Chapter II. Background Information and Activities in Support of the Second Phase of the Karst Study

Introduction

This chapter presents additional background information on the sites and a summary of activities and observations during the project period leading up to the environmental and performance sampling described in chapter 1. This information relates to the bathhouses and water use, the history of upgrade activities and operational observations, and water quality measurements.

Bathhouses

The bathhouse at Hickory was originally established around 1962/63. The bathhouse at Magnolia II was likely established in the early 1970s[1]. Following the renovations of 2003 through 2005, and subsequent replacement of waterless urinals with low-flush toilets, the two bathhouses had the following configurations:

Magnolia II serves 20 campsites, each equipped with electricity and potable water supply. The bathhouse includes 4 showers, 4 sinks, and 4 low-flush toilets. The water meter also includes an outside faucet in front of the faucet, which was rarely used based on observations during site visits. The estimated sewage flow per Florida onsite sewage regulations is 1000 gpd.

Hickory serves 25 campsites, each equipped with electricity and potable water supply. The campground host site is located next to the bathhouse and the 2003/2004 renovations included providing a sewer connection for this site directly into the septic tank. The Hickory bathhouse includes 4 showers, 4 sinks, 4 toilets and 2 ADA compartments, which each included a shower, sink and toilet. It also includes an outside drinking fountain, which was not operable during most of the time period covered by this study [2]. The estimated sewage flow per Florida onsite sewage regulations is 1250 gpd.

The flood stages at Manatee Springs are: 2-yr flood 7 ft; 10 yr flood 13 ft; 100-yr flood 16 ft[3]. The elevation of the top of well casings at Hickory was surveyed to be between 14 and 17 feet (NGVD 1929). The elevation of the top of well casings at Magnolia II was surveyed to be between 6.5 and 10.3 feet (NGVD 1929).

Flow Data

Methods

The State Park staff performs approximately weekly maintenance visits of the onsite systems installed in the park. During these visits, the ranger usually washes off the outlet filters, checks the pump functioning, and records elapsed pump times and water meter readings.

Two years of records were copied from park service records to assess the distribution of observed flows, relative to the design values. The two years were the period from 1/17/2005, when water meter readings began to be included for the park's maintenance visits at Hickory, to 1/16/2006, and from 12/03/2007 to 12/01/2008. The records were generally weekly, with occasional deviations up to three days and one instance each in which one weekly visit had been omitted, and one additional instance when a reading for Magnolia II had not been recorded. Flows between system visits (weekly), monthly, quarterly and annual averages were calculated based on these values and their distribution graphed. The peak factor was calculated as the maximum yearly value of an average flow conditions divided by the annual average flow for that year and system.

Results

Figures 1 and 2 show the distribution of weekly and monthly average water uses for the two sites. Table 1 shows the statistical characteristics of water use. All four yearly series of observations show that the longer averaging periods tend to hide the very low and very high water use values.

These data resulted in an average peaking factor of 2.4 for weekly water use; 1.6 for monthly water use, and 1.2 for quarterly water use. Averaging water use over the two years, the design flow for both systems corresponds to a peaking factor of 2.1, which in this case is about the same as the peaking factor for the 98%-tile of the weekly water uses or approximately the second highest weekly water use in a year.

The flow data were obtained after the bath houses had been renovated and low-flush toilets been installed. Flows before these renovations during the work for phase I of this study, while not measured, can be expected to have been higher.

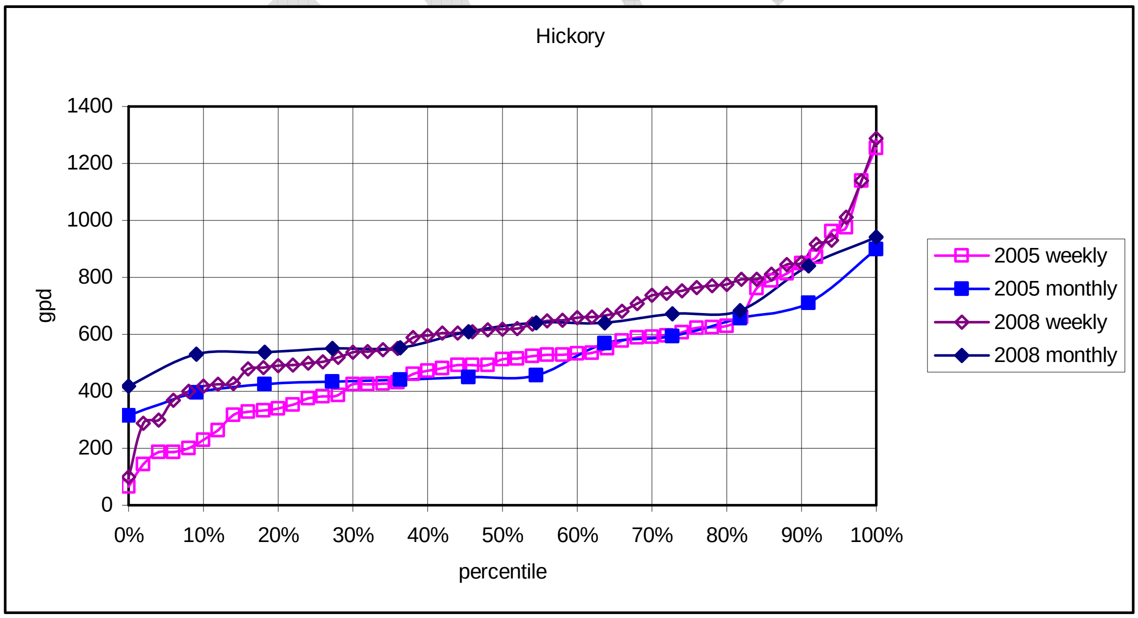


Figure 0-1. Distribution of weekly and monthly water use data for the Hickory bath house (design flow =1200 gpd)

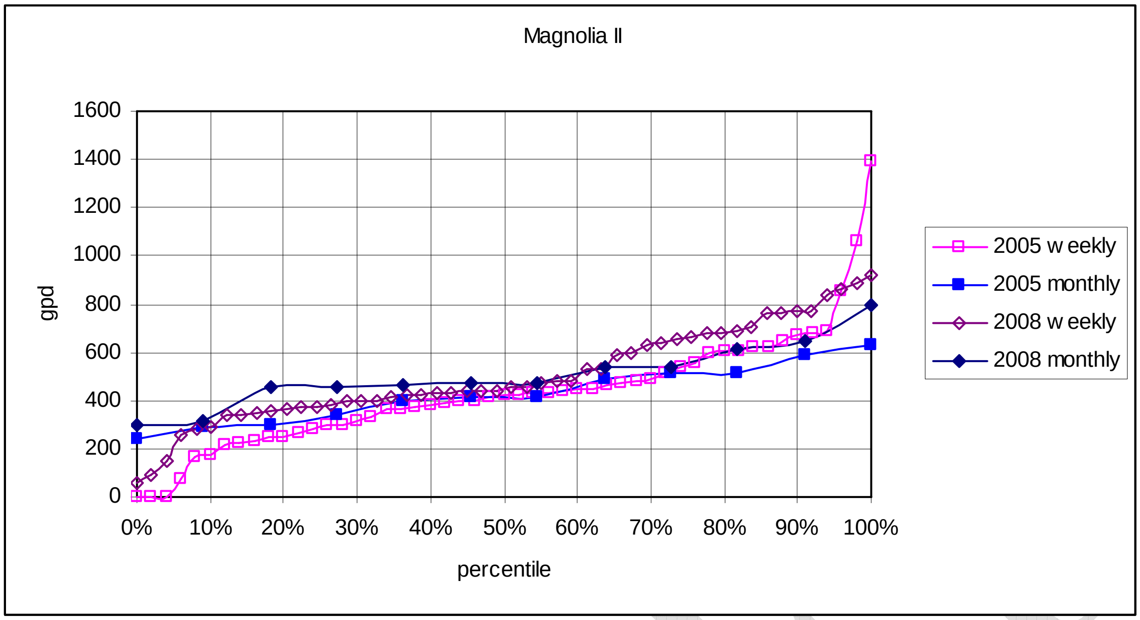


Figure 0-2. Distribution of weekly and monthly water use data for the Hickory bath house (design flow =1000 gpd)

Table 1. Summary of water use data for the two bathhouses, based on approximately weekly recordings

	Hickory (design flow 1200 gpd)						Magnolia II (design flow 1000 gpd)					
	2005 (average=524 gpd)			2008 (average=637 gpd)			2005 (average=425 gpd)			2008 (average=507 gpd)		
	Weekly	monthly	quarterly	weekly	monthly	quarterly	weekly	monthly	quarterly	weekly	monthly	quarterly
Stdev	243	164	84	211	142	118	249	121	52	200	137	74
Median	513	453	515	619	625	626	423	414	431	448	473	514
98-percentile	1139	858	634	1140	920	779	1061	620	483	889	765	578
Maximum	1255	899	641	1288	942	786	1395	630	485	917	798	579
peaking factor	2.4	1.7	1.2	2.0	1.5	1.2	3.3	1.5	1.1	1.8	1.6	1.1

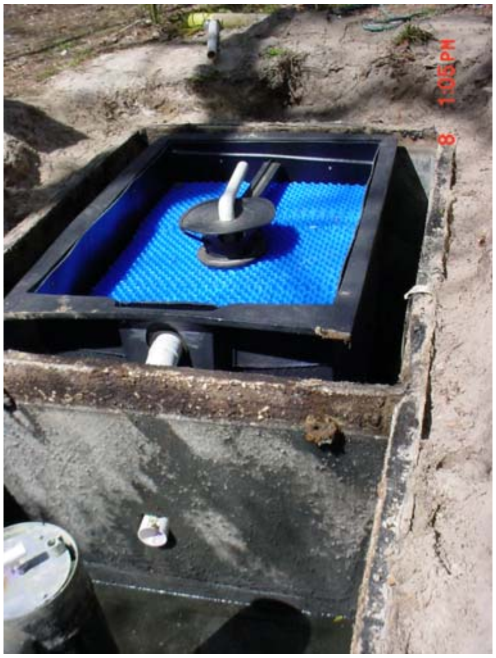
Treatment Systems and Upgrades

Hickory

The renovations implemented as part of phase I of this study and as part of the bathhouse renovations had resulted in the following configuration: The effluent from a 2300 gallon dual compartment septic tank flows to a Wye, from where valves determine if it flows either through a distribution box to a set of trenches that were subject of the study in the first phase, or through a 750 gallon tank to a 1250 gallon pump tank, from where the effluent is pumped to a low-pressure dosed mound (picture 1). During this construction some of the existing clay tile or drainage pipe and gravel drain lines of the site were intercepted.
The solicitation by the department for a proposal in 2005 emphasized the need to reuse the existing tanks upstream of the Wye in order to facilitate dispersal in the old drainfield within a limited budget. The only proposal by an engineer the department received resulted in the installation of a combined activated sludge/fixed film kit in the first compartment of the septic tank for nitrogen reduction (picture 2) and a phosphorus absorbing media into the second compartment in April through June of 2006. Initial operational and clogging problems at the inlet end were resolved and the treatment unit began operation.
The park management pumps all onsite systems out annually during the summer as a matter of routine maintenance. During these annual tank pumpings in 2007 and 2008 in was evident that the system as installed was not capable of treating the wastewater, resulting in excessive accumulation of solids in the kit. The kit was also deeper submerged in the effluent than designed, suggesting a backing up problem. At least in part this appeared to be due to lack of storage space for the large amount of indigestible solids received by the treatment system.
During the project period the system had recurrent problems with the pump system, including floats, controls or pumps. This has lead to intermittent use of the old drainfield contrary to what had originally been the plan for this study. Maintenance actions resolved issues temporarily until the spring of 2009 when it appears that the pump system is working properly continuously.
Concurrently with the 2008 pumping, the tanks were certified by a septic tank contractor and a site evaluation was completed that found an additional drain line in preparations for further modifications. The constraints of the site, including the presence of a concrete pad over the building sewer lines precluded installation of an additional trash tank upstream of the treatment tank. The engineer who had provided the original design developed a revised design that did not

include phosphorus absorption and replaced the intermediate 750 gallon tank with a 1138 gallon tank large enough to hold the treatment kit. The design then utilized a branch off from the existing low-pressure dosing lines coming out of the existing pump tank to return the effluent to the old drainfield. In this way, the old drainfield is lift dosed.
During construction parts of the old kit were damaged (picture 3), so a partially new kit was installed in the new treatment tank (picture 4). During the construction the installer determined that the first tank had been installed not level but uphill with the effluent side about three inches higher than the influent side. The modification was finally completed on March 23, 2009 (picture 5), the and the flow was then directed to the old drainfield.

Picture 1. Hickory bathhouse on 03/03/2006. Dosing tank in front, septic tank to the left of posts.



Picture 2. Original initial installation showing little solids storage room 03/08/2006.

Picture 3. Broken treatment kit, due to increased weight from solids accumulation (note textiles) (March 2009)

Picture 4. New treatment tank with treatment kit installed March 23, 2009

Picture 5. Post-installation site condition March 23, 2009.

Magnolia II

The aerobic treatment system and a pump system to a drainfield further removed from the flood plain were installed for the Park Service in 2004 as part of their continuing efforts to improve onsite sewage treatment within the state park system. This resulted in a conversion of the 2300 gallon existing septic tank to a function as trash tank. The effluent from the septic tank flows through a Wye, where valves allow control of flow towards either the old drainfield that was studied in phase I or to the aerobic treatment unit. The aerobic treatment unit with a nominal treatment capacity of 1000 gpd is followed by a 1050 pump tank. This pump tank is fiberglass tank with a midseam. The pump design includes two alternating pumps that transport effluent away from the system.

The pump system has experienced intermittent problems, so that effluent from the septic tank rather than the aerobic treatment unit has from time to time period discharged to the gravity-fed drainfield studied during phase I. In the beginning of 2007, one pump became operational and effluent was discharged at the new drainfield away from the monitoring wells. After some additional pump issues, by 10/14/2008, pumps were operational and the effluent set to be pumped to the new drainfield. As reported by the park manager, the problems here appear to have centered around the functioning of the control panel.

While the original treatment concept for this system envisioned the use of recirculation from the ATU to the septic tank, further review of Florida studies found that a combination of aerobic treatment unit and drainfield had been suggested as nutrient reducing treatment. Eventually these considerations concluded with a design the allows the effluent from the ATU to be lift-dosed into the old drainfield.

In preparation of this modification, a site evaluation was completed in May 2008. All tanks were pumped and certified as structurally sound and all drainfields were evaluated according to DOH standards. This information was a necessary component of the septic modification permit.

In June 2008 an inspection and maintenance visit by the regional distributor of the ATU-technology occurred who restored the aeration system and resolved an overheating problem of the air supply.

The modifications to the system as previously existing were the following (picture 6):

- Install piping to allow alternating drainfield lift-dosing from the existing ATU to either the old existing drainfield for the duration of the research project or to the new existing drainfield
- Install an inspection port to monitor quality of effluent going into the old drainfield
- Replace the existing distribution box and piping between the distribution box and the proposed inspection port

The modifications were made in February 2009, and on March 09, 2009, the ATU-effluent was directed toward the monitored drainfield after verification that the old drainfield was not pressurized by a dose of effluent. During this work concerns about float functioning arose and on March 31, further observations suggested that the on-float was not working properly, and that leakage through the mid-seam of the pump tank might be occurring. On April 02, 2009, the float was replaced and set to trigger pumping below the water level reaches the mid-seam.

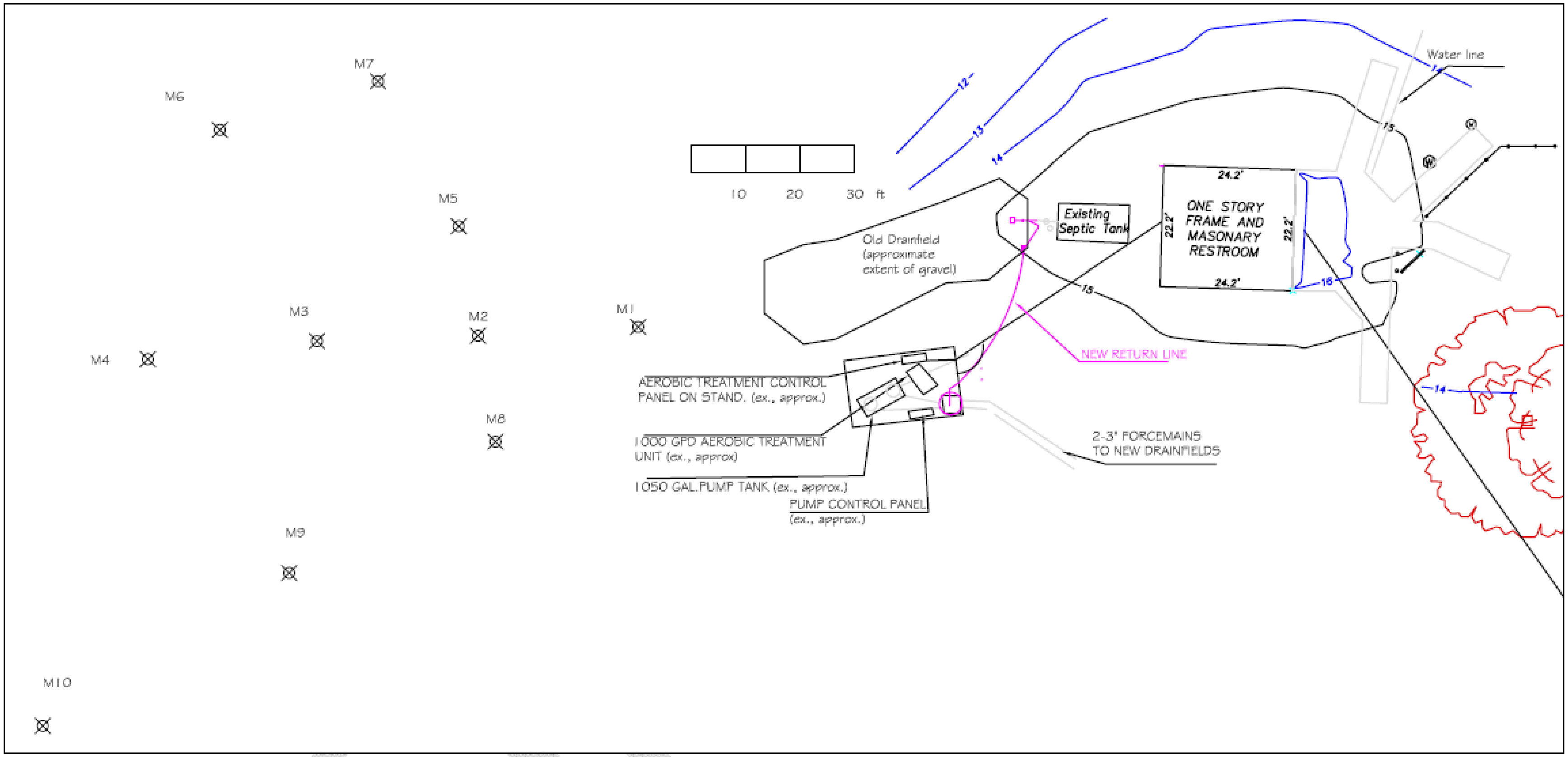


Figure 1. Magnolia II bathhouse with treatment system and monitoring wells.

Picture 6. Magnolia II: Installing the return line from the ATU to the old drainfield, 02/24/2009.

Picture 7. Magnolia II: old drainfield on 02/24/2009 and 03/31/2009, prior to consistent dosing of the old drainfield.

Drainfield Use

Methods

Drainfield use was reconstructed based on comments and annotations found in the weekly OSTDS-maintenance visits by park staff; a history of maintenance events and observations recorded by the park ranger; notes in communications between park and Department staff, and observations during field visits by Department staff.

Results

At the Hickory site, the bathhouse was closed from 09/04/2003 through 05/02/2004 for renovations to the bathhouse and installation of a pump tank to a low-pressure dosed drainfield some distance away. Pump time readings show pumping to the new drainfield from 07/26/2004-07/25/2005 with the exception of closing for hurricane from 09/02/2004 to 10/04/2004. From 07/25/2005 through 08/29/2005 the old drainfield was used during repairs to the pressure line. From 08/29/2005 to some time between August 2006 and May 2007 the new drainfield was used. The old drainfield was then used through 05/30/2008. From then on, the new drainfield was used, with possible short periods of interruptions to accommodate work on the pumps. After installation of the modifications the valve was switched predominantly to the old drainfield on 03/23/2009. From 04/13 through 04/27/2009 the park was closed due to flooding. About 06/08/2009 the valves were adjusted to distribute flow both to the old and the new drainfield.

At the Magnolia II site, bathhouse renovation began on 04/19/2004. This renovation included installation of an aerobic treatment unit and a pump tank to serve a low pressure dosed drainfield some distance away. From 9/02/2004 to 10/04/2004 the park was closed due to hurricanes. Pump timer readings indicate that with the exception of 10/11/2004 through 01/03/2005 when the new drainfield was used, the old drainfield was predominantly used through January 2006. Issues relating to the control panel for the pump station and the pumps resulted in intermittent use of the new drainfields from then on. From 02/2006 to 04/10/2006 the new drainfield was used, followed by a period of time through 08/17/2006 when the old drainfield was used. New drainfield use continued through at least June 2007, but the old drainfield was then used for a period before 3/3/2008, and continued to be used from sometime between 03/11/2008 and 5/5/2008 through 10/14/2008. From 10/14/2008 through 03/09/2009 the new drainfield was used, at which time the modifications had been completed and the treated effluent flow was predominantly directed to the old drainfield. On 03/31/2009 it was discovered that the on-float for the pump controls was not working properly, this may have resulted in a release of effluent from the pump tank to its immediate surroundings prior and after this time instead of flowing to the designated drainfield. About 04/02/2009, the pump floats were repaired to ensure operation of the pumps and flow to the drainfields. From 04/13 through 04/27/2009 the park was closed due to flooding. About 06/08/2009 the valves were adjusted to distribute flow both to the old and the new drainfield.

Water Quality Measurements

Methods

Water and effluent samples were obtained on several occasions by DOH staff, the Department's contractor for sampling, and Suwannee River Water Management District staff, as detailed below. Two laboratories analyzed samples for this project. In phase 1 of the study and through 2008, Ackuritlabs (A) in Tallahassee analyzed the samples. Late in 2008, the contractor for sampling in this study began to utilize McGlynn Laboratories (M) in Tallahassee. Both laboratories were NELAC-certified for the methods used. The slight variations in methods applied are shown in table 2.

Table 2. Laboratory analytes and methods used by the two laboratories providing data for this study.

Analyte	Units	Ackuritlabs, Inc.	McGlynn Laboratories
Fecal Coliform	cfu/100 mL	SM 9222D	SM 9222D
Nitrite-N	mg/L	SM 4500NO2B	EPA 354.1
Nitrite+Nitrate-N	mg/L	n/a	EPA 353.3
Nitrate-N	mg/L	EPA 353.3	calc
Ammonia-N	mg/L	EPA 350.2	EPA 350.3
TIN	mg/L	n/a	calc
TKN	mg/L	EPA 351.3	EPA 351.4
organic N (calc)	mg/L	n/a	calc
TN	mg/L	Calculated	Calculated
TP	mg/L	EPA 365.3	EPA 365.2
Ortho-Phosphorus	mg/L	EPA 365.3	n/a
cBOD5	mg/L	SM 5210 B	n/a
TSS	mg/L	EPA 160.2	n/a
Alkalinity	mg/L as CaCO3	EPA 310.1	n/a

OSTDS Water Quality Measurements

Methods

Samples were either obtained with an intermediate container that was rinsed with effluent before taking the sample, or by means of the pumping equipment of a global water automatic sampling device, which included flushing the line before taking a sample. Samples indicated as taken from within the effluent filter were obtained by removing the effluent filter, letting turbidity settle and taking a sample from within the frame of the effluent filter.

Concentrations in and out of the treatment units were measured on several occasions. The occasion can be grouped together as follows:
During the first phase of the nutrient reducing design, both systems were envisioned to function with an effect of treatment on the most upgradient tank compartment. Without a separate tank, there would be no raw sewage to measure influent concentrations in. To accommodate this, concentrations in the outlet filters of the septic tanks were measured, as well as other points representing effluent concentrations. These sampling events were funded by the Department and performed by DOH staff. They occurred on 03/23/2006, 05/15/2007, and 06/04/2007.

In 2007, the park management obtained funding from the Florida Department of Environmental Protection for lab analyses of a one-time sampling event of multiple aerobic treatment units and arranged with Department of Health staff to take the samples in combination with sampling the treatment systems under study as discussed before. These samples were taken on 05/15/2007 and 06/04/2007, mostly by means of an intermediate container that was held under free-flowing effluent into pump tanks.

On two occasions DOH's contractor for sampling also obtained samples from onsite systems in association with a well sampling event. Several locations were sampled on 01/10/2006. The pump tank basin of Magnolia II was sampled on 01/14/2009.

Results

Table 3. Magnolia II nutrient and fecal coliform data for septic tank effluent and ATU effluent.

Effluent Type	Effluent Location	Sampling	Dups	Date	Sampler	Lab	Fecal Coliform	Nitrite-N	Nitrate-N	Nitrite+ Nitrate-N	Ammonia-N	TKN	TN	TP
							cfu/ 100 mL	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Septic	in effluent filter			1/10/2006	HH	A	50000	.012U	0.367		68.9	70.4	70.8	31.3
Septic	in effluent filter	int. cont.		3/23/2006	ER	A		.012U	.012U		79.9	133	133	10.9
Septic	in effluent filter	int. cont.	dup	3/23/2006	ER	A		.012U	.012U		82.6	110	110	12.2
Septic	in effluent filter	pump		3/23/2006	ER	A		.012U	.012U		83.4	148	148	11.8
Septic	in effluent filter	pump	dup	3/23/2006	ER	A		.012U	.012U		90	148	148	10.8
Septic	in effluent filter	pump		5/15/2007	ER	A				.012U	62.4	70.6	70.6	11.8
Septic	in effluent filter	pump		6/4/2007	ER	A				0.165	104	107	107.2	14.7
ATU	pump tank	pump		3/23/2006	ER	A		.012U	.012U		92	96.7	96.7	12.3
ATU	pump tank	pump		3/23/2006	ER	A		.012U	.012U		92.8	116	116	10.2
ATU	after ATU	free fall		5/15/2007	ER	A				.012U	67	73.4	73.4	13.1
ATU	after ATU	free fall		6/4/2007	ER	A				0.193	92.6	101	101.2	15
ATU	pump tank	pump		6/4/2007	ER	A				0.143	94.2	99.6	99.7	14.3
ATU	pump tank	pump		1/14/2009	HH	M	3780	0.371	63.113	63.484	2.025	3.003	66.487	20.802

Table 4. Hickory nutrient and fecal coliform data for septic tank effluent and ATU effluent and treatment compartment.

Effluent Type	Effluent Location	Sampling	Dups	Date	Sampler	Lab	Fecal Coliform	Nitrite-N	Nitrate-N	Nitrite+ Nitrate-N	Ammonia-N	TKN	TN	TP	Ortho-P
							cfu/ 100 mL	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Septic	in effluent filter	int. cont.		1/10/2006	HH	A	280000	.012U	0.351		90.2	95.7	96.1	18.1	
Septic	pump tank	int. cont.		1/10/2006	HH	A	150000	.012U	0.389		92.2	110	110	19	
Septic	in effluent filter	pump		3/23/2006	ER	A		.012U	.012U		104	109	109	9.38	.014 U
Septic	pump tank	int. cont.		3/23/2006	ER	A		.012U	.012U		104	115	115	10	.014 U
Septic	pump tank	pump		3/23/2006	ER	A		.012U	.012U		101	121	121	8.53	.014 U
ATU	in effluent filter	pump		5/15/2007	ER	A				.012U	79.8	80.4	80.4	13.5	
ATU	in effluent filter	pump		6/4/2007	ER	A				63	40.8	46.2	109.2	12.2	
ATU	D-box	pump		6/4/2007	ER	A				61.5	37.5	44.2	105.7	12.5	
ATU	on treatment unit	pump		5/15/2007	ER	A				17.5	61	67	84.5	14	
ATU	on treatment unit	pump		6/4/2007	ER	A				59.5	34.2	37.6	97.1	12.4	
ATU	in effluent filter, stirred, contained solids	pump		5/15/2007	ER	A				0.575	83.9	559	560	15.2	

Table 5. Nutrient and fecal coliform data for ATU effluent of other bathhouse/restroom systems and a dumping station

System	Effluent Location	Sampling	Date	Sampler	Lab	Fecal Coliform	Nitrite-N	Nitrate-N	Nitrite+ Nitrate-N	Ammonia-N	TKN	TN	TP	Ortho-P
						cfu/ 100 mL	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Manatee Concession	after ATU	free fall	5/15/2007	ER	A	53600 B,L			.012U	80.2	94.2	94.2	12.7	
Fanning Springside	after ATU	free fall	5/15/2007	ER	A	630 B			22.7	4.03	4.48	27.2	2.44	
Fanning Springside	after ATU	free fall	6/4/2007	ER	A	31600			56	65	65.8	121.8	11	
Fanning Wayside	after ATU	free fall	6/4/2007	ER	A	170000			0.198	162	168	168.2	11.3	
Manatee Dumping Station	dosing tank	pump	3/23/2006	ER	A		.012U	.012U		772	785	785	57.5	.014U

Table 6. Magnolia II cBOD5, TSS and alkalinity data for septic tank effluent and ATU effluent.

Effluent Type	Effluent Location	Sampling	Dups	Date	cBOD5 mg/L	TSS mg/L	Alkalinity, mg/L as CaCO3
Septic	in effluent filter	int. cont.		3/23/2006	112	118	672
Septic	in effluent filter	int. cont.	dup	3/23/2006	100	68	624
Septic	in effluent filter	pump		3/23/2006	128	66	596
Septic	in effluent filter	pump	dup	3/23/2006	129	126	608
Septic	in effluent filter	pump		5/15/2007	220	54	510
Septic	in effluent filter	pump		6/4/2007	164	38	750
ATU	pump tank	pump		3/23/2006	80.4	52	596
ATU	pump tank	pump		3/23/2006	88.9	52	580
ATU	after ATU	free fall		5/15/2007	139	34	510
ATU	after ATU	free fall		6/4/2007	146	28	730
ATU	pump tank	pump		6/4/2007	111	18	640

Table 7. Hickory cBOD5, TSS and Alkalinity data for septic tank effluent and ATU effluent and treatment compartment.

Effluent Type	Effluent Location	Sampling	Date	cBOD5 mg/L	TSS mg/L	Alkalinity, mg/L as CaCO3
Septic	in effluent filter	pump	3/23/2006	149	164	520
Septic	pump tank	int. cont.	3/23/2006	91.5	46	584
Septic	pump tank	pump	3/23/2006	100	58	540
ATU	in effluent filter	pump	5/15/2007	239	92	570
ATU	in effluent filter	pump	6/4/2007	73.8	50	320
ATU	D-box	pump	6/4/2007	70.7	22	320
ATU	on treatment unit	pump	5/15/2007	161	122	420
ATU	on treatment unit	pump	6/4/2007	83.8	30	290
ATU	in effluent filter, stirred, contained solids	pump	5/15/2007	1363	10510	800

Table 8. cBOD5, TSS and alkalinity data for ATU effluent of other bathhouse/restroom systems and a dumping station.

System	Date	cBOD5 mg/L	TSS mg/L	Alkalinity, mg/L as CaCO3
Manatee Concession	5/15/2007	176	50	600
Fanning Springside	5/15/2007	5.4	4	147
Fanning Springside	6/4/2007	51.5	12	
Fanning Wayside	6/4/2007	118	28	
Manatee Dumping Station	3/23/2006	507	810	2500

Discussion

Effluent sampling. Except for TSS, agreement between duplicate samples was usually within 10%. There appeared to be no consistent difference between taking a sample with an intermediate container and pumping it when both were done. Effluent filter sampling at Hickory on 5/15/2009 showed that raising the effluent filter to gain access to the effluent can introduce sufficient turbulence to entrain solids. During the performance sampling this problem was addressed by lifting the effluent filter only briefly and a short distance and inserting the top of the peristaltic tubing inside Measurements since then suggest that nitrification is accomplished in the aerobic treatment unit.

Additional Background Water Quality Monitoring Data

Methods

The water quality of the potable water supply was determined by three grab samples from the faucet before the Magnolia II bathhouse. The potable water supply for all of Manatee Springs Park stems from a well upgradient of the bathhouses. The raw water is then treated and supplied to the bathhouses and campgrounds.

Grab samples were taken once from catfish hotel and from Manatee Springs. On the occasion of well sampling at the two bathhouses, water samples were also obtained from monitoring wells operated by the Suwannee River Water Management District. These wells are equipped with pumps. These samples were only analyzed for fecal coliform and nutrients.

One equipment blank of the auto sampler pumping equipment was taken by taking a sample from a DI water bottle.

Results

The results for fecal coliform and nutrients are shown in table 11. The results for cBOD5, TSS and alkalinity are shown in table 12.

Additional Well Monitoring Data

Methods

The Department’s contractor for sampling was tasked with additional sampling to maintain a record of the development of concentrations over time until the modifications to the treatment systems were accomplished. These sampling events followed the same procedures as the regular sampling for this project, and were funded by the Department. Such sampling events occurred on 05/10/2004, 11/23/2004, 1/26/2006, and 1/14/2009.

On May 20, 2008, in combination with the pump-out of tanks for preparation of permitting, DOH staff used the YSI probe to measure field parameters in the monitoring wells. The wells were not purged prior to measuring on this occasion.

Results

Table 9. Well nutrient and fecal coliform data at Magnolia II.

Well	Dups	Date	Sampler	Lab	Fecal Coliform	Nitrite-N	Nitrate-N	Ammonia-N	TKN	TN	TP
					cfu/100 mL	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
M1		5/10/2004	HH	A	< 2	< 0.012	38.1	1.76	2.1	40.2	0.363
M1		11/23/2004	HH	A	< 2	< 0.012	17.2	0.834	0.878	18.1	0.295
M1		1/26/2006	HH	A	2U	0.018	19.8	0.401	0.784	20.6	0.28
M2		5/10/2004	HH	A	< 2	< 0.012	25.8	0.072	0.095	25.9	0.886
M2		11/23/2004	HH	A	< 2	< 0.012	4.5	0.142	0.146	4.65	0.282
M2		1/26/2006	HH	A	2U	.012U	9.03	0.038	0.165	9.2	0.54
M2		1/26/2006	HH	A	2U	0.013	8.34	.067U	0.118	8.46	0.542
M3		5/10/2004	HH	A	< 2	0.036	22.8	0.074	0.087	22.9	0.458
M3		11/23/2004	HH	A	< 2	0.031	2.03	0.165	0.264	2.29	< 0.014
M3		1/26/2006	HH	A	2U	0.035	4.38	.067U	0.163	4.54	0.308
M4		5/10/2004	HH	A	< 2	< 0.012	0.774	0.138	0.313	1.09	< 0.014
M4		11/23/2004	HH	A	< 2	< 0.012	0.302	0.15	0.199	0.501	< 0.014
M4		1/26/2006	HH	A	2U	.012U	0.061	.067U	2.06	2.12	.014U
M5		5/10/2004	HH	A	< 2	< 0.012	30.8	0.59	0.66	31.5	0.076
M5		11/23/2004	HH	A	2	0.031	10.9	0.373	0.427	11.3	< 0.014
M5		1/26/2006	HH	A	2U	.012U	19.5	0.395	0.451	20	0.029
M6		5/10/2004	HH	A	< 2	0.012	14.8	0.18	0.213	15	< 0.014
M6		11/23/2004	HH	A	< 2	0.014	9.47	0.248	0.256	9.73	< 0.014
M6		1/26/2006	HH	A	2U	0.066	16	0.259	0.357	16.4	.014U
M7		5/10/2004	HH	A	< 2	< 0.012	18.4	0.143	0.203	18.6	0.107
M7		11/23/2004	HH	A	< 2	< 0.012	10.6	0.157	0.187	10.8	< 0.014
M7		1/26/2006	HH	A	2U	0.016	24.8	0.754	0.932	25.7	0.181
M8		5/10/2004	HH	A	< 2	< 0.012	37.9	0.962	0.965	38.9	1.36
M8	dup	5/10/2004	HH	A	< 2	< 0.012	38.3	0.933	1.01	39.3	1.28
M8		11/23/2004	HH	A	< 2	0.031	1.49	0.155	0.157	1.65	0.046
M8	dup	11/23/2004	HH	A	< 2	0.029	1.53	0.067	0.094	1.62	0.401
M8		1/26/2006	HH	A	2U	0.016	2.16	0.079	0.22	2.38	0.223
M9		5/10/2004	HH	A	< 2	< 0.012	35.9	0.219	0.273	36.2	< 0.014
M9		11/23/2004	HH	A	< 2	< 0.012	0.405	0.172	0.19	0.595	< 0.014
M9		1/26/2006	HH	A	2U	.012U	0.207	.067U	0.264	0.471	.014U
M10		5/10/2004	HH	A	6	< 0.012	< 0.012	0.083	0.481	0.481	< 0.014
M10		11/23/2004	HH	A	54	< 0.012	< 0.012	0.211	0.257	0.257	< 0.014
M10		1/26/2006	HH	A	2U	.012U	.012U	0.07	0.263	0.263	.014U

Table 10. Well nutrient and fecal coliform data at Hickory.

Well	Dups	Date	Sampler	Lab	Fecal Coliform	Nitrite-N	Nitrate-N	Ammonia-N	TKN	TN	TP
					cfu/100 mL	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
C3a		1/26/2006	HH	A	2U	.012U	1.09	0.197	0.265	1.36	.014U
C5		5/10/2004	HH	A	< 2	< 0.012	32.7	< 0.067	< 0.071	32.8	< 0.014
C5		11/23/2004	HH	A	< 2	< 0.012	6.72	0.118	0.128	6.85	< 0.014
C5		1/26/2006	HH	A	2U	.012U	8.36	.067U	0.081	8.44	.014U
S1		5/10/2004	HH	A	24	< 0.012	33.6	0.147	0.197	33.8	0.452
S1	dup	5/10/2004	HH	A	22	< 0.012	38.3	< 0.067	0.08	38.4	0.485
S1		11/23/2004	HH	A	22	< 0.012	5.44	0.422	0.469	5.91	0.15
S1	dup	11/23/2004	HH	A	< 2	< 0.012	4.38	0.378	0.406	4.79	0.182
S1		1/26/2006	HH	A	2U	.012U	58.8	0.069	0.098	58.9	.014U
S2		1/26/2006	HH	A	2U	.012U	0.881	.067U	0.098	0.979	.014U
S3		11/23/2004	HH	A	< 2	< 0.012	0.021	< 0.067	< 0.071	0.021	< 0.014
S4		11/23/2004	HH	A	< 2	< 0.012	0.1	0.094	0.1	0.2	< 0.014
S4		1/26/2006	HH	A	2U	.012U	0.17	.067U	0.109	0.279	.014U

Table 11. Nutrients and fecal coliform in tap water, surface water, background wells and an equipment blank.

Location	Date	Sampler	Lab	Fecal Coliform	Nitrite-N	Nitrate-N	Nitrite+ Nitrate-N	Ammonia-N	TKN	TN	TP
Tap water				cfu/100 mL	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Mag II	5/10/2004	HH	A		< 0.012	0.054		< 0.067	0.265	0.319	< 0.014
Mag II	3/23/2006	ER	A		.012U	.012U		.067U	0.14	0.14	0.259
Mag II	5/15/2007	ER	A				.012U	.067U	0.096	0.096	.014U
Surface water											
Catfish Sink	11/23/2004	HH	A	8	< 0.012	1.42		< 0.067	< 0.071	1.42	< 0.014
Manatee Spring	11/23/2004	HH	A	6	< 0.012	1.75		< 0.067	< 0.071	1.75	< 0.014
Background Wells											
MB2	1/26/2006	HH	A	2U	.012U	1.39		.067U	0.091	1.39	.014U
SRWMD #4	1/10/2006	HH	A	<2	.012U	0.351		.067U	0.103	0.478	.014U
CA	1/26/2006	HH	A	2U	.012U	0.264		0.067	0.264	0.264	.014U
Equipment Blank	3/23/2006	ER	A		.012U	.012U		.067U	.071U	.071U	.014U

Location	Date	cBOD5	TSS	Alkalinity,
		mg/L	mg/L	mg/L as CaCO3
Mag II	5/10/2004			174
Mag II	3/23/2006	2.0U	2.0U	185
Mag II	5/15/2007	2.0U	3	182
Equipment Blank	3/23/2006	2.0U	2.0U	10.0U

Table 12. cBOD5, TSS and alkalinity in tap water and an equipment blank.

[1] Personal communication by Mark Hooks, DOH, based on information provided earlier by Bill Roberson, assistant park manager 10/1/2004
[2] Field notes 3/31/2009
[3] http://www.srwmd.state.fl.us/services/flood+plain+elevation/fpe+details.asp?riverid=4 accessed 6/1/2004