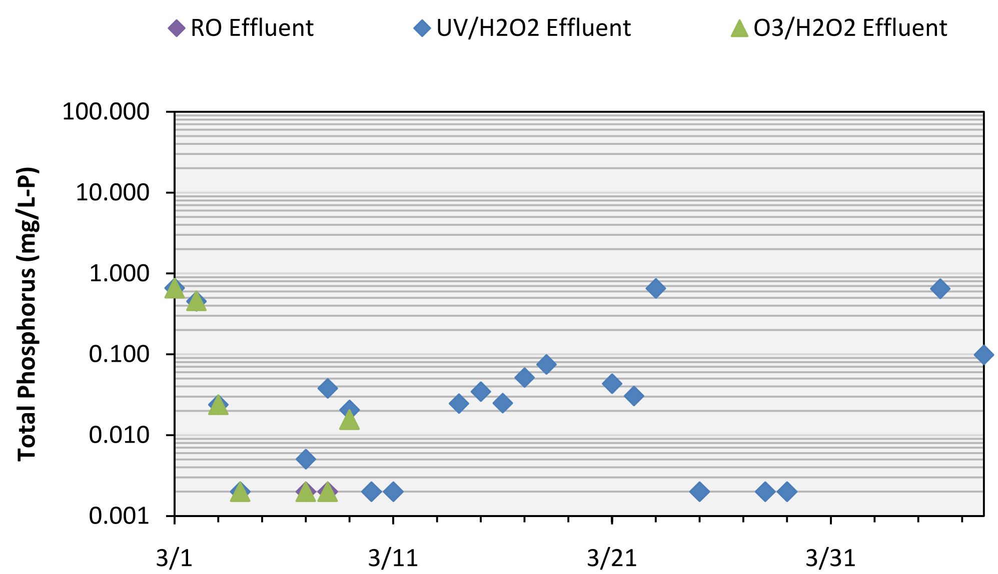


Figure 6 – Influent and Effluent Total Phosphorus Concentrations for the MBR System



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Respectfully submitted,

MWH Americas, Inc.

Yurfa Glenny
Project Manager

cc.

Attachments: Daily Operational Logs Month No. 5
Provisional Daily and Weekly Water Quality Results

Attachment A

CD

Water Quality and Operations Data

Monthly Microconstituent Data

Attachment B
Laboratory Reports

Attachment B

CD

MWH Laboratories

Water Quality Data Reports

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Project Team

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MWH

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