Florida Department of Health
Bureau of Onsite Sewage Programs
Research Review and Advisory Committee Meeting

DATE AND TIME: **September 10, 2009 at 1 pm**

PLACE: Florida Department of Health Southwood Complex
Betty Easley Conference Center
4075 Esplanade Way, Room 180
Tallahassee, FL 32399
850-245-4070

To attend via Conference Call: 1-888-808-6959
Conference Code: 1454070#

This meeting is open to the public

AGENDA: FINAL

1. Introductions and Housekeeping
2. Review Minutes of Meeting July 1, 2009
3. Presentation and Discussion on Town of Suwannee Study
4. Discussion on the Florida Nitrogen Reduction Strategies Study
5. Brief Updates on Ongoing and Future Projects
6. Other Business
7. Public Comment
8. Closing Comments, Next Meeting, and Adjournment

Research Review and Advisory Committee for the Bureau of Onsite Sewage Programs

Approved Minutes of the Meeting held at the Betty Easley Conference Center, Tallahassee, FL
September 10, 2009
Approved by RRAC March 23, 2010

In attendance:

- **Committee Membership and Alternates**:
  - **In person:** Anthony Gaudio (vice chairman, member, Septic Tank Industry); Bill Melton (member, Consumer); Jim Oskowis (member, Local Government)
  - **Via teleconference:** David Carter (chairman, member, Home Building Industry); Kim Dove (member, Division of Environmental Health); Tom Higginbotham (alternate, Division of Environmental Health); Jim Peters (alternate, Professional Engineer), Patti Sanzone (member, Environmental Interest Group); John Schert (member, State University System); and Pam Tucker (member, Real Estate Profession)
- **Not represented**: Restaurant Industry
- **Visitors**:
  - In person: Larry Danek (Environmental Consulting & Technology, Inc.); Justin Hubbard (Infiltrator Systems); Leland Smith (Environmental Consulting & Technology, Inc.)
  - Via teleconference: Josefin Edeback (Hazen and Sawyer);
- **Department of Health (DOH), Bureau of Onsite Sewage Programs**:
  - Paul Booher; Kara Loewe; Debra Roberts; Eberhard Roeder; and Elke Ursin

1. **Introductions:** Nine out of ten groups were present, representing a quorum. Chairman Carter called the meeting to order at 1:10 p.m. Introductions were made and some housekeeping issues were discussed.

2. **Review of Previous Meeting Minutes**:

   Motion by Anthony Gaudio and seconded by Bill Melton to approve the minutes as submitted. All were in favor with none opposed and the motion passed unanimously.

3. **Updates on projects**

   a. **Town of Suwannee Study** – The sampling has been completed, which included source tracking to detect the human DNA component. The final draft report is in, and comments are due to Elke by noon on Tuesday September 15th. The RRAC voted at the July 1st meeting to renew the contract to conduct sampling again during November/December 2009 and the paperwork is now routing.

   Larry Danek with Environmental Consulting & Technology, Inc. (ECT) presented on the results of the study. He outlined the project team, the project goals and objectives, the project history, the sampling plan, the 2009 results, the comparison of those results to the 1996 results, conclusions, and recommendations. The goal of the project was to evaluate the impacts of closing 850 OSTDS in the Town of Suwannee. The objectives were to identify and obtain supplemental data, repeat the 1996 sampling protocol, modify the sample parameter list as necessary, add DNA source tracking, compare river stations with canal stations, and compare the 2009 results with the 1996 results. ECT was the original

contract provider in 1996. The before and after results of the studies done in 1996 and 1997 were confounded by much more rainfall stemming from an El Niño event in 1997. One interesting result that was found during the sampling was that the total Kjeldahl nitrogen seemed to follow the same pattern as the river discharge, and nitrate-nitrite-nitrogen behaved in the opposite manner. As the river flow increased, the nitrate-nitrite-nitrogen decreased.

Some of the conclusions were that Salmonella was found more often in the river than in the canals of the town. Nitrate + nitrite concentrations exhibited a strong negative correlation with river flow. There was consistently more nitrate + nitrite in the river samples than in the canals. The source tracking results of enterococci indicated a human source was present approximately 42 percent of the time and approximately equally present in the canals and the river. The total and fecal coliforms were much higher in the canals than in the river. The fecal coliforms decreased from 1996 to 2009, whereas the total coliforms increased. Simple statistical comparisons of the 2009 results with the 1996 results were complicated by large changes in the river (control) stations. There was a significant reduction in fecal coliforms in the canals as compared to the river stations from 1996 to 2009. There was no large improvement in water quality in the canals between 1996 and 2009 that could be attributed to closing the OSTDS.

One recommendation was to repeat the study in November/December to decrease the environmental variables (seasonal and river flow variability). This additional study would provide a comparison of 1996 preconstruction data under similar environmental conditions, and will also allow for a comparison of winter conditions with the 2009 summer conditions.

There was a discussion on whether the nitrate/nitrite levels could be controlled or influenced by the spring flow. There was also a discussion on the wastewater treatment plant (WWTP) that was installed: where it is located (northeast of the town), what type of treatment does it do, how the waste is disposed (spray irrigation), whether the lines are gravity or pressure dosed, the cost for the conversion to sewer, etc. Some of these details are to be researched and possibly added to the report. A discussion was had on about pharmaceuticals in the wastewater and Larry Danek stated that this was looked at in the original study but nothing was found and that these tests can be very expensive. There was a question on whether there are any other septic tanks along the river outside of the town, and there probably are but they are sparse. There was a discussion on whether resampling again in November/December will yield better results. Jim Oskowis stated that there are lots of good reasons why septic tanks are not preferable to sewer and that it was common sense for this development, with its proximity to surface water and small lots, that sewer would be the preference anyway. He suggested looking at some other location where septic systems could be justified based on lot size, groundwater conditions, and proximity to surface waters. Anthony Gaudio stated that community resources have been devoted to take the town off septic, and many locations in similar situations are looking for a rational for expending their resources. The purpose of the conversion for the Town of Suwannee was due to the Salmonella contaminating the oyster beds offshore. Eberhard Roeder said that if the purpose of converting from septic to sewer is to improve water quality, it is important to measure that improvement. For this study, there was preliminary data and the post conversion data in 1997 was confounded by the amount of rain. This

sampling effort may have been confounded by the seasons. Another sampling event in November/December may close the loop.

Anthony Gaudio made a motion, seconded by John Schert, to continue with the renewal process to replicate the sampling effort during November and December of 2009 and allow department staff to decide if the sampling will not commence based on factors such as river discharge levels (if greater than 10,000 cubic feet per second the sampling shall not take place), water temperature values, or impending significant weather events. In the case the department decides not to commence sampling the RRAC has the opportunity to reverse the decision and advise the department to move forward with sampling. All were in favor and the motion passed.

b. **Florida Onsite Sewage Nitrogen Reduction Strategies Study** – An overview was given outlining what has happened since the last meeting. Numerous reports have been submitted and reviewed by RRAC and DOH:

- Passive nitrogen removal study phase II quality assurance project plan
- Literature review on onsite nitrogen reducing technologies
- Classification, ranking, and prioritization of technologies
- Prioritization of nitrogen reduction technologies
- Literature review of nitrogen reduction by soils and shallow groundwater
- Literature review on nitrogen fate and transport modeling
- Report on selection of existing data sets for model calibration

Dr. Smith and Josefin Edeback presented to the TRAP on the project. Pam Tucker provided a brief summary of what happened at the TRAP. She stated that Chairman Harper wanted a summary letter to be presented to the TRAP next time that shows where the project is and a simple summary that the lay person can understand. There was a suggestion to amend the contract to include this information with the progress reports. The contract amendment, as recommended at last meeting, is currently being discussed with the provider. There was a discussion on the existing septic tanks at the proposed test facility site and how the issue of groundwater infiltration into the tanks through the risers should be fixed. Anthony Gaudio mentioned a manufacturer in Massachusetts that makes a liner to go into the tank and that this might be a cheaper repair option. Josefin Edeback stated that once the construction costs have been estimated, within the next month, an amendment will be done. Once the construction costs have been finalized there may be another amendment later. Elke Ursin will post the final reports once they have been approved. There was also a discussion on the Task C facility design having mound geometries that are different from the code and the general thought was to keep within the code. Anthony Gaudio stated that the focus of the study for this phase is on continuing the passive nitrogen work that Dr. Smith did. Paul Booher stated that this project was originally scoped out for several millions of dollars over several years and that this first phase is less than one million dollars over about 18 months. Having an understanding of what the passive systems can do early on will help the rest of the study when there will be a focus on the field work. The first progress report to the legislature on this project is due in February and the draft report will need to be submitted to the RRAC for review in December. A phone conference to discuss this report is planned for sometime early to mid December.

c. **Manatee Springs, Performance of Onsite Systems Phase II Karst Study** – The original contracted sampling work has been completed. The draft report from FSU was submitted at the July 1st meeting and comments were sent back to the provider. The final report has been received and is being reviewed by staff to ensure previous comments have been addressed. Chapter 2 of the report, which includes the history of the system upgrades and pre-modification sampling, was submitted with the meeting material for this meeting. Comments on this report are due to Elke Ursin by September 15th. The final report on the entire project, which combines FSU's report and Chapter 2, is to be submitted to EPA and the RRAC by the end of September. An additional sampling event occurred on September 10th during non-flood conditions. Once the sample event results have been analyzed, the final report that was sent to EPA will be amended with the new information and a draft of this report will be sent to the RRAC for review and comment.

d. **Monroe County Performance Based Treatment System Performance Assessment** – Quality control of existing data is ongoing. All sampling has been completed. A report summarizing this project is being written.

e. **319 Project on Performance and Management of Advanced Onsite Systems** – For the database task, data has been gathered from the state database, any county specific databases, and from Carmody. The data fields and database structure have been discussed and sketched. There are approximately 15,000 advanced systems in the state. There was a discussion on the review of data from operating permits that has been gathered from the various sources and how there is limited overlap of the data. The Florida State University Survey Research Laboratory was selected to perform the user-group perceptions survey task, and they are currently in the process of developing the surveys with the homeowner and regulator surveys nearing completion. Once the surveys have been finalized they will be sent to the RRAC. A draft of the Quality Assurance Project Plan has been submitted to the RRAC, and comments are due by September 22nd. Bill Melton stated that the sampling schedule is very ambitious. Some of the next steps for this project are to finalize the Quality Assurance Project Plan for the sampling, and selection of home sites to sample. There was a discussion on what criteria should be used to select systems for sampling. Should there be a purely random sample taken or should the criteria be stratified? If it is stratified, what criteria should be used (i.e. age of system, commercial vs. residential, maintenance history, system manufacturer, ATU vs. PBTS)? Bill Melton stated that ATU's have performance data from NSF, so it might be better to focus on PBTS. Jim Oskowis suggested looking at food service facilities. Anthony Gaudio suggested excluding older systems (>15 years old) because the newer systems may outperform the older systems. Jim Oskowis stated that maintenance history is one important criteria to look at. Eberhard Roeder stated that the database may not have some of the more detailed criteria available, so a stratified sampling by some criteria may not be possible. Paul Booher suggested that if a system is selected and turns out not to be operational when you go out to sample, that the system condition should be noted but not sampled. Elke Ursin suggested first running some statistics on the overall sample population and then running a random sample and evaluating the results to eliminate some of the over or under represented systems. The RRAC will provide thoughts on what criteria to use to select systems and comments on the QAPP to department staff by September 22nd.

f. **Optical Wastewater Tracers Study**: The final report on this project is due at the end of October.

4. **Upcoming Projects**

   a. **Statewide Inventory of Onsite Sewage Treatment and Disposal Systems in Florida Study**: RRAC voted the continuation of this project as a priority at the May 27th meeting. Initial internal discussions have begun on how to proceed with this. The RRAC is still on board with the department coming back with different proposals at a future meeting on how to move forward with this project. Several counties, people involved in the BMAP process, and DEP personnel have expressed interested in obtaining and utilizing the data and the process of sharing the data is being streamlined.

   b. **Columbia County Nitrogen Well Sampling Study**: The first step for this project is to obtain a purchase order with a lab that is able to do the sample analysis. The department has been inquiring with the DOH lab in Jacksonville to see if they would be able to do the analysis and it is looking increasingly as if this would not be possible. Private labs will be contacted to see if they might be able to do the analysis. The Columbia County Health Department staff is interested in collecting the samples.

5. **Other Business** – Bill Melton brought up the Alternative Drainfield Product Study idea again, and there was a discussion on how to approach this as a future project. He suggested do a failure study looking at what was installed, how many failed, and in what timeframe the systems failed. Anthony Gaudio suggested doing this as a physical analysis rather than a data analysis. Bill Melton suggested that someone come to the next RRAC meeting to discuss what the capability is to design something that could capture the failure rate. Eberhard Roeder stated that someone could come to the next meeting to talk about what the department's current efforts are on premature failure rates and see if that is a good starting point. Elke Ursin mentioned a publication on the NSF 240 Alternative Drainfield Media Systems task group that is looking at minimum standards for these types of systems.

   Anthony Gaudio mentioned that another possible future project would be looking at bacterial and viral pollution from OSTDS to ground waters and surface waters. He stated that bacterial and viral pollution is more in DOH's jurisdiction than the nitrogen issue is. Nitrogen is not a public health issue until it gets to pretty high levels.

6. **Public Comment** - The public were allowed to comment throughout the meeting. There was no public comment.

7. **Next Meeting** – The next meeting will be scheduled for the beginning of December. The meeting location has not been determined, but the option of having a live meeting via teleconference and/or via a web conference was discussed and staff will research this further. The focus of the next meeting will be to discuss the progress report on the Nitrogen Reduction Strategies Study as well as discuss current and proposed research projects.

Jim Oskowis made a motion to adjourn, seconded by Bill Melton, and the meeting adjourned at 4:42 p.m.

Draft Quality Assurance Project Plan
For
Assessment of Water Quality Protection by Advanced Onsite Sewage Treatment and Disposal Systems (OSTDS): Performance, Management, Monitoring

DEP Agreement No. G0239

Draft 1
July 9, 2009

Prepared for:
State of Florida Department of Environmental Protection
3900 Commonwealth Boulevard
Tallahassee, FL 32399-3000

Prepared by:
Florida Department of Health
Bureau of Onsite Sewage Programs
4052 Bald Cypress Way BIN # A-08
Tallahassee, Fl 32399-1713

Approved: _____ Date: _____
FDEP Project Manager

Approved: _____ Date: _____
FDOH Contract Manger

Approved: _____ Date: _____
Engineer

Prepared: _____ Date: _____
Wastewater Sampling Specialist

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1.0 Overview

1.1 Project Purpose

To evaluate the performance of advanced systems throughout the State of Florida and identify best management practices with regards to compliance.

1.2 Background information

Onsite Sewage Treatment and Disposal Systems (OSTDS) are one of the nutrient sources in nutrient impaired watersheds. Estimates of the extent of their contribution to nitrogen loadings for different watersheds in Florida have ranged between less than five and 20%. Conventional OSTDS (septic tank-drainfields) have limited capacity to reduce nitrogen concentrations in water discharged to the drainfields. Because of this, residential density limitations have been used as one approach to meet the nitrate drinking water standard of 10 mg/L, which is not necessarily protective of ecological health. The phosphorus loading from OSTDS has been of most concern in the Florida Keys, where small lots, poor soils, and building practices increase the risks of impacts on surface water.

To achieve higher reductions of nutrient concentrations, additional treatment steps in OSTDS are necessary. Advanced OSTDS can utilize various approaches to improve treatment before discharge to a drainfield, or the drainfield itself can be modified. On occasion, engineers have included the drainfield as part of the treatment process, usually as means to achieve fecal coliform removal. In such cases, the engineer is required to include shallow groundwater monitoring wells in the monitoring plan.

The emphasis of this study will be on assessing the effectiveness of pretreatment before discharge to the drainfield. There are two large permitting categories in Florida onsite regulations that qualify as advanced treatment: Aerobic Treatment Units (ATUs) (Florida Administrative Code 64E-6.012), which are generally permitted based on certification by the National Sanitation Foundation; and performance-based treatment systems (PBTS) (Florida Administrative Code 64E-6, part IV), which are permitted based on design by an engineer experienced in wastewater. A third permitting category, rarely used, consists of engineer-designed alternative systems, such as sand filters.

Advanced systems have been required by local regulations, at least in part, with the objective to reduce nitrogen loading to sensitive areas (Florida Keys, St. George Island, Aucilla and Suwannee River floodplains, and Volusia County). In addition, Florida Administrative Code (FAC) 64E-6 requires advanced treatment, sometimes including nitrogen and fecal coliform removal, for lots where the usually required setback or authorized lot flow restrictions cannot be met.

Advanced systems differ in three aspects from conventional treatment systems that consist of a septic tank with drainfield. The design of advanced systems is more variable than the prescriptive approach for conventional systems. They need more frequent checkups and maintenance, which has been the reason for requiring operating permits for them. The performance expectations are more specific than absence of sewage on the ground surface, while failure definitions for advanced systems are vaguer. The first two issues have been challenges for the permitting process. Site specific performance specifications are not captured completely in the three databases that are used statewide for tracking permits, two that were developed for conventional system permitting for the state, and one that was developed for inspection tracking by Carmody, Inc. The third issue has made it hard to determine how well this aspect of Florida's onsite program is working. Until early 2001, operating permit fees allowed County Health Departments to perform limited sampling. In 2001, the legislature decided to limit operating permit fees. Since then, there has been no systematic statewide assessment of the management and performance of these systems. The proposed project aims to perform such a statewide assessment and develop improvements in the management of advanced systems where indicated.

1.3 Sampling locations

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The project is to be performed statewide. The specific sampling locations will be selected based upon one or more of the following criteria: system type, system age, geographic location, random sampling, and density of advanced systems. The systems will be selected based on the Task 2 project database. If manufacturer information and system type are available initially for at least half of the systems, the sampling will be stratified to assure proportional representation of manufacturers and system types. The final subgroup categories and sizes will be determined with input from the DOH Research Review and Advisory Committee (RRAC) and consideration of the results of Task 1.

Due to the wide range of sampling locations associated with this project, it is anticipated that several NELAP certified laboratories will be utilized. NELAP-certified laboratory services will be provided by DOH-labs, procured in a set of purchase orders with local labs, or by contract with regional labs.

1.4 Overview of project sampling plan

An estimated total of seven hundred samples will be collected. A total of six hundred samples will be collected from the effluent port and 100 samples will be collected from the influent port. All samples will be tested for total suspended solids (TSS), Total Nitrogen (TN), and Bio-chemical Oxygen demand (CBOD5). A total of 300 fecal coliform and TP will be sampled within close proximity to testing Lab to ensure holding time requirement.

1.5 Project objectives

The objectives of the overall project are to quantify the reduced loading of contaminants from advanced Onsite Sewage Treatment and Disposal Systems (OSTDS) to the environment; assess the operational status of systems under the current management framework; survey perceptions of user groups regarding the management of such systems; validate elements of a monitoring protocol for consistent assessment of systems; document good management practices.

1.6 Project Milestones

Table Project Milestones

Task	Activity	Start	Complete
1	Detailed sampling QAPP development, staff training	Month 1	Month 3
1	Detailed sampling	Month 3	Month 9
1	Analysis of detailed sampling	Month 9	Month 12
2	Database development	Month 1	Month 6
3	Survey (contracting for services)	Month 2	Month 4
3	Survey (CHDs)	Month 4	Month 6
3	Survey (other stakeholders)	Month 6	Month 12
4	Assessment of operational status and performance	Month 6	Month 23
5	Assessment of annual variability of performance	Month 9	Month 21
6	Case studies of best management practices	Month 13	Month 23
7	Project administration	Month 1	Month 30

This Quality Assurance Project Plan (QAPP) lays out the methodologies, procedures and other requirements necessary for collecting data adequate to support the goals of the project. Subsequently, the water quality data gathered through the sampling will be used to assess the overall performance of these systems. The data will be used to recommend best management plans which will help ensure that advanced systems are performing as designed.

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1.7 Definitions:

A. **Advanced system:** Include aerobic treatment units (ATUs), performance-based treatment systems (PBTS), innovative systems, and sand or gravel filters.
B. **Biochemical oxygen demand (CBOD5**): The concentration of oxygen (expressed as mg/l) utilized by microorganism in the oxidation of organic matter during a five day period at a temperature of 20 Degree Celsius or 68 degrees Fahrenheit.
C. **Data quality indicators:** Quantitative and qualitative measures of principal quality attributes including precision, accuracy, representative-ness, comparability, completeness, and sensitivity employed as a means of specifying criteria which, if achieved, will provide and indication that the resulting data are expected to meet the data quality objectives of the standard.
D. **Manufacturer:** The entity that develops, designs, and produces residential or commercial wastewater treatment systems.
E. **NELAP:** National Environmental Laboratory Accreditation Program
F. **Quality Assurance Project Plan (QAPP):** a written document that describes the implementation of quality assurance and quality control (QA/QC) activities during the life of the project.
An official "hard copy" report shall be signed by FDOH and transmitted to FDEP along with copies of all supporting documentation such as chain of custody records, field reports, photographs, and/or notes.

G. **RRAC:** Research Review and Advisory Committee, Department of Health committee formed under F.S. 381.0065(4)(o).
H. **Total nitrogen:** The sum of the total Kjeldahl nitrogen (TKN), Nitrite (NO2), and Nitrate (NO3) in a sample, expressed as mg/L as N.
I. **Total suspended solids:** The quantity of solids (expressed as mg/L) readily removed from a well mixed sample with standard laboratory filtering procedures.

2.0 Project Organization and Management:

2.1 Organization Chart of Key Personnel

An official "hard copy" report shall be signed by FDOH and transmitted to FDEP along with copies of all supporting documentation such as chain of custody records, field reports, photographs, and/or notes.

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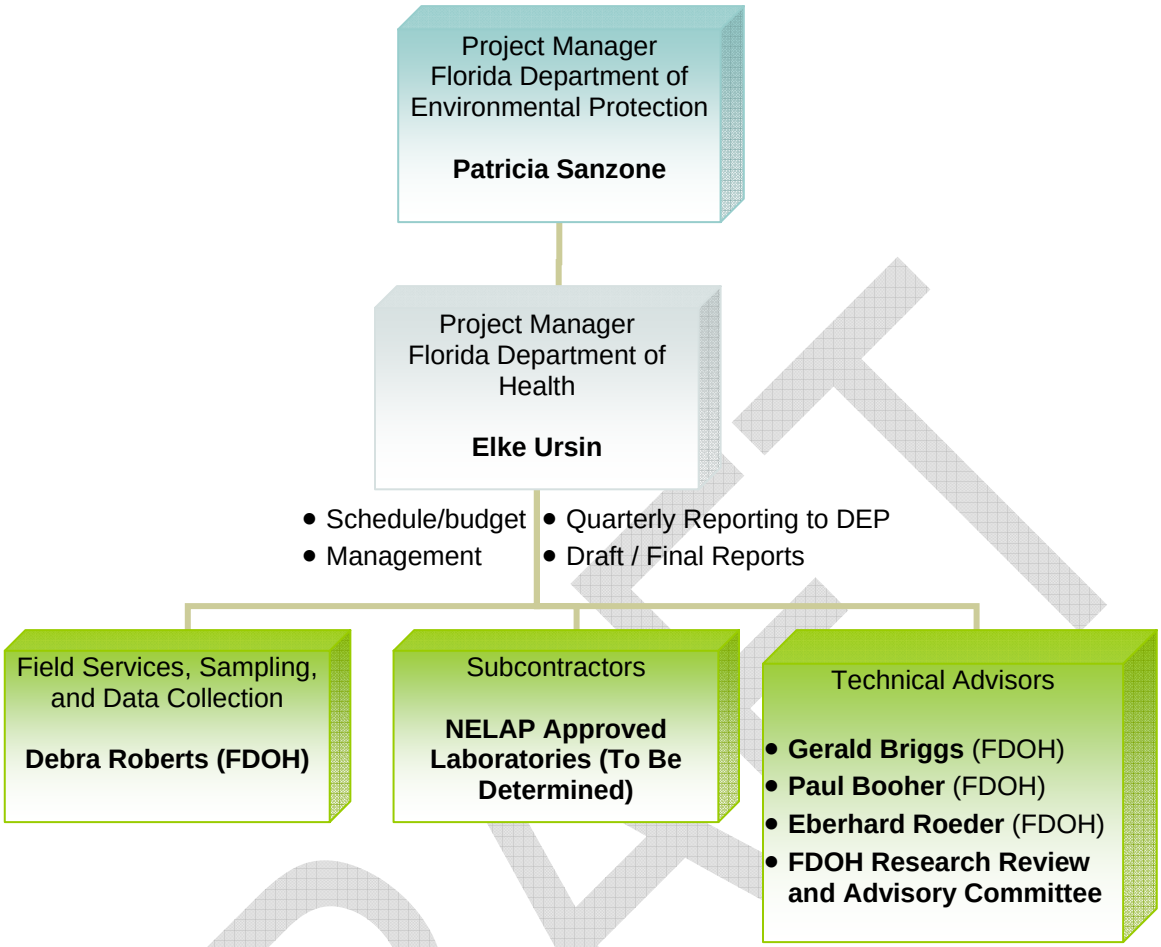

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2.2 Training Requirements and Certification

The next OSTDS certification training begins on October 12 thru October 16 of 2009. Debra Roberts is enrolled and plans to obtain this certification.

The Department of Health licensed professional engineer, certified environmental health professionals, the Research Review and Advisory Committee, and other interested parties will be conducting draft and final report review.

Debra received her Bachelor of Science in 2001 from Florida A&M University major in Biology and minor in Chemistry. In addition she has worked as a QA Chemistry and Environmental Lab technician, Chemist and Quality Assurance Supervisor with an extensive knowledge of standard operating procedures with respects to handling samples, collection, preservation, transport and storage, documentation, chain of custody record completion, and communication with event coordinators and laboratory staff.

The selected laboratory will be NELAP certified according to EPA standards methods. Equipment probe numerical values will be obtained in accordance with manufacturers instructions.

3.0 Experimental Approach

3.1 General approach and testing conditions

The samples shall be collected and analyzed by a NELAP certified laboratory.

3.2 Experimental design and sampling strategy

This experiment is designed to measure the overall performance of advanced systems. The sampling parameters include system type, system age, geographic location, random sampling, and density of advanced systems.

3.3 Sampling / monitoring points

A total of 600 samples will be collected from the effluent port. The reminding 100 samples will be collected from the influent port. An additional 100 sample sites will be selected as alternative sites if the influent port is not accessible in the original sample population.

3.4 Frequency of sampling

The initial sampling timeline requires that 700 samples are collected within the project period. An estimated amount between 5 to 10 samples will be collected daily. Subsequently, a select number of 70 systems will be sampled on a quarterly basis thereafter.

3.5 Measurement and parameters of interest

Obtaining access to property will serve as a limiting factor, however if a relationship with the associated system maintenance entity is developed this might aid in the process of gathering a larger number of samples. The basic project design is to sample a total of 700 ports which would serve as a representative population.

4.0 Sampling Procedures

4.1 Laboratory Methods

Samples from selected onsite systems will be analyzed for some or all of the parameters shown in Table 4.1A. Samples will be collected from the treatment process point as noted: Influent samples from settling tank where present or as far upstream in the treatment process as practical. The effluent samples will be obtained from the dosing tank or chlorination chamber.

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Table 4.1A Laboratory Parameters

Parameter	Method	Method Detection Limit
$CBOD_5$	SM 5210B	2.0 mg/L
TSS	EPA 160.2	2.0 mg/L
Nitrate Nitrogen	SM 4500NO3 F	.05 mg/L
Nitrite Nitrogen	SM 4500NO3 F	.03 mg/L N
Total Kjeldahl Nitrogen	EPA 351.2	.070 mg/L N
Ammonia Nitrogen	EPA 350.1	0.04 mg/L N
TN	Calculated	.120 mg/L N
TP	EPA 365.4	.080 mg/L P
Fecal coliform	SM9222D	4CFU/100 mL

4.2 Sample Plan

An effluent grab sample will be collected from 700 systems. A total of 100 grab samples will be collected from the influent port. Field duplicates of both influent and effluent samples will be collected one duplicate for every ten samples.

The selected OSTDS will be sampled according to the following plan: On Mondays through Thursday's samples will be collected and delivered daily to an approved NELAP laboratories. Friday's will be used to call owners, enter data collected from the labs, enter field notes, and gather necessary paperwork for future site preparation.

This sample scheme will produce approximately 30 grab samples per week, with a total estimated completion timeframe of 24 weeks or 6 months.

4.3 Preparation prior to sampling

4.3.1 Initial Coordination With Maintenance Entities

Prior to the first sampling event, the sampler will coordinate with the assigned maintenance entity for the respective system. The maintenance entity can assist in setting up the property, uncovering the settling tank, and may have valuable insight into the workings of the onsite system.

4.3.2 Determination of Sample Points

Influent and effluent sample points will be determined individually for each of the wastewater systems to be sampled. Existing site conditions, manufacturer's recommendations, and other pertinent information will be considered when establishing sample points. A schematic of each of the wastewater systems, with the influent and effluent sample points clearly delineated, will be maintained in the individual system file, and the same locations will be used at every sampling event for a given system if applicable.

Influent samples from the settling tank prior to treatment shall be preferred. Influent samples from the upstream side of a treatment tank can be used if accessible and no settling tank is available. Precautions will be taken when taking samples from inside a treatment unit so as not to disturb equipment or the treatment process.

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4.3.3 Notification

Two days prior to the field sampling, a telephone call will be made to the homeowner to let them know when the health department staff will be on their property. Any questions they may have about the sampling process will be answered.

4.3.4 Equipment

Steps will be taken to ensure that auto-samplers are clean and hoses are free of obstructions. After each testing event, the jug will be filled with tap water and allowed to run through the hose. The jug will be emptied and left to air dry. Precautions will be taken to ensure that the battery for the auto sampler is fully charged. All necessary sample containers will be collected. Personal protective equipment (latex gloves, hand-sanitizer, and eye protection) will be made available. The vehicle shall have sufficient fuel. The laboratory provided sample cooler-kit will be packed and the coolers filled with ice. Bring all necessary tools such as sharpies, garbage bags, Channel locks, screw drivers, crowbars, etc.

4.3.5 Files

Collect the system schematics, maintenance reports, permit files, engineering schematics and other paperwork that will assist in the field evaluation. Be sure to have a supply of “Chain of Custody” forms. Be sure to have directions to the property and have a site plan available.

4.4 Preparation prior to each sampling event

4.4.1 **Preparing the Site**

Once at the site, knock on the door to let the homeowner know you are there. Assess the situation to ensure there are no dangers, such as dogs, that may affect your work.

Take the auto samplers out of the vehicle. Find the influent sample point which should already be designated on the system schematic. Place the automatic sampler near the influent sample point. Find the effluent sample point, also designated on the system schematic and place another automatic sampler near this point.

Expose the sample points by getting weeds, or other obstructions, away from the sampling points, making them easily accessible.

Have the laboratory provided sample cooler-kit on the site prior to the collection of samples.

4.5.2 Collecting Samples with Auto-Samplers

4.5.2.1. Obtain the sampling kit containing the bottles, chain of custody forms, and additional preservatives from the laboratory. The exterior and accessible interior portions of the automatic sampler should be washed with liquinox soap and rinsed with tap water.

4.5.2.2. All tubing should be visually checked. Tubing that has became discolored or has lost its elasticity should be changed and new pump tubing should be installed.

4.5.2.3. Disposable unpowdered gloves are recommended for assembly of the unit at the sampling location and for disassembly to protect personnel

who collect the samples and to assure the integrity of the samples. Disposable gloves should be changed at each sampling location.

4.5.2.4. A minimum of 100 milliliters should be collected each time the unit activates.

4.5.2.5. Pack ice inside and around the sampler or set refrigerated units to 4 degrees Celsius**.**

4.5.2.6. For commercial systems, collection line tubing should not be resting on the bottom or against the walls of the tank. Place the tubing in an area were wastewater flows freely without obstruction. For influent samples, return sludge or other influences should not affect the sample.

NOTE: If the unit does not start the sample cycle press the pump test button to initiate a sample. If the pickup strainer is under water the bottle will fill to the desired level then the pump will back flush the pickup hose to clear it.

After the autosampler jug is filled with the desired amount of sample, follow the following steps to fill the sample containers

4.5.2.7. Cover the opening of the automatic sampler collecting jug with a cap and turn the large sample jug from the auto-sampler upside down, then right-side up, 4 times.

4.5.2.8. Pour the sample effluent from the large container into the $CBOD_5$ lab bottle.

4.5.2.9. Pour sample effluent from the large container into the TSS lab bottle

4.5.2.10. Pour sample effluent from the large container into the TP lab bottle.

4.5.2.11. Pour sample effluent from the large container into the TKN lab bottle

4.5.2.12. Pour sample effluent from the large container into the nitrate/nitrite/alkalinity lab bottle.

4.5.2.13. Pour sample effluent from the large container into the container that is used for field determinations (visual/olfactory), these are done for one effluent sample for each sampling event.

4.5.2.14. Pour sample effluent from the large container into the 100 mL whirl-pack for fecal coliform.

4.5.3 Sample Labeling

Sample containers from the laboratory are marked: influent grab CBOD5, influent grab TSS, effluent grab $CBOD_5$, etc. etc. Be sure that your sample corresponds to the label provided by the laboratory. The name of the sample will be:

Automatic sequential number generated from database and Last five digits of the Operating permit number. For example: 001-12345To insure accuracy and traceability of the sample, bottles should not be labeled prior to field use. At the time of sampling the bottles will be labeled. This will minimize the possibility of mislabeling the samples.

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The labels also include designations for:
Influent/ effluent
Grab sample
Duplicate
Field blank
Sampling date and time

4.5.4 Duplicates, Field, and Equipment Blanks

4.5.4.1 Duplicates

Duplicate samples are two or more samples collected and processed such that the samples are considered identical in composition. They are collected at the same time and place, and are preserved and transported in the same manner. Concurrent duplicates are multiple (usually two) samples collected from the environment as close as practical to the same location and time. These duplicates are used to assess variability introduced by sample collection, processing, and analysis. It assumes that the environment being sampled is itself sufficiently homogeneous at the scale (in the space and time) of the duplicate samples taken. It is recognized that duplicate samples inherently include variability in the environment unless a single environmental sample is split. Field duplicates of both influent and effluent samples will be collected one duplicate for every ten samples.

4.5.4.1.1 Collect enough effluent to fill 2-series of sample bottles (8 bottles total). This should be approximately 6 L.

4.5.4.1.2 Fill the sample bottles.

4.5.4.1.3 Label the bottles as described in section 4.5.3 making sure to mark them as “DUPLICATE” samples.

4.5.4.2 Field Blanks

The field blank is a water sample that is intended to be free of analytes of interest. Blank samples are analyzed to test for bias that could result from contamination of environmental samples by the analytes of interest during any stage of sample collection, processing, and analysis. A field blank is prepared in the field and used to demonstrate that: (1) sample collection and processing has not resulted in contamination and (2) sample handling and transport has not introduced contamination.

In addition, because the field blank is treated like an environmental sample at the laboratory, it includes potential contamination introduced during laboratory handling and analysis.

Field blanks should be prepared immediately before collecting and processing an environmental sample at a selected site. Use only deionized water from the contacted laboratory.

Field blanks of both influent and effluent samples will be collected one duplicate for every ten samples.

4.5.4.2.1 Collect a field blank sample by pouring the blank water into the sample bottle. Cap and Shake.

4.5.4.2.2 Preserve the sample on ice at 4 degrees centigrade.

4.5.4.2.3 Label the bottles as described in section 4.5.3 making sure to mark them as “FIELD BLANK” samples.

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4.5.4.2.4 Be sure your field blank is added to the appropriate QC lab bottles. Mark the appropriate chain of custody form with the source of deionized water.

4.5.5 Chain of Custody Forms

The appropriate chain of custody form shall be used for all sample collections. Samplers shall sign when the cooler is relinquished to the shipper. The laboratory attendant shall sign when the cooler is delivered by the shipping agent. The Chain of Custody Form insures accountability for sample integrity. Copies of the chain of custody forms shall be retained during the period of sampling and analysis.

4.6 Sample Analysis

4.6.1 Laboratory Submissions

The approved laboratories will provide sample collecting bottles with applicable additives.

After collection the samples will be kept in a cooler with ice to maintain a constant temperature of 4 degrees Celsius. Time management becomes critical when attempting to observe the 6-hour holding time for fecal coliform samples.

All samples will be sent to the laboratory and analyzed for $CBOD_5$, TSS, and TN. A maximum of 300 samples will be analyzed for fecal coliform and total phosphorus.

Batched samples for $CBOD_5$, TSS, TN, TP, and fecal Coliform shall be submitted to the qualified laboratory daily. The sample batch of 5 to 10 aliquots shall be packed in ice, securely sealed to prevent water loss from the cooler, and marked “WATER SAMPLES”. All necessary shipping information, including the method of payment shall be included on the shipping label. Call the shipping company to insure proper pick-up as valid sample analysis is dependent on maintaining proper holding times. Make a copy of the chain of custody form and retain in a folder with owner information.

4.6.2 Visual / Olfactory Protocols

4.6.2.1 Determine effluent discharge color using the following rating scale: Colorless, Grey, Black

4.6.2.2 Determine the effluent discharge odor using the following rating scale: No odor, musty, Septic odor

4.6.2.3 Record V/O observations on the chain of custody form.

5.0 DATA MANAGEMENT

5.1 Documentation and Records

Required documentation will include:
1. Registration of sample site in approved Access database
2. Chain of custody records for sample
3. Lab analysis report as filed by contracted laboratory manger

Copies of chain of custody records, laboratory reports, and other documentation will be submitted to the FDOH project manager for archiving. Upon completion of the review, a final report, including lab reports and chain of custody records will be archived at 4052 Bald Cypress Way Bin# A-08, Tallahassee, FL 32399 and submitted to the FDEP project manager.

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5.2 Data Entry into MS-Access Database

A newly created statewide MS-Access database was created for this project. This database will be maintained on a server accessible to the Bureau of Onsite Sewage Programs. The database will be made available to the FDEP project manager at the end of the project, or as requested.

Information needed for data entry will be gathered from the laboratory results and field notes. Data entry for each sample event will be doubled checked by the project Technical Advisors or their assignees for accuracy and comparison. Any changes done during the quality check will be noted in the database.

Additionally, notes will be taken for each location and documented in a field notebook titled “319 Project”. A schematic of actual system installation will be drawn and a copy will be placed in the folder created for each system sampled. If unusual events are noted at a location they will be documented in the comment section of the database.

6.0 Testing and Measurement Protocols

6.1 Data Review

All data collected by this project is subject to review. This will allow for individuals or groups to determine if the data meet the Quality Assurance Project Plan (QAPP) objectives.

6.2 Data Integrity

Sampling chain of custody sheet must be filled at the time prior to delivery to the lab. Upon receipt, the lab will document the arrival time. This will ensure compliance with holding time requirements.

6.3 Data Entry

Data is then entered into the database described in section 5.2 which is designed to flag any values which fall outside of the expected range for each parameter.

7.0 QA/QC Checks

7.1 Verification Test Data-Data Quality indicators (DQI)

Several data quality indicators (DQIs) have been identified as key factors in assessing the quality of the data and in supporting the verification process. These indicators are: Precision, accuracy, representativeness, comparability and completeness.

7.2 Precision

Analytical precision is a measurement of how far an individual measurement may deviate from a mean of replicate measurements. Precision is evaluated from analysis of field and laboratory duplicates and spiked duplicates. The standard deviation (SD), relative standard deviation (RSD), and/or relative percent difference (RPD) recorded from sample analyses are methods used to quantify precision. RPD is calculated by the following formula:

$$RPD= [abs (C1-C2])/ (C1+C2)/ 2] X 100\%$$

Where: C1= concentration of compound or element in the sample
C2= concentration of compound or element in the duplicate

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Field duplicates of both influent and effluent samples will be collected one duplicate for every ten samples. The laboratory will run duplicate samples as part of the laboratory QA program.

7.3 Accuracy

Accuracy is the measure of value or calculated sample value and the value of the sample. Spiking a sample matrix with a known amount of a constituent and measuring the recovery obtained in the analysis is a method of determining accuracy. The following equation will be used to calculate percent recovery:

$$\text{Percent recovery} = [(AT-Ai)/As] \times 100\%$$

Where: AT= Total amount measured in the spiked sample
Ai= Amount measured in the un-spiked sample
As= Spiked amount added to the sample

During the verification test, the laboratory will run matrix spike samples at a frequency of one spiked sample from every 10 samples analyzed. The laboratory will run an analysis on the laboratory control prior to testing samples.

7.4 Comparability

Comparability refers to the ability to compare data from different sources with a degree of confidence. The site selected may be in the same location or close proximate to one another. The data will be compared to determine the degree of differences in data being collected at these selected sites.

7.5 Representativeness

Representativeness is the degree to which data accurately and precisely represent a characteristic population, parameter at a sampling point, a process condition, or an environmental condition. The sampling location for the samples will be designed for easy access to help ensure that a representative sample of flow is obtained in each grab sample bottle. The laboratory will follow the set procedures in accordance to the good laboratory practices for homogenous mixing of grab container contents prior to sub-sampling in order to ensure a homogenous mix.

Representativeness will be monitored through QA/QC audits by the FDOH Laboratory, including review of the laboratory procedures for a sample handling and storage, review and observation of the sample collection, and review of operating logs maintained at the site

7.6 Completeness

Completeness is a measure of the number of valid samples and measurements that are obtained during a test period. Completeness will be measured by tracking the number of valid data results against the specific requirements in the test plan. The goal for this data quality objective will be to obtain a minimum of 700 valid samples.

8.0 Data Handling Procedures

8.1 Chain of Custody

Chain of custody form will be completed at the time of sampling. This will ensure that concurrent documentation is practiced in accordance with current good manufacturing policies.

8.2 Data Review/ Validation/ Verification Procedures

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Upon receipt of data analysis the information will be updated in the statewide database by the sample collector.

8.3 Statistical Analysis of Data

The original hard copy will be stored at FDOH for a period of 10 years.

8.4 Interim Reports and Final Product Documents

The data will be reviewed, analyzed, and interpreted by FDOH.

9.0 Assessment/Oversight

9.1 Schedule of Audits

The Research Review and Advisory Committee will review this QAPP and overall project design and may suggest procedural refinements or additional testing procedures. Any such change will be subjected to approval by the FDEP Project Manager and FDOH Project Manager. At least one lab audit will be performed during the testing by the FDOH representative.

9.2 Corrective Action

After initial review by the FDOH and the RRAC, a preliminary draft report will be provided to FDEP Project Manager. Any corrections to sampling locations, sample results, or collection information will be made to update the report. The corrected report shall be submitted to the RRAC and posted on the FDOH website.

Electronic copies of the lab reports, chain of custody records, field reports, and the final report from the sampling event shall be stored on FDOH data servers.

10.0 References

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11.0 Appendices

11.1 Appendix A – Standardized Data Forms
11.2 FDEP SOPs

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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.

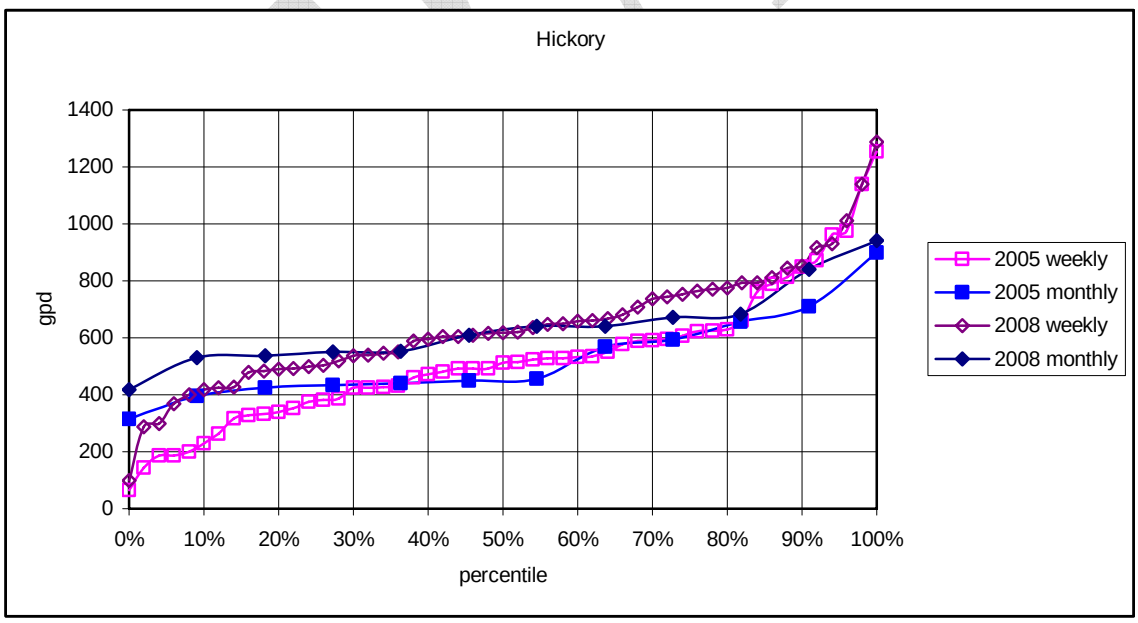

Figure 0-1. Distribution of weekly and monthly water use data for the Hickory bath house (design flow =1200 gpd)

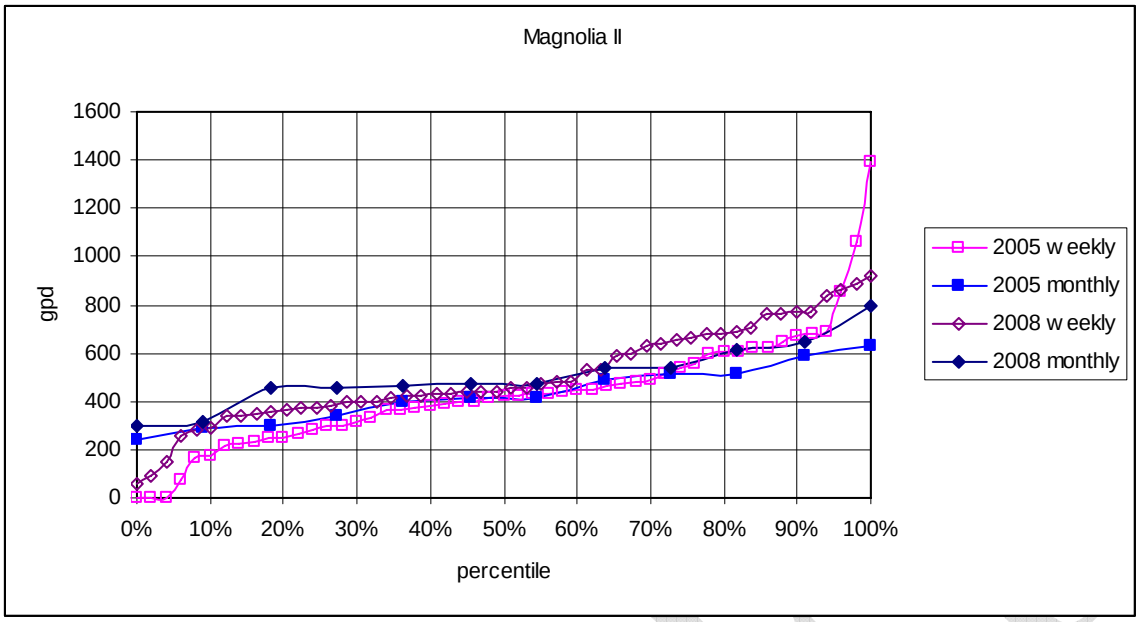

Figure 0-2. Distribution of weekly and monthly water use data for the Hickory bath house (design flow =1000 gpd)

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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

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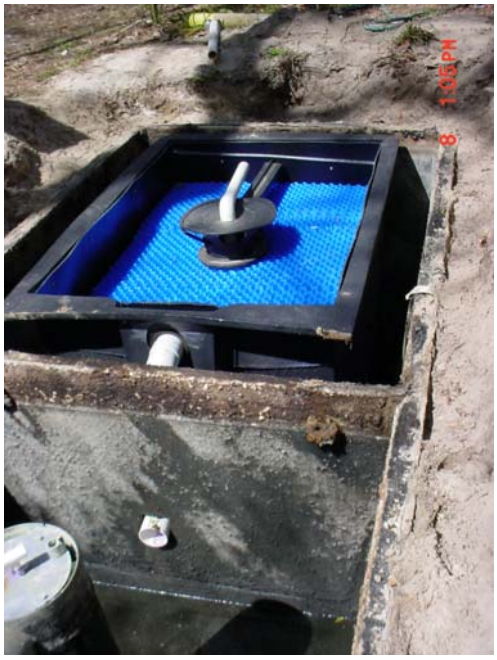
include phosphorus absorption and replaced the intermediate 750 gallon tank with a 1138 gallon tank large enough to hold the treatment kit. The design then utilized a branch off from the existing low-pressure dosing lines coming out of the existing pump tank to return the effluent to the old drainfield. 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)

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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.

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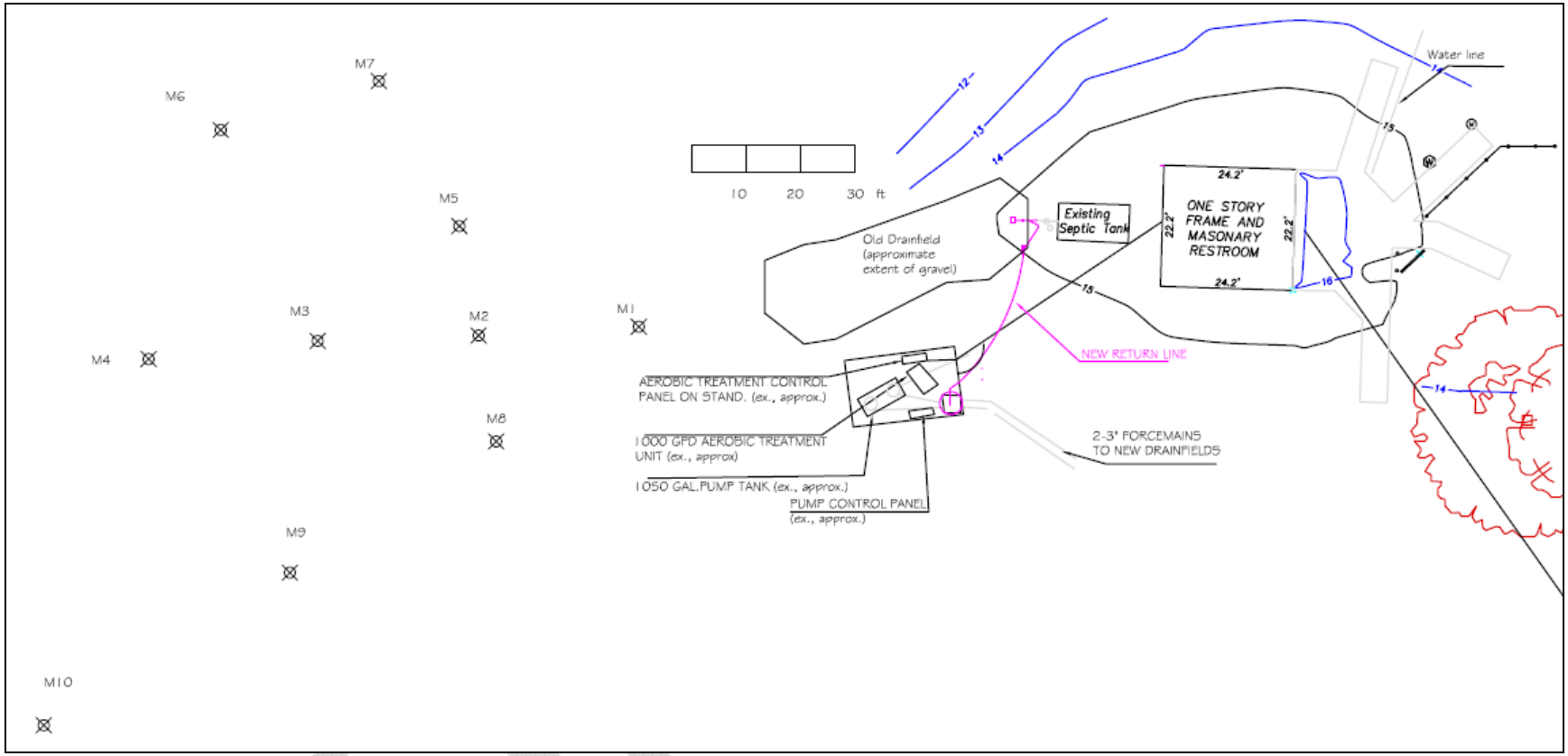

Figure 1. Magnolia II bathhouse with treatment system and monitoring wells.

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

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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	.014U
Septic	pump tank	int. cont.		3/23/2006	ER	A		.012U	.012U		104	115	115	10	.014U
Septic	pump tank	pump		3/23/2006	ER	A		.012U	.012U		101	121	121	8.53	.014U
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	

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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

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

Effluent Type	Effluent Location	Sampling	Dups	Date	cBOD5	TSS	Alkalinity,
					mg/L	mg/L	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	TSS	Alkalinity,
				mg/L	mg/L	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	TSS	Alkalinity,
		mg/L	mg/L	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

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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.

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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.

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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

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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

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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

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Department of Health
Bureau of Onsite Sewage Programs
Research Review and Advisory Committee

Wednesday September 10, 2009

1 pm – 5 pm

Agenda:

1. Introductions and Housekeeping
2. Review Minutes of Meeting on July 1, 2009
3. Presentation and Discussion on Town of Suwannee Study
4. Discussion on the Florida Nitrogen Reduction Strategies Study
5. Brief Updates on Ongoing and Future Projects
6. Other Business
7. Public Comment
8. Closing Comments, Next Meeting, and Adjournment

Introductions & Housekeeping

- Travel forms
- Roll call
- Identification of audience

Review Minutes of Meeting July 1, 2009

- See draft minutes

Town of Suwannee Study

Purpose: Test the difference in water quality after central sewer has been installed in an area previously served by onsite sewage systems

Progress:

- Sampling completed, which included source tracking to detect human DNA component
- Final draft report is in, comments due to Elke by noon on Tuesday September 15th
- RRAC voted to renew the contract to conduct sampling again during December/January 2009 and paperwork is now routing

Presentation on Town of Suwannee Study Results by Environmental Consulting & Technology (ECT)

Ongoing projects

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Purpose: Develop passive strategies for nitrogen reduction that complement use of conventional onsite sewage treatment and disposal systems, and further develop cost-effective nitrogen reduction strategies

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Progress:

- Numerous reports have been submitted and reviewed by RRAC and DOH:
  - Passive nitrogen removal study phase II quality assurance project plan
  - Literature review on onsite nitrogen reducing technologies
  - Classification, ranking, and prioritization of technologies
  - Prioritization of nitrogen reduction technologies
  - Literature review of nitrogen reduction by soils and shallow groundwater
  - Literature review on nitrogen fate and transport modeling
  - Report on selection of existing data sets for model calibration
- Dr. Smith and Josefin Edeback presented to the TRAP on the project
- Contract amendment, as recommended at last meeting, is currently being discussed with provider

Manatee Springs, Performance of Onsite Systems Phase II Karst Study

Purpose: Test the difference in water quality after nutrient reducing systems are installed in a Karst area

Progress:

- Original contracted sampling work completed
- Draft report submitted, comments sent back to provider (FSU)
- Final report received, is being reviewed by staff to ensure comments addressed, and final approved report will be distributed to RRAC in near future
- Final report on entire project to be submitted to EPA by end of September
- Added an additional sampling event during non-flood conditions which will occur during mid-September

Monroe County PBTS Assessment: Next Phase of Sampling in the Keys

Purpose: Evaluate effectiveness of Performance Based Treatment Systems in the Keys

Progress:

- Quality control of existing data ongoing
- All sampling completed
- Report summarizing this project being written

319 Project on Performance and Management of Advanced Onsite Systems

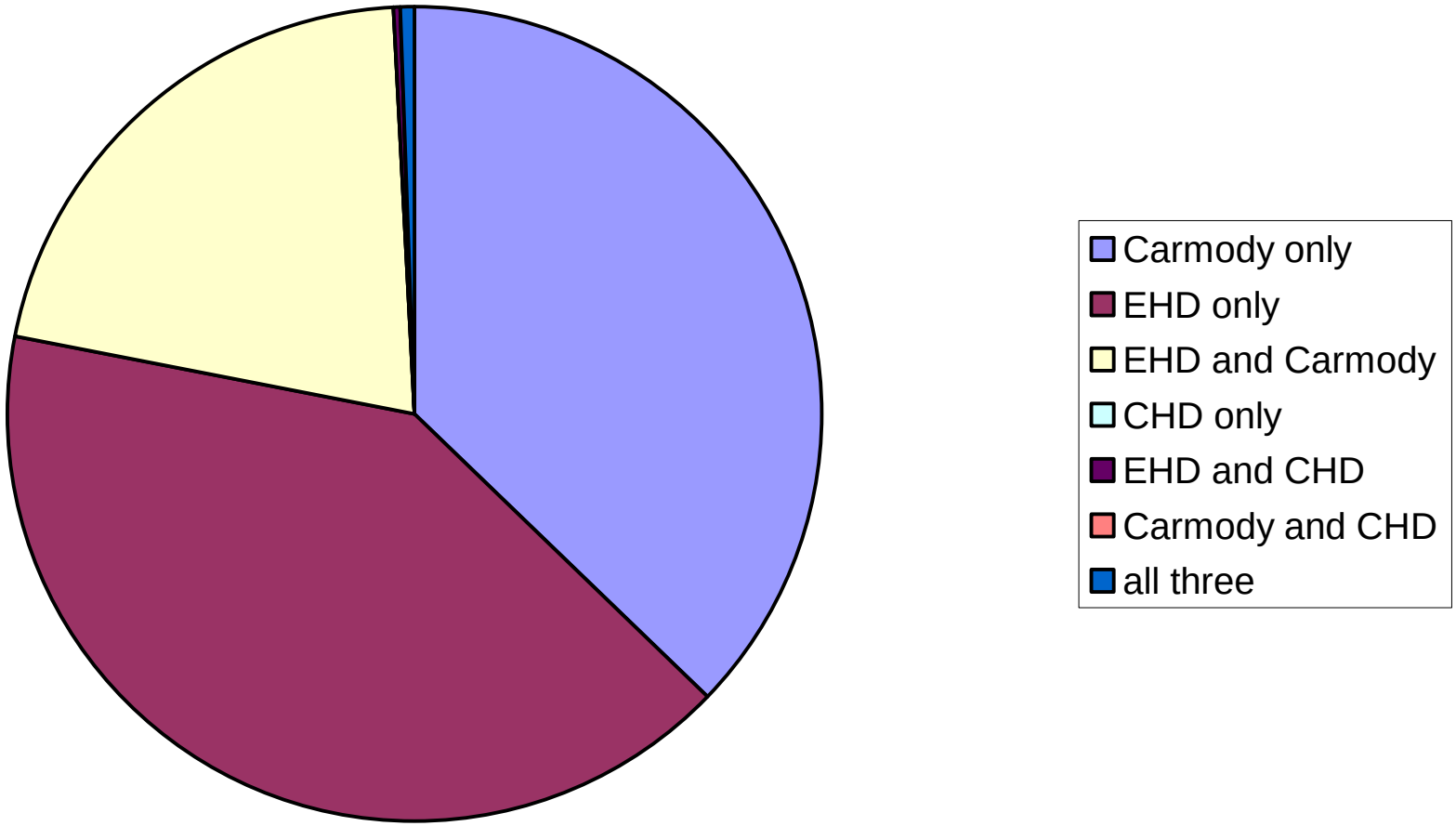
Purpose: Assess water quality protection by advanced onsite sewage treatment and disposal systems throughout the State of Florida

Progress:

- Database of advanced systems:
  - Data has been gathered from the state database, any county specific databases, and from Carmody
  - Data fields and database structure have been discussed and sketched
- Survey of user groups perceptions task:
  - Provider is Florida State University Survey Research Laboratory
  - Development of surveys is ongoing with several of the surveys nearing completion
- Quality Assurance Project Plan (QAPP) draft report submitted to RRAC
  - Discussion?
- Next steps: Finalization of QAPP, selection of homesites to sample (criteria?)

Review of Data

Matching of "Operating Permit" Records
(Total =16,529 distinct records)



Optical Wastewater Tracers Study

Purpose: Test the feasibility of detecting wastewater inputs to Florida surface waters using optical characteristics such as optical brighteners from laundry detergents as tracers

Progress:

- Final report to EPA due end October

Upcoming projects

Statewide Inventory of Onsite Sewage Treatment and Disposal Systems in Florida Study

Purpose: To provide a comprehensive inventory of the OSTDS in the state

Progress:

- RRAC voted the continuation of this project as a priority at the May 27th meeting
- Initial internal discussions have begun on process forward
- Several counties, people involved in the BMAP process, and DEP personnel have expressed interested in obtaining and utilizing the data and the process of sharing the data is being streamlined

Columbia County Nitrogen Well Sampling Study

Purpose: To see whether pathogens and nutrients in well water on river-front lots are elevated and effected by either river or septic system influences, and whether there is any seasonal variability in this

Progress:

- Obtain purchase order with a lab that is able to do the sample analysis
- Coordinate with Columbia County Health Department staff to conduct the sampling

Other Business

Public Comment

Next Meeting

Upcoming meeting topics:

Nitrogen Study Status Update

Proposed dates for next meeting:

- Suggestions?

Closing Comments and Adjournment

Florida Department of Health (FDOH)

Research Review and Advisory Committee (RRAC) Meeting Summary

Meeting on September 10, 2009

Betty Easley Conference Center, Tallahassee, FL

- **RRAC Members/Alternates Present**:
  - In person: Anthony Gaudio, Bill Melton, and Jim Oskowis
  - Via teleconference: David Carter, Kim Dove, Tom Higginbotham, Jim Peters, Vince Seibold, Patti Sanzone, John Schert, and Pam Tucker

  Nine out of ten groups were present, representing a quorum

- **Review of Previous Meeting Minutes**: The minutes were approved as submitted.

- **Updates on projects:**
  - **Town of Suwannee Study**: The sampling has been completed, which included source tracking to detect human DNA component. The final draft report is in, and comments are due to Elke by noon on Tuesday September 15th. The RRAC voted at the July 1st meeting to renew the contract to conduct sampling again during December/January 2009 and the paperwork is now routing. Larry Danek with Environmental Consulting & Technology, Inc. (ECT) presented on the results of the study. Some of the conclusions were that Salmonella was found more often in the river than in the canals of the town. Nitrate + nitrite exhibited a strong correlation with river flow. There was consistently more nitrate + nitrite in the river samples than in the canals. The source tracking results indicated a human source was present approximately 42 percent of the time and approximately equally present in the canals and the river. The total and fecal coliforms were much higher in the canals than in the river. The fecal coliforms decreased from 1996 to 2009, whereas the total coliforms increased. Simple statistical comparisons of the 2009 results with the 1996 results were complicated by large changes in the river (control) stations. There was a significant reduction in fecal coliforms in the canals as compared to the river stations from 1996 to 2009. There was no large improvement in water quality in the canals between 1996 and 2009 that could be attributed to closing the OSTDS. A motion was passed to continue with the renewal process to replicate the sampling effort during November and December of 2009 and allow department staff to decide if the sampling will not commence based on factors such as river discharge levels (if greater than 10,000 cubic feet per second the sampling shall not take place), water temperature values, or impending significant weather events. In the case the department decides not to commence sampling the RRAC has the opportunity to reverse the decision and advise the department to move forward with sampling.

  - **Nitrogen Reduction Strategies Study**: An overview was given outlining what has happened since the last meeting. Numerous reports have been submitted and reviewed by RRAC and DOH:
    - Passive nitrogen removal study phase II quality assurance project plan
    - Literature review on onsite nitrogen reducing technologies
    - Classification, ranking, and prioritization of technologies
    - Prioritization of nitrogen reduction technologies

- Literature review of nitrogen reduction by soils and shallow groundwater
- Literature review on nitrogen fate and transport modeling
- Report on selection of existing data sets for model calibration

Dr. Smith and Josefin Edeback presented to the TRAP on the project. The contract amendment, as recommended at last meeting, is currently being discussed with provider. There was a discussion on the existing septic tank at the proposed test facility site and how the issue of groundwater infiltration into the tanks through the risers should be fixed. There was also a discussion on the Task C facility design having mound geometries that are different from the code. The first progress report on this project is due in February and the draft report will need to be submitted to the RRAC for review in December. A phone conference to discuss this report is planned for sometime early to mid December.

- **Manatee Springs, Performance of Onsite Systems Phase II Karst Study**: The original contracted sampling work has been completed. The draft report was submitted at the July 1st meeting and comments were sent back to the provider (FSU). The final report has been received and is being reviewed by staff to ensure comments addressed. The final report on entire project to be submitted to EPA and the RRAC by the end of September. An additional sampling event will be done during non-flood conditions, which occurred on September 10th. Once this sampling event has been completed, the final report that was sent to EPA will be amended with the new information and a draft of this report will be sent to the RRAC for review and comment.

- **Monroe County Performance Based Treatment System Performance Assessment**: Quality control of existing data is ongoing. All sampling has been completed. A report summarizing this project is being written.

- **319 Project on Performance and Management of Advanced Onsite Systems**: For the database task, data has been gathered from the state database, any county specific databases, and from Carmody. The data fields and database structure have been discussed and sketched. There was a discussion on the review of data from operating permits that has been gathered from the various sources and how there is limited overlap of the data. The Florida State University Survey Research Laboratory was selected to perform the user-group perceptions survey task, and they are currently in the process of developing the surveys with the homeowner and regulator surveys nearing completion. A draft of the Quality Assurance Project Plan has been submitted to the RRAC, and comments are due by September 22nd. Some of the next steps for this project are to finalize the Quality Assurance Project Plan for the sampling, and selection of home sites to sample. There was a discussion on what criteria should be used to select systems for sampling. Should there be a purely random sample taken or should the criteria be stratified? If it is stratified, what criteria should be used (i.e. age, commercial vs. residential, age of system, maintenance history, system manufacturer, ATU vs. PBTS)? The RRAC will provide thoughts on this to department staff.

- **Optical Wastewater Tracers Study**: The final report on this project is due at the end of October.

- **Upcoming projects:**
  - **Statewide Inventory of Onsite Sewage Treatment and Disposal Systems in Florida Study**: RRAC voted the continuation of this project as a priority at the May 27th meeting. Initial internal discussions have begun on how to proceed

with this. The RRAC is still on board with the department coming back with different proposals at a future meeting on how to move forward with this project. Several counties, people involved in the BMAP process, and DEP personnel have expressed interested in obtaining and utilizing the data and the process of sharing the data is being streamlined.

- **Columbia County Nitrogen Well Sampling Study**: The first step for this project is to obtain a purchase order with a lab that is able to do the sample analysis. The department has been inquiring with the DOH lab in Jacksonville to see if they would be able to do the analysis and it is looking increasingly as if this would not be possible. Private labs will be contacted to see if they might be able to do the analysis. The Columbia County Health Department staff is interested in collecting the samples.

- **Other Business**: Bill Melton brought up the Alternative Drainfield Product Study idea again, and there was a discussion on how to approach this as a future project. Anthony Gaudio mentioned that another possible future project would be looking at bacterial and viral contributions from OSTDS to ground waters and surface waters.
- **Public Comment**: The public were allowed to comment throughout the meeting. There was no public comment.
- **Next Meeting**: The next meeting will be scheduled for the beginning of December. The meeting location has not been determined, but the option of having a live meeting via teleconference and/or via a web conference was discussed and staff will research this further. The focus of the next meeting will be to discuss the progress report on the Nitrogen Reduction Strategies Study as well as discuss current and proposed research projects.

DRAFT

EVALUATION OF WATER QUALITY AROUND THE TOWN OF SUWANNEE, FLORIDA, AND COMPARISON TO HISTORIC DATA

CONTRACT COQOT

Prepared for:

DIVISION OF ENVIRONMENTAL HEALTH
BUREAU OF ONSITE SEWAGE PROGRAMS
Tallahassee, Florida

Prepared by:

Environmental Consulting & Technology, Inc.
3701 Northwest 98th Street
Gainesville, Florida 32606

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EXECUTIVE SUMMARY

In 1989 to 1990 salmonella contamination was detected in commercially-harvested oysters from an area around the town of Suwannee. The contamination was suspected to be caused and/or contributed to by onsite sewage treatment and disposal systems (OSTDS) in the town. To alleviate the contamination source, plans were approved to abandon all OSTDS and route all sewage to a central wastewater treatment plant (WWTP). All OSTDS were closed by 1998, and the WWTP became operational during that time.

The Florida Department of Health (DOH) contracted with Environmental Consulting & Technology, Inc. (ECT) to conduct sampling in 1996 and 1997 in and around the town to evaluate potential differences in water quality immediately before and after construction and operation of the WWTP. The study included weekly sampling at stations in the Suwannee River (up and downstream of the town) and in the canals within the town. A report of this study was issued in 1998. General trends observed during the study included:

- There were more occurrences of salmonella at the river station than the canal stations.
- Salmonella was always present at the furthest upstream river station and one downstream river station.
- There were more occurrences of salmonella during the postconstruction sampling than preconstruction.
- Pre- and postconstruction salmonella occurrences were comparable in the four river stations.
- Fecal coliform was also analyzed, but there was a negative correlation with salmonella, as the amount of fecal coliform increased, the occurrence of salmonella decreased.

The study suggested the town was not the sole source of salmonella, as this organism was routinely found upstream of the town indicating a potential regional issue. Salmonella

was detected in the canals during low slack tides suggesting the town was a contributor to bacterial contamination, therefore the change from OSTDS to the WWTP would be beneficial.

Unfortunately, an El Niño episode persisted during the time of postconstruction sampling which produced very high river flows and potentially introduced other bacterial contamination sources. As such, this weather anomaly affected the postconstruction results and limited the ability to compare with preconstruction data.

In September 2008, the FDOH issued an Invitation to Negotiate (ITN) to conduct a follow-up study. The intent of the study was to provide an updated evaluation of the environmental impacts of abandoning the OSTDS and sewering the town to a central WWTP. ECT responded to the ITN and was selected to conduct the study. A study plan and quality assurance project plan (QAPP) were prepared and approved, and sampling for this project was conducted in June and July 2009.

The 1996 and 2009 study designs were intended to have common study components to facilitate data comparison. However, in 2009 other analytical parameters were added to provide additional information: total phosphorus, enterococci, and deoxyribonucleic acid (DNA) source (human versus animal) tracking.

The results of the 2009 study did not indicate a significant improvement in water quality from 1996 attributable to closing the OSTDS. Comparison of the 1996 and 2009 data were difficult due to changes in river flows, variability in river (control) station data, and seasonal differences, particularly water temperatures.

However, observations that could be made include:

- Salmonella occurrences were higher in the river than in the canals in both 2009 and 1996 indicating the canals were not the primary source of salmonella. The occurrences of salmonella in 2009 were slightly higher than 1996.

- Nitrate + nitrite (NO_x) exhibited a strong correlation with river flow and decreased with increasing river flow. TKN increased with increasing river flow. There was consistently more NO_x in the river samples than in the canals.
- The source tracking results indicated human material was present about 42 percent of the time and about equally present in the canals and the river.
- The total and fecal coliform values were much higher in the canals than in the river in both 1996 and 2009. The fecal coliforms decreased from 1996 to 2009 in both the canals and the river stations whereas the total coliforms increased from 1996 to 2009. The higher values in the canals as compared to the river are probably from wildlife concentrated near the canals.
- Simple statistical comparison of the 2009 results with the 1996 results were complicated by large changes in the parameters measured the river (control) stations resulting from variability in river flow and possibly water temperature (seasonality). Consequently, a more detailed statistical approach was used to filter the effects of changes in the control stations.

Using a statistical method to account for the variability in the river (control) stations, the only statistically significant observation was a reduction in fecal coliforms in the canals in 2009 as compared to 1996. This would indicate a benefit of closing the OSTDS. However, the 2009 sampling was conducted in the summer as opposed to late fall/winter in 1996 and the potential seasonal affects on fecal coliforms have not been assessed.

The difficulty to date in assessing the potential benefits of OSTDS closure in the town of Suwannee is controlling outside environmental influences that can mask any real changes that might be present. In 1997 the large increase in rainfall and river flow resulted in large changes in the river (control) stations. Similar large changes observed in the river station were apparent in the canals, but it could not be determined if the improvements resulted from general changes in water quality in the area or resulted from closing the OSTDS. Similarly in 2009, a significant reduction in fecal coliforms was apparent in the canals, but it was not certain if this was a direct result of OSTDS closures or a seasonal effect caused by warmer water or variation in wildlife occurrences.

Consequently, it is recommended that the sampling be repeated in November/December in an attempt to closely match the environmental conditions present during the baseline sampling in 1996. This should allow for two key comparisons:

- Comparison of the 1996 baseline conditions (pre-OSTDS closure) under the similar seasonal and river flow conditions.
- Comparison of the winter conditions with the 2009 summer conditions.

This should enhance the chances of identifying benefits of the OSTDS closure if they exist.

1.0 INTRODUCTION

1.1 PROJECT HISTORY

A cooperative study by the Florida Department of Natural Resources (FDNR, now the Florida Department of Environmental Protection [FDEP]), the Florida Department of Agriculture and Consumer Services (FDACS), and the U.S. Food and Drug Administration (FDA) in 1990 (Glatzer, 1990), investigated an incident of gastroenteritis in Florida during the fall and winter of 1989 to 1990. At least two of the cases were indicative of salmonellosis. Samples of oysters from Louisiana and Florida were analyzed for *Salmonella*. About 39 percent of the oysters tested positive for *Salmonella*; approximately 90 percent of these oysters were from Suwannee Sound and adjacent areas to the north and south—Horseshoe Beach and Cedar Key, respectively. In addition, *Salmonella* was detected in water samples taken above and below the town of Suwannee. Other possible sources identified by Glatzer (1990) were the waterfowl and wildlife in the area. In May 1990 FDNR reclassified the oyster areas of Suwannee Sound. This reclassification included closure line changes and a new management plan based on rainfall amount.

According to the Florida Department of Health and Rehabilitative Services (FDHRS, 1991), now the Florida Department of Health (FDOH), the town of Suwannee had a total of 717 onsite sewage and treatment disposal systems (OSTDS). Of these, seven (i.e., <1 percent) systems were considered adequate. The remaining 710 inadequate OSTDS were identified as one of the sources for fecal contamination of the oysters in Suwannee Sound and adjacent areas. Because of the number of inadequate OSTDS, plans were approved to construct a central wastewater treatment plant (WWTP). The facility became operational in October 1997 and connections to the system began immediately. The OSTDS were pumped out and abandoned (filled with sand) at the same time each household was connected to the WWTP system. By the end of November or mid-December 1997, all but about 50 of the OSTDS were closed. The remaining 50 OSTDS were closed by March 1998. Instead of the 717 OSTDS initially reported by FDHRS (1991), 850 OSTDS were found; all were properly abandoned.

To investigate the impacts the OSTDS closures and utilization of a central WWTP would have on surface water around the town of Suwannee, a water quality study was contracted by the FDOH to Environmental Consulting & Technology, Inc. (ECT). Sampling was conducted in 1996 prior to the OSTDS closure and again from November 1997 through January 1998 following the OSTDS closure, and a report was issued in 1998 (ECT, 1998).

In September 2008, the FDOH issued an Invitation to Negotiate (ITN) titled *Evaluation of Water Quality around the town of Suwannee*. The intent of the proposed study was to provide an updated evaluation of the environmental impacts of abandoning the OSTDS and sewering the town to a central WWTP. ECT responded to the ITN and was selected to conduct the study. Sampling for this project was conducted in June and July 2009. This report presents the results of the 2009 sampling and comparisons to the 1998 report data.

1.2 PROJECT GOALS

The goal of the initial project was to evaluate the potential for restoration of commercially viable oyster harvesting in Suwannee Sound following the connection of the town of Suwannee to a WWTP. The specific objectives included:

- Conduct a preliminary online literature search to identify and evaluate various methods for detecting domestic sewage in receiving waters.
- Prepare a plan of study (POS) and quality assurance project plan (QAPP) that would lay out a sampling strategy to meet the goals of the project.
- Conduct pre-construction (of the WWTP) field sampling that would: (1) determine the optimum day of the week to sample, if any; (2) confirm that low tide was the ideal worst-case time to sample; (3) evaluate the various methods selected for detection of domestic sewage; and (4) quantify water quality conditions in the Suwannee River in the vicinity of the town of Suwannee prior to the construction of the WWTP and subsequent abandonment of the OSTDS.
- Conduct postconstruction sampling in order to determine what changes, if any, resulted from the town of Suwannee converting from OSTDS to the WWTP with land disposal.

- Evaluate the field data and data from other sources in light of the information obtained from the ongoing online literature search and determine if there has been any change in water quality and if the change is statistically significant.

The primary goal of the current project is to generate a comparative water quality database by duplicating the previous study's weekly sampling effort. The specific sampling approach designed to achieve this goal is:

- Collect samples at the same ten stations (nine surface water and one ground water) as used in the 1996 to 1998 project.
- Collect samples over the same duration (eight consecutive weekly events).
- Collect surface water samples during the same tidal cycle (low slack).
- Analyze samples for the same microbiological and nutrient parameters plus the addition of total phosphorus, enterococci, and DNA source tracking.
- Use the same surface water sampling and *in situ* data collection protocols. The ground water sampling technique was revised from using a bailer to use of a peristaltic pump and tubing as required by FDEP.
- Sampling on the same day each week (Monday) as was done during the earlier study.

An additional task of the project was to identify and compile supplemental data from other sources of water quality and hydrology in the project area.

2.0 STUDY COMPONENTS

2.1 SAMPLING EVENTS

2.1.1 SAMPLING SCHEDULE

A total of eight consecutive weekly sampling events were conducted to collect water quality samples and *in situ* data. Prior to implementing the weekly sampling, a reconnaissance field trip was conducted jointly by ECT and FDOH project management personnel to inspect current conditions at the proposed sampling locations and confirm station locations.

Sampling was performed on Monday of each week, and began on May 26, 2009, and was completed on July 13, 2009. Each weekly sampling event was scheduled so the surface water sampling duration would bracket the projected time of a low slack tide. Tide projections were obtained from an internet Web site (www.saltwatertides.com), which provided daily semi-diurnal tide time projections for the tide at the mouth of the Suwannee River. It was initially anticipated that it may take up to 4 hours for surface water station monitoring, therefore the sampling start times were 2 hours before the projected low slack tide time. After the first several events, it was determined the surface water stations could be completed in approximately 2 hours. Therefore, the sampling start time was revised to 1 hour before the projected low slack tide. Sampling was conducted at low tides to assure samples in the canals collected water issuing from the canals and not water entering from the river.

2.1.2 SAMPLING LOCATIONS

Ten water quality sampling locations consisting of nine surface water stations and one ground water station were monitored for this project. Figure 2-1 displays the locations of all ten stations. The ground water station was a shallow well (6 feet [ft] below ground surface) located on Leon Drive and was the same property as the previous study. The well was positioned downgradient from an abandoned residential OSTDS site field, and installed with a hand auger.

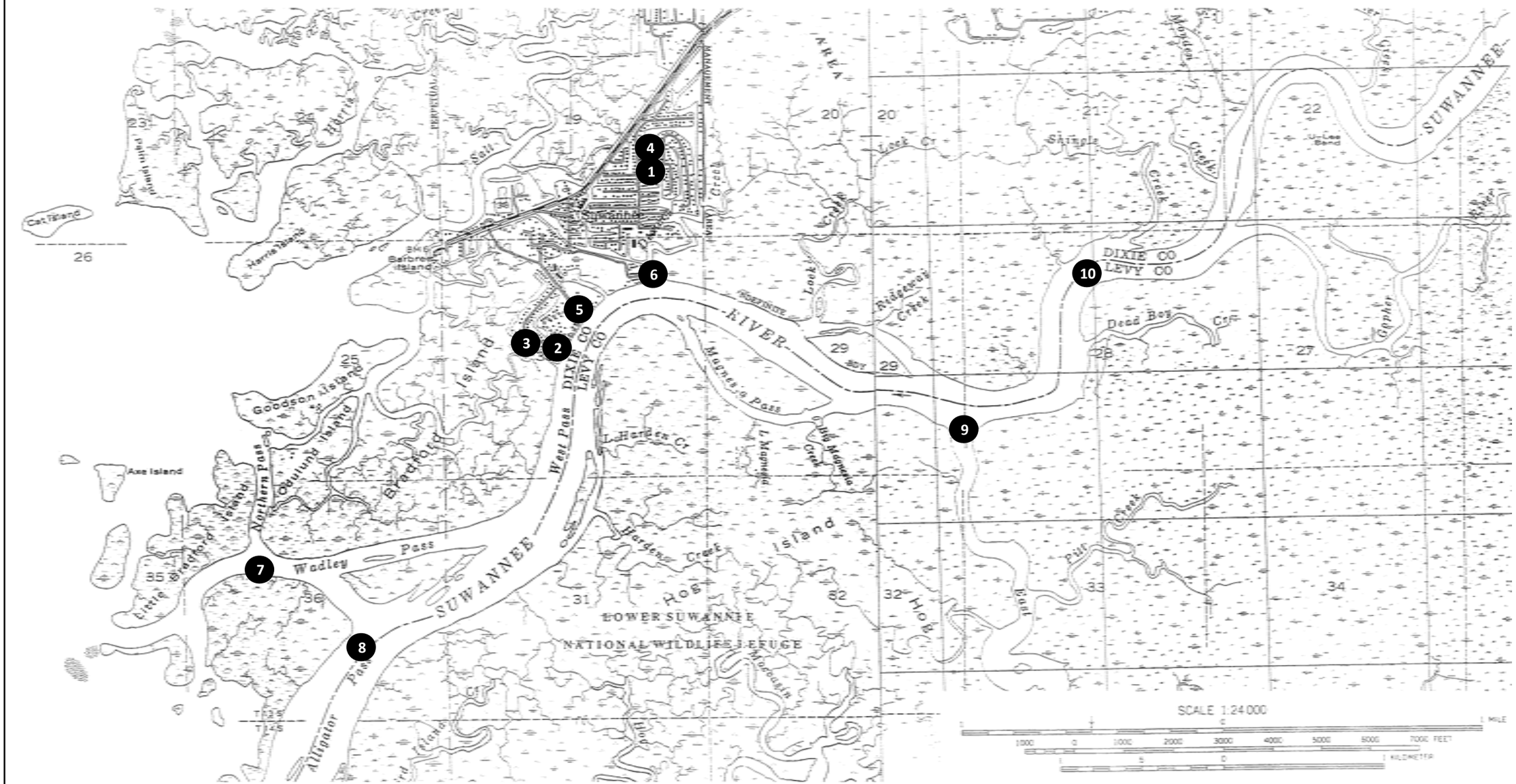

FIGURE 2-1.

SAMPLING LOCATIONS

Source: ECT, 2009.

ECT

Environmental Consulting & Technology, Inc.

The surface water stations include one control station (Station 10) located approximately 2 miles upstream of the town. The remaining stations were located in canals within the town (Stations 2,3,4,5, and 6) and in major passes of the Suwannee River delta, specifically East Pass (Station 9), Alligator Pass (Station 8), and Wadley Pass (Station 7). To ensure the same station locations were occupied on each survey, the station's latitude and longitude coordinates were programmed during the recon trip and stored in a global positioning system (GPS) receiver for future navigation to stations. Table 2-1 provides the position coordinates for all stations.

2.1.3 SAMPLING PARAMETERS

Water temperature, specific conductance, pH, and dissolved oxygen (DO) were measured *in situ* at all stations during each survey. The measurements at Station 1 (monitor well) were done as required by the FDEP standard operating procedure (SOP) for well sampling to demonstrate adequate purging of the well prior to sample collection. Measurements at the surface water stations were made at three depths (surface, mid-depth, and bottom) to document the physical characteristics in the river/canals water column at the time of sampling and assess any stratification. The surface and bottom reading were done 1 foot (ft) below the surface and 1 ft above the bottom, respectively.

Water quality samples were collected from within the first 1 ft of the water column and analyzed for several nutrients and microbiological parameters. Table 2-2 presents a list of the parameters analyzed as well as ancillary information pertaining to the samples. Please note, after the fourth sampling event a decision was made in conjunction with FDOH to discontinue sampling for total phosphorus and to substitute DNA source tracking analyses.

2.2 SAMPLING AND ANALYTICAL METHODS

2.2.1 FIELD PROTOCOLS

In situ measurements of water temperature, specific conductance, pH, and DO were made at three depths in the water column at surface water stations using a Yellow Springs Instrument® (YSI) Model 556 multiparameter system. During monitor well purging, turbidity was also measured with a Hach Model 2100P turbidimeter.

Table 2-1. Town of Suwannee Water Quality Station Coordinates

Station	Latitude	Longitude
1	29 18 55.40	83 08 21.16
2	29 19 15.80	83 08 43.64
3	29 19 16.18	83 08 48.74
4	29 19 57.32	83 08 20.76
5	29 19 23.97	83 08 37.12
6	29 19 30.91	83 08 20.35
7	29 18 28.16	83 09 49.57
8	29 18 11.02	83 09 25.43
9	29 18 55.55	83 07 09.68
10	29 19 29.18	83 06 42.70

Source: ECT, 2009.

Table 2-2. Town of Suwannee Water Quality Sample Information

Parameter	Analytical Method	Preservation	Holding Time
Total Coliform	SM 9222 B	Cool 4° Celsius	6 hours
Fecal Coliform	SM 9222 D	Cool 4° Celsius	6 hours
Enterococci	EPA 1600	Cool 4° Celsius	6 hours
Salmonella	SM 9260 B	Cool 4° Celsius	6 hours
Nitrate+Nitrite	EPA 353.2	Cool 4° Celsius H2SO4 to pH < 2	28 days
Total Kjeldahl Nitrogen	EPA 351.2	Cool 4° Celsius H2SO4 to pH < 2	28 days
Total Phosphorus	EPA 365.1	Cool 4° Celsius H2SO4 to pH < 2	28 days

Note: EPA = U.S. Environmental Protection Agency.
H_2SO_4 = sulfuric acid.
SM = Standard Method (APHA, 1998).

In situ measurements at surface water stations were recorded at 1 ft below the surface, mid-depth, and 1 ft above the bottom on standardized forms developed by ECT. Data collection time and depths were also recorded along with the total depth at each station. The total water depth and measurement depths were determined by graduations on the YSI meter cable, which was attached to a weighted polypropylene line. *In situ* measurements during the monitor well purging prior to sample collection, were done per the requirements in the FDEP ground water sampling standard operating procedure (SOP) FS 2200 and were recorded along with other SOP required ancillary data/information on FDEP form FD 9000-24.

The *in situ* measurement instruments were calibrated at the beginning and end of each sampling day, and the calibration results were documented on FDEP-generated forms. Per a request from FDOH, all field records included in weekly field data/information packets have been transmitted as a separate electronic data submittal to FDOH, prior to submission of this report.

Per the previous study, surface water sample collection was done as a surface grab sample from within the top 1 ft of the water column. The sample was collected using an extra pre-cleaned 1 liter sample container provided by the laboratory. This technique is consistent with the surface water sampling FDEP SOP FS 2100, specifically FS 2110. (1.1.1). A new sample container was used at each station precluding the need to decontaminate the sampling device between stations and avoiding the potential for station cross-contamination.

Samples were collected using the following steps:

- Samples were collected from the bow of the boat and away from the outboard motor.
- The sampler wore a powder-free shoulder-length glove to submerge the sample container and a standard length powder-free latex glove when handling the sample containers. New gloves were used at each station.
- The 1-liter sampling container cap was removed and the container was slowly submerged with the opening first into the water.

- The bottle was held with the opening pointed up stream and water was water allowed to fill the container.
- The container was retrieved and aliquots were dispensed to the individual sample containers for preservation, storage, and shipment to the laboratory.

Please note a modification from the FDEP SOP (FS 2100[1.1.2]) sampling process. The extra sample container used to collect samples was not rinsed prior to sample collection to avoid residuals from surface water sheens and surface floating vegetation that could be caused by multiple container immersions.

Each stations sample kit had one pre-preserved container with sulfuric acid for nutrient analyses. Acid preservation is done to maintain sample integrity and requires lowering the sample pH to 2 standard units (su) or below. Adequate preservation was checked during the first five sampling events using color-coded pH sticks. All checks yielded results below 2 su, and ranged from 1.0 to 1.6 su. This information was recorded on the *in situ* data form in the comments section.

The monitor well sample was collected with a variable-speed peristaltic pump and tubing. Well purging and sampling was done per FDEP SOP 2200 that reference specific sections of the SOP pertaining to use of a peristaltic pump and other aspects of the SOP addressing the over-all purging and sampling process. Per the SOP, general procedures followed included:

- Wearing powder-free latex gloves when handling tubing and sample containers.
- Use of new tubing during each sampling event.
- Controlled pump rate to maintain constant water level in the well and to minimize entrainment of solids
- Use of rolled plastic around the well to prevent pump tubing from contacting surrounding soils when deploying.
- Stabilization of *in situ* parameters within SOP criteria before collecting samples.

Each station's sample container kit was stored in a sealable (e.g., Zip-Loc®) bag prior to and following sampling to prevent station cross-contamination. Samples were placed in ice immediately following collection and until delivery to the laboratory. Samples were delivered to the laboratory within the 6-hour holding time required for the microbiological parameters and accompanied by the laboratory chain of custody form that included the following information:

- Lab client name and contact information.
- Project name, number, and location.
- Sample identifications.
- Sample type.
- Date and time of sample collection.
- Number of containers per sample.
- Sample preservation method.
- Parameters to be analyzed.
- Types of samples containers used.
- Name and affiliation of sampler.

2.2.2 LABORATORY METHODS

Analytical methods used for water quality samples are summarized in Table 2-3. All sample analyses were conducted by Advanced Environmental Laboratories, Inc. (AEL), Gainesville, Florida, with exception of deoxyribonucleic acid (DNA) source tracking which was done by Source Molecular Laboratory, Inc., Miami, Florida. At the time the contract was awarded, AEL held FDOH accreditation for fecal coliform, total coliform, total phosphorus (TP), total Kjeldahl nitrogen (TKN), and nitrate + nitrite (NO_x) analyses. Subsequent to contract award and initiation of sample collection, AEL applied for and received accreditation for enterococci and salmonella analyses per the methods in Table 2-3.

Table 2-3. Town of Suwannee Water Quality Sample Analyses Methods

Parameter	Analytical Method
Total Coliform	SM 9222 B
Fecal Coliform	SM 9222 D
Enterococci	EPA 1600
Salmonella	SM 9260 B
Nitrate+Nitrite	EPA 353.2*
Total Kjeldahl Nitrogen	EPA 351.2*
Total Phosphorus	EPA 365.1
DNA Source Tracking	Human enterococci Identification

*Revision 2.0, 1993.

Note: EPA = U.S. Environmental Protection Agency.
SM = Standard Methods.

Source: ECT, 2009.

2.3 QUALITY ASSURANCE/QUALITY CONTROL

Prior to initiation of field activities and per Task 1 of the contract, a Quality Assurance Project Plan (QAPP) was developed by ECT and approved by FDOH and FDEP (ECT, 2009). The document provides methodologies used for water quality sampling, data collection, sample analyses, data review and verification, and reporting.

2.3.1 SAMPLING ACTIVITY

For each of the eight weekly sampling events, a field data/information packet was assembled and completed to provide guidance/details to the sampling personnel to ensure all required activities and all necessary documentation were completed per the FDEP SOP employed for project execution. The packet consisted of reference material and ECT and FDEP standardized forms to document information and data. The packet consisted of the following:

- A form listing itemization of the various records and logs to be completed during sampling and data collection.
- Identification of the *in situ* parameters to be monitored and procedures to be followed.
- Identification of field personnel, sampling date and time period, and project and site name.
- Equipment checklist.
- Identification of laboratory parameters, analytical method numbers, sample preservation requirements, and sample holding times.
- A daily field activity log.
- A project sampling schedule with sample start times based on predicted time of low slack tide and identification of quality assurance/quality control (QA/QC) samples types (i.e., duplicates, field and equipment blanks) to be collected per trip.
- List of project team member phone numbers.
- List of sampling station coordinates.
- Site map.
- Surface water sampling/*in situ* data collection form.

- Ground water sampling form.
- Instrument calibration forms.

As previously discussed, sampling activity prescribed to applicable sections FDEP SOPs, specifically SOP FS 2100 was referenced for surface water sampling and FS 2200 for ground water sampling. The instruments used to collect *in situ* data were calibrated at the beginning and completion of each sampling day and documented on FDEP developed forms. The parameters calibrated on each survey were specific conductance, pH, DO, and turbidity. Step one of calibration consisted of measuring and adjusting meter responses to vendor supplied standards for specific conductance (two standards), pH (three buffer solutions), and turbidity (four primary formazin standards). DO was calibrated following the air calibration procedure in a water-vapor saturated chamber. The DO reading was adjusted to read the correct concentration based on ambient temperature in the calibration chamber and referencing Table FT 1500-1: Solubility of Oxygen in Water at Atmospheric Pressure in the FDEP SOP FT 1500 for measuring DO. The temperature thermistor on the YSI meter was checked periodically against an NIST-traceable thermometer.

Immediately following calibration and to confirm meter accuracy, an initial calibration verification (ICV) was conducted consisting of re-measuring a calibration standard for specific conductance and pH and DO in the water vapor saturated calibration chamber. Calibration adequacy and meter accuracy were deemed acceptable if the ICV meter responses were within FDEP- stipulated acceptance criteria. For DO, the acceptance criteria is +/- 0.3 milligrams per liter (mg/L) of the solubility table concentration for the ambient temperature in the calibration chamber during the ICV; specific conductance is within +/- 5 percent of the standard concentration; and for pH within +/-0.2 su of the buffer value; for turbidity the acceptance criteria ranges from 5 to 10 percent dependent on the concentration of the standard. At the end of the sampling day, a post or continuing calibration verification (CCV) was conducted to check on meter reading stability over the course of the sampling day. The CCV responses were deemed acceptable based on the same criteria for the ICV.

All ICV and CCV meter responses were within acceptance criteria for the eight sampling events, with the following exceptions: June 8, 2009 (Event 3), CCV responses for specific conductance were outside the +/- 5 percent criteria for two standards checked. The 445 microseiman (µS) standard read 585 µS (31 percent) and the 700 µS standard read 911 µS (30 percent). It was later determine that a "burr" on a cable to connecting plug caused a poor connection resulting in the poor meter response during the CCV. The problem was corrected and all subsequent specific conductance calibrations for the balance of the project were within criteria. Also, because the *in situ*-specific conductance readings during events were consistent with other surveys, the data were deemed useable and included in the project database. Another variation occurred on June 15, 2009 (Event 4) when the 20 NTU turbidimeter standard read 18 NTU (10 percent), which was marginally outside the acceptance criteria of 8 percent. The reason for the offset is unknown, and all subsequent calibration responses were within criteria. Also on June 22 (Event 5), the DO CCV reading was 7.30 mg/L and should have been 7.62 mg/L. This response was outside the +/-0.3 mg/L criteria, but only marginally and was not considered a justification to qualify the DO measurements for that event and data were included in the project database.

Per the contract and routine FDEP sampling program requirements, 10 percent of all laboratory samples were QA/QC samples consisting of either a field blank, equipment blank, or field duplicates. Based on 10 samples per 8 weeks of sampling which equates to a total of 80 samples, a minimum of 8 QA/QC samples were required for the project. This requirement was met and exceeded as a total of 9 QA/QC samples were collected. Table 2-4 presents a listing, by sampling event, of the types of QA/QC samples generated to satisfy the projects requirements.

The field blank sample was generated by pouring laboratory-provided analyte-free water directly into a set of sample containers to assess the potential for sample contamination from the sampling environment and during handling/transport from the field to the lab. The equipment blank was generated by processing analyte-free water through the sampling apparatus (pump/tubing or sample container used to collect surface water

Table 2-4. Project Mandated Quality Assurance/Quality Control (QA/QC) Samples

Sampling Event No.	Date	Field QA/QC Sample	Lab QA/QC Samples
1	5/26/2009	Field Blank/ Equipment Blank	Lab Matrix Spike & Matix Spike Duplicate
2	6/1/2009	Duplicate (Station 10)	
3	6/8/2009	Duplicate (Station 9)	
4	6/15/2009	Duplicate (Station 8)	Lab Matrix Spike & Matix Spike Duplicate
5	6/22/2009	Duplicate (Station 7)	
6	6/29/2009	Duplicate (Station 6)	Lab Matrix Spike & Matix Spike Duplicate
7	7/6/2009	Equipment Blank	
8	7/13/2009	Duplicate (Station 4)	Lab Matrix Spike & Matix Spike Duplicate

Source: ECT, 2009.

samples) to simulate sample collection and assess whether the sampling apparatus could contaminate the samples. Duplicate samples were generated by filling two sets of sample containers consecutively at the assign station using the identical sampling procedure.

Table 2-5 presents the results of the field and equipment blank samples collected on sampling events 1 and 7. Sample Event 1 equipment blank was generated using the monitor well pump and tubing for Station 1, and the equipment blank on Event 7 was generated with the sample container used to collect the sample at Station 9. All data for blank samples were below the analytical methods detection limits, with the exception of TP in the Event 1 equipment blank. TP was detected at 0.007 mg/L, which was 0.001 mg/L above the detection limit. The sample associated with the blank, the monitor well sample (SW1A), had a TP concentration of 1.01 mg/L. This is orders of magnitude above the level detected in the blank and was therefore considered inconsequential and not warranting qualifying the well results. Also, the sample was not reanalyzed because the QAPP stipulated reanalyses "if an analyte was detected in a blank at 10 percent of a quantified project sample," which clearly was not the case in this instance.

Table 2-6 presents the results of the field generated duplicate samples collected on six of eight sampling events. Duplicate sample analysis is a means to evaluate analytical data precision or reproducibility as it relates to sample collection and laboratory analysis. Duplicate samples were collected by consecutively filling two sets of sample containers with the same sampling device and using common procedures to handle, store, and transport the samples.

To evaluate the results of the field duplicate samples and per the QAPP, ECT used the laboratory acceptance criteria for the nutrient parameters TP, TKN, and NO_x, for duplicate analyses of matrix spike and matrix spike duplicate samples. Duplicate sample acceptance criteria is the relative percent difference between the two samples, and is calculated by dividing the concentration difference of the two samples by the average concentration of the samples and converting the result to a percentage value.

Table 2-5. Town of Suwannee QA/QC Blank Sample Results

Parameter	Event No. 1 Field Blank	Event No. 1 Equipment Blank	Event 7 Equipment Blank
Total Coliform (col/100 mL)	1 U	1 U	1 U
Fecal Coliform (col/100 mL)	1 U	1 U	1 U
Enterococci (col/100 mL)	1 U	1 U	1 U
Salmonella	Absent	Absent	Absent
Nitrate+Nitrite (mg/L)	0.003 U	0.003 U	0.003 U
Total Kjeldahl Nitrogen (mg/L)	0.08 U	0.08 U	0.08 U
Total Phosphorus (mg/L)	0.006 U	0.007	not sampled

Note: col/100 mL = colonies per 100 milliliters of sample.
mg/L = milligrams per liter.
U = analyzed but not detected.

Table 2-6. Town of Suwannee QA/QC Field Duplicate Sample Results

Parameter	Event 2			Event 3			Event 4			Event 5			Event 6			Event 8			Acceptance Criteria (%)
	Sample	Dupli-cate	RPD (%)	Sample	Dupli-cate	RPD (%)	Sample	Dupli-cate	RPD(%)	Sample	Dupli-cate	RPD (%)	Sample	Dupli-cate	RPD(%)	Sample	Dupli-cate	RPD (%)	
Total Coliform (col/100 ml)	400	308		462	400		400	400		924	1230		2930	2000		616	1230		
Fecal Coliform (col/100ml)	11	10		11	17		8	12		54	42		80	57		100	90		
Enterococci (col/100 ml)	11	14		29	21		17	26		77	52		171	189		8	6		
Salmonella	Absent	Absent		Absent	Absent		Present	Absent		Present	Present		Absent	Absent		Absent	Absent		
Nitrate+ Nitrite (mg/L)	0.364	0.364	0%	0.270	0.275	2%	0.322	0.327	2%	0.389	0.393	1%	0.438	0.453	3%	0.028	0.015	60%	0 - 10
Total Kjeldahl Nitrogen (mg/L)	0.88	0.93	6%	0.78	0.81	4%	0.89	0.85	5%	0.81	0.77	5%	0.71	0.65	9%	0.90	0.84	7%	0 - 10
Total Phosphorus (mg/L)	0.180	0.198	10%	0.147	0.150	2%	0.149	0.144	3%	NS	NS		NS	NS		NS	NS		0 – 20

Note: col/100 mL = colonies per 10 milliliters of sample.
mg/L = milligrams per liter.

The relative percent difference (RPD) is calculated as a percentage by dividing the average concentration of the sample and duplicate by the difference of the two concentrations.

Source: ECT, 2009.

Reviewing Table 2-6 indicates there was only a single instance where duplicate field sample results did not fall within the acceptance criteria. That was from Event 8 analyses for NO_x with an RPD of 60 percent. The reason for the difference in the duplicate sample results is unknown, but the over-all project dataset for this parameter is considered usable as the other five field duplicate NO_x results are well within acceptance criteria. It should be noted that the initial duplicate sample result for TKN of 0.60 mg/L on Event 2 event did not agree well with the sample results at 0.88 mg/L. A request was made for re-analyses of the duplicate TKN, which yielded results of 0.93 mg/L and the resultant RPD of 6 percent using the re-analysis value. There was a similar occurrence for TP on Event 4, where the initial duplicate analysis concentration of 0.71 mg/L did not agree well with the sample concentration of 0.149 mg/L. Again a request was made for re-analysis of the duplicate sample for TP, which yielded a concentration of 0.144 mg/L, which yielded an RPD of 3 percent.

Microbiological analyses methods do not require development of acceptance criteria for duplicate samples. The method does include analyses of duplicates only as a general guide to evaluate consistency in method protocol based on data reproducibility or precision. According to communication with the project contract laboratory, agreement in microbiological duplicate samples values within the same order of magnitude is generally considered adequate. As such, no RPD criteria for microbiological parameters are included in Table 2-6. Based on general acceptance for microbiological duplicates agreeing within the same order of magnitude, the data displayed on Table 2-6 are for the most part good. The total coliform results do have a couple of instances of numerical values having considerable differences, specifically events 5, 6, and 8. However based on the acceptability of duplicate microbiological data agreeing within the same order of magnitude the results were deemed acceptable and included in the data analyses.

Per the contract and QAPP, a planning audit was conducted by FDOH on June 15, 2009, which included inspection of laboratory and field sampling records. Additionally, the FDOH personnel accompanied the ECT field team to the project site on June 15 (sampling Event 4) to observe sampling and data collection protocols. A report of the audit was issued to FDEP on July 16, 2009. Prior to and in preparation for the planning

audit, ECT conducted an internal audit to determine if proper preplanning/scheduling was being conducted to ensure the successful execution of the sampling event and adequate communications between ECT and laboratories was occurring.

2.3.2 LABORATORY ANALYSES

Microbiology QA/QC procedures used in the laboratory for coliforms, enterococcus, and salmonella included the following:

- Blanks—Pre-, post-, and mid- sample analyses (after every 10 samples). The source of any positive results in a blank sample are investigated to include reagent water, media, instruments, and general housekeeping adequacy.
- Duplicates—Duplicate analyses are performed weekly, and the precision is calculated per method procedures to assess the overall on-going lab QA/QC program and do not apply to an individual batch of sample results.
- Positive and Negative Controls:
  - Coliforms—10 positive colonies plus atypical colonies verified by incubation in lauryl tryptose broth/brilliant green lactose bile broth/escherichia coli (LTB/BGB/EC) medias.
  - Enterococcus—10 typical and atypical colonies verified on brain-heart infusion broth (BHIB) + 6.5 percent sodium chloride (NaCl), BHIB at 44.5 degrees Celsius (°C), bile esculin azide (BEA) agar, biochemically with calalase and gram stain.
  - Salmonella—For positive controls, salmonella organisms are inoculated with urea reagent and incubated. The salmonella colonies should urease negative and remain orange in color. Negative controls are done with *S. aureus*. The *S. aureus* culture should urease positive and turn pink in color.

Additional QC measures included temperature monitoring of incubators at the beginning and completion of an incubation period, chlorine residual check of all samples, and a monthly double-count check by a second analyst.

Laboratory QA/QC procedures for DNA source tracking included initial performance recovery (IPR), ongoing performance recovery (OPR), matrix spikes (MS), negative and

positive control analysis, method blanks, and media sterility checks. OPR analysis occurs after every 20 field and matrix spike samples or one per week that samples are analyzed. IPR and OPR analyses require preparation of a 100-milliter (mL) sample of water and seeding it with approximately 20 colony-forming units (cfu) of enterococcal surface protein (ESP) gene-containing *Enteroccus faecium* (C68) and then processing the samples as outlined in the procedure. IPR is performed with four samples. The method performance is based on a positive polymerace chain reaction (PCR) signal for all *Enteroccus faecium* (C68) seeded samples. Negative controls are run using sterile reagent water, non-ESP *Enteroccus faecium*, or autoclaved field samples. All negative control samples should result in a negative PCR signal. Analysis of positive and negative controls is conducted whenever new media or reagent is used. Method blanks are tested to see the sterility of equipment used, and a media sterility check is incubated at 36.5 degrees Celsius (°C) + 1.0°C for 24 + 2 hours and analyzed for growth.

Laboratory chemical analyses QA/QC included daily instrumentation calibration and use of several precision and accuracy evaluation samples to determine the acceptability of each batch of sample analyzed. The types of samples used include method blanks, matrix spike, matrix spike duplicates, and secondary source calibration check standards. The results of these QA/QC samples must meet the laboratory's established acceptance criteria in order for project sample results to be deemed reportable. Table 2-7 provides acceptance criteria for calibration standards, method blanks, matrix spike, and matrix spike duplicates samples as well as other ancillary information on the analytical methods employed for this project.

As noted previously, regarding blanks, if an analyte is detected in a blank sample and is 10 percent of a quantified project sample, a reanalysis will be required. The source of the blank contamination would be investigated to attempt resolution. If the detection persists, the data from that sample round will be deemed questionable and may be omitted from project data analyses. Data would be flagged if used.

Table 2-7. Chemistry Analyses QA/QC Operations Information and Data Acceptance Criteria

Parameter	Number of Calibration Standards	Calibration Acceptance Criteria (%)	Method Blank Criteria	Secondary Standard Recovery Criteria (%)	Matrix Spike Recovery Criteria (%)	Matrix Spike Duplicate Acceptance Criteria (% RPD)	Practical Quantitation Limit (mg/L)	Method Detection Limit (mg/L)
Total Kjeldahl nitrogen(TKN)	6 + blank	90 to 110	< MDL	90 to 110	90 to 110	0-10	0.10	0.08
Total phosphorus (TP)	9 + blank	80 to 120	< MDL	80 to 120	80 to 120	0-20	0.006	0.006
Nitrate + nitrite (NOx)	9 + blank	90 to 110	< MDL	90 to 110	90 to 110	0-10	0.004	0.003

Note: MDL = method detection limit.
RPD = relative percent difference.

Typical matrix spike concentrations for total phosphorus range from 0.1 to 0.3 mg/L, 1 to 2 mg/L for TKN, and 0.4 to 1 for nitrate + nitrite.

Source: AEL, 2009.
ECT, 2009.

Another item regarding laboratory QA/QC samples is that the project contract required matrix spike and matrix spike duplicate samples be designated for this project at a set frequency during the sampling period as follows:

- The first time a sample is collected (Event 1).
- One in each additional 20 samples, after the first 20 samples.
- The last time a sample is collected (Event 8).

Matrix spike and matrix spike samples are included in each batch of samples analyzed during a lab work shift. A sample batch may consist of up to 20 samples and may be comprised of samples from a number of different projects and therefore potentially different matrix characteristics. The spiked samples are a means to assess the possibility of positive/negative bias in parameters of interest for this project, TKN, NO_x, and TP, caused by the chemical and/or physical composition of a sample. Typically, samples selected for spiking are arbitrarily selected by the lab, unless a client requests their sample(s) be used.

As mentioned, this project required samples from three events be used for the matrix spike and matrix spike duplicates. The lab was notified verbally and on the chain-of-custody forms on each event that this project's samples were to be spiked, which were events 1, 4, and 8. In addition, the labs used this project's samples on all other events (2, 3, 5, 6, and 7) as the spike samples. This obviously enhanced the data validation process for this project. The majority of laboratory QA/QC met acceptance criteria.

Table 2-8 presents a listing of chemistry analyses QC/QA sample results that did not meet acceptance criteria and the laboratory's assessment of sample data usability.

Table 2-8. Laboratory QA/QC Sample Result Excursion Information

Sample Event	Param-eter	Sample Type(s)	Spike Acceptance Criteria (%REC)	Spike Recovery (%REC)	Duplicate Acceptance Criteria (RPD)	Duplicate Samples Results (RPD)	Lab Data Qualifier Code	Code Description/Data Resolution
1	NOx	Duplicate			0-10	50	D-RNG	Concentration difference of sample(0.005 mg/L) and duplicate (0.003 mg/L)is low (0.002 mg/L) compared to MDL(0.003 mg/L). Lab policy is when difference is low relative to MDL, sample not re-run and project data deemed acceptable.
4	TKN	Duplicate			0-10	11	D-RNG	Concentration difference of sample(0.86 mg/L) and duplicate (0.96 mg/L)is low (0.10mg/L) compared to MDL(0.08 mg/L). Lab policy is when difference is low relative to MDL, sample not re-run and project data deemed acceptable.
4	TKN	Matrix			0-10	2	CUST	Although matrix spike duplicate %REC exceeded acceptance criteria, the %RPD for between matix spike and matix spike duplicate met acceptance criteria therefore project results deemed acceptable.
		Spike & Matrix Spike	90-110	109				
		Duplicate	90-110	111				
5	TKN	Duplicate			0-10	17	D-RNG	Concentration difference of sample(1.19 mg/L) and duplicate (1.00 mg/L)is low (0.19 mg/L) compared to MDL(0.08 mg/L) . Lab policy is when difference is low relative to MDL, sample not re-run and project data deemed acceptable.
5	NOx	Duplicate			0-10	11	D-RNG	Concentration difference of sample(0.018 mg/L) and duplicate (0.020 mg/L)is low (0.002 mg/L) compared to MDL(0.003 mg/L). . Lab policy is when difference is low relative to MDL, sample not re-run and project data deemed acceptable.
6	TKN	Duplicate			0-10	16	D-RNG	Concentration difference of sample(0.75 mg/L) and duplicate (0.64 mg/L)is low (0.09 mg/L) compared to MDL(0.08 mg/L). Lab policy is when difference is low relative to MDL, sample not re-run and project data deemed acceptable.
6	NOx	Duplicate			0-10	15	D-RNG	Concentration difference of sample(0.014 mg/L) and duplicate (0.012 mg/L)is low (0.002 mg/L) compared to MDL(0.003 mg/L). Lab policy is when difference is low relative to MDL, sample not re-run and project data deemed acceptable.

Table 2-8. Laboratory QA/QC Sample Result Excursion Information (Continued, Page 2 of 2)

Sample Event	Param-eter	Sample Type(s)	Spike Acceptance Criteria	Spike Recovery	Duplicate Acceptance Criteria	Duplicate Samples Results	Lab Data Qualifier Code	Code Description/Data Resolution
7	TKN	Matrix	90-110	80	0-10	4	CUST	Although matrix spike and matrix duplicate %REC was below acceptance criteria, the %RPD
		Spike &						for between matix spike and matix spike duplicate met acceptance criteria therefore project results deemed acceptable.
		Matrix Spike Duplicate	90-110	77				
8	TKN	Matrix	90-110	89			S-REX	Poor matix recovery;recreated extract
		Spike Matrix Spike	90-110	83			S-CON	Poor matrix recovery on reextract;results and recoveries confirmed. Sample results flagged (J4) due to below criteria spike recovery.

Note: mg/L = milligrams per liter.
NO_x = nitrate + nitrite.
%REC = percent recovery.
RPD = relative percent difference.
TKN = total Klejdahl nitrogen.

Source: AEL, 2009.
ECT, 2009.

3.0 SUPPLEMENTAL DATA

ECT conducted an online search of possible data sources in the project area including state organizations such the FDEP, FDACS, Suwannee River Water Management District (SRWMD), and individual research professors at the University of Florida who have conducted research work in Suwannee Sound. These professors included Dr. Tom Frazer, Dr. Ed Philips, and Dr. Shirley Baker at the Institute of Food and Agricultural Sciences (IFAS). However water quality data were not available from IFAS, but were available from the other three state agencies. Additionally, river flow data have been obtained from the U.S. Geological Survey (USGS), which has maintained temporary and on-going monitoring stations in the lower Suwannee River basin. Precipitation data have also been obtained for the SRWMD station closest to the project area. The river flow and rainfall data have been summarized in Section 4 of this report.

FDACS collects and manages water quality data in and bordering the project area for their Shellfish and Environmental Assessment program (SAES). Also, FDEP's Storage and Retrieval database (STORET) compiles biological, chemical, and physical data for ground and surface waters of Florida. Within storet are 27 monitoring stations in the vicinity of the project area, of which only eleven had water quality data. Five of these eleven stations are operated by FDACS; the remaining six stations are maintained by either FDEP or SRWMD. Table 3-1 presents information on the eleven STORET listed stations, and Figure 3-1 displays these station locations as well as the ECT stations in order to provide a visual of the proximity of the STORET and ECT stations.

Water quality data from FDACS and STORET were screened to retain the parameters that are common to this project, including total and fecal coliform, NO_x, TKN, and TP. Enterococci and salmonella were not available from either source. Table 3-2 presents a data inventory for individual parameters for each station and a statistical summary of the data record. The table also lists the project stations closest to the STORET stations.

Table 3-1. FDEP STORET Stations in the Vicinity of the Project Area

Organization	Station ID	Station Name	Latitude (ddmmss)	Longitude (ddmmss)	County
FDACS	28SEAS201	South side of Wadley Pass at Junction with North Pass	29 18 31	83 09 51	DIXIE
FDACS	28SEAS202	Northern Pass Channel Marker #9	29 18 55	83 09 48	DIXIE
FDACS	28SEAS244	Confluence of Suwannee River & East Pass	29 18 54	83 07 11	LEVY
FDACS	28SEAS246	Suwannee River at mouth of Channel to Suwannee Shores Marina	29 19 31	83 08 20	DIXIE
FDACS	28SEAS428	SW of channel marker #27 & NE channel marker #25 in river	29 18 10	83 09 20	LEVY
FDEP	SRE060C1	Alligator Pass above split with Wadely Pass	29 18 39	83 08 49	LEVY
SRWMD	SRE080C1	Salt Creek at Marker 20	29 19 24	83 09 47	DIXIE
SRWMD	SUW275C1	Suwannee River at Gopher River	29 19 41	83 06 11	DIXIE
SRWMD	SUW285C1	Suwannee River #2 East Pass near branch off	29 18 59	83 07 10	DIXIE
SRWMD	SUW305C1	Suwannee River inWest Pass	29 18 44	83 08 50	DIXIE
FDEP	SUW410C1	Suwannee River in East Pass	29 18 02	83 06 52	LEVY

Note: FDEP = Florida Department of Environmental Protection.
FDACS = Florida Department of Agriculture and Consumer Services.
SRWMD = Suwannee River Water Management District.

Source: ECT, 2009.

File: M:\acad\081081\Sampling_Locations.mxd

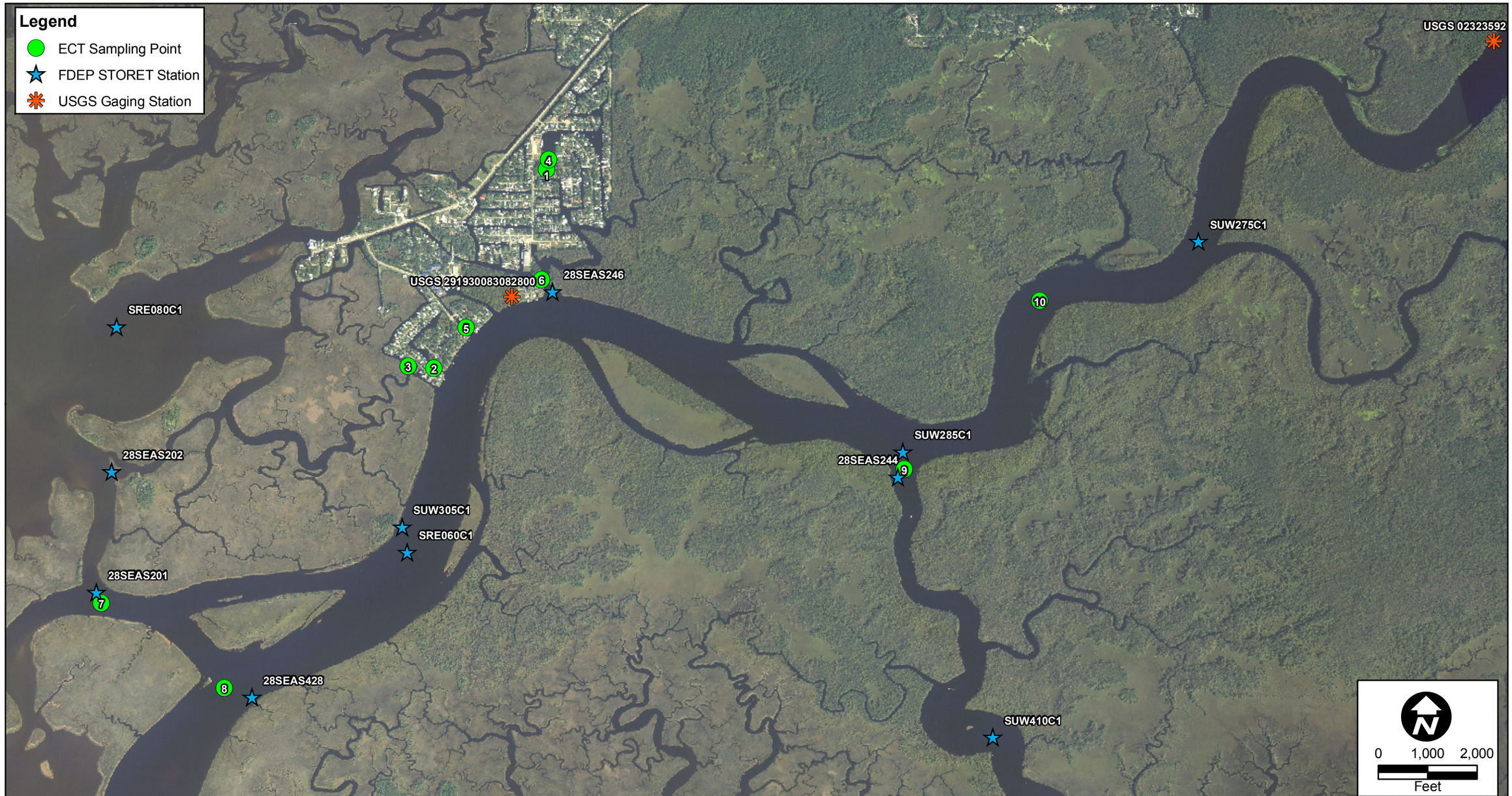

FIGURE 3-1.
STORET, ECT, AND USGS STATIONS

Source: NRCS, 2007; FDEP, 2009; USGS, 2009; SRWMD, 2009; ECT, 2009.

ECT
Environmental Consulting & Technology, Inc.

Table 3-2. Supplemental Water Quality Data

Parameter: *Fecal coliform (colonies/100ml)*

Organization	STORET Station ID	Sampling Period Begin	Sampling Period End	ECT Stations*	Statistical Summary # of samples	Average	Minimum	Maximum	95th percentile	5th percentile
FDACS	28SEAS201	3/7/1996	4/29/2009	7	158	81	1	920	240	7
FDACS	28SEAS202	9/28/1983	4/29/2009	---	262	79	1	540	344	7
FDACS	28SEAS244	9/28/1983	4/29/2009	9	239	69	1	920	222	5
FDACS	28SEAS246	9/28/1983	4/29/2009	1 to 6	245	109	1	1,600	350	8
FDACS	28SEAS428	3/7/1996	4/29/2009	8	157	77	1	540	240	8
SRWMD	SRE080C1	10/3/1995	2/11/2009	---	88	94	1	990	347	2
SRWMD	SUW275C1	2/11/1989	3/11/2009	10	71	96	1	1,700	360	1
SRWMD	SUW285C1	10/11/1999	3/11/2009	9	53	85	1	920	302	5
SRWMD	SUW305C1	2/13/1990	3/11/2009	7, 8	66	118	1	1,480	523	1

Parameter: *Total coliform (colonies/100ml)*

Organization	STORET Station ID	Sampling Period Begin	Sampling Period End	ECT Stations	Statistical Summary # of samples	Average	Minimum	Maximum	95th percentile	5th percentile
SRWMD	SRE080C1	10/3/1995	2/11/2009	---	88	523	9	5,500	1,969	13
SRWMD	SUW275C1	2/11/1989	3/11/2009	10	70	503	1	3,700	2,200	10
SRWMD	SUW285C1	10/11/1999	3/11/2009	9	54	606	1	6,400	2,240	40
SRWMD	SUW305C1	2/13/1990	3/11/2009	7, 8	65	763	1	12,000	2,640	12

Parameter: *Total phosphorus (mg/L)*

Organization	STORET Station ID	Sampling Period Begin	Sampling Period End	ECT Stations	Statistical Summary # of samples	Average	Minimum	Maximum	95th percentile	5th percentile
SRWMD	SRE080C1	10/3/1995	4/20/2009	---	135	0.107	0.030	0.655	0.170	0.044
SRWMD	SUW275C1	2/11/1989	5/28/2009	10	238	0.128	0.038	0.890	0.196	0.076
SRWMD	SUW285C1	10/11/1999	5/28/2009	9	135	0.118	0.038	0.288	0.196	0.075
SRWMD	SUW305C1	2/13/1990	5/28/2009	7, 8	175	0.127	0.006	1.2	0.206	0.071

Parameter: *Total Kjeldahl nitrogen (mg/L)*

Organization	STORET Station ID	Sampling Period Begin	Sampling Period End	ECT Stations	Statistical Summary # of samples	Average	Minimum	Maximum	95th percentile	5th percentile
SRWMD	SRE080C1	10/3/1995	4/20/2009	---	125	0.72	0.05	1.72	1.38	0.22
SRWMD	SUW275C1	2/11/1989	5/28/2009	10	237	0.58	0.05	5.90	1.17	0.13
SRWMD	SUW285C1	10/11/1999	5/28/2009	9	135	0.65	0.05	2.22	1.32	0.17
SRWMD	SUW305C1	2/13/1990	5/28/2009	7, 8	175	0.62	0.05	1.56	1.20	0.16

Parameter: *Nitrate + nitrite (mg/L)*

Organization	STORET Station ID	Sampling Period Begin	Sampling Period End	ECT Stations	Statistical Summary # of samples	Average	Minimum	Maximum	95th percentile	5th percentile
SRWMD	SRE080C1	10/3/1995	4/20/2009	---	135	0.33	0.00	0.90	0.80	0.02
SRWMD	SUW275C1	2/11/1989	5/28/2009	10	238	0.62	0.01	1.35	1.09	0.11
SRWMD	SUW285C1	10/11/1999	5/28/2009	9	135	0.68	0.00	1.62	1.14	0.18
SRWMD	SUW305C1	2/13/1990	5/28/2009	7, 8	175	0.60	0.01	1.30	1.02	0.11

Note: FDACS = Florida Department of Agriculture and Consumer Services.
FDEP = Florida Department of Environmental Protection.
SRWMD = Suwannee River Water Management District.

Source: ECT, 2009.

Fecal coliform is monitored at eight stations by the SRWMD or FDACS in the project area. As shown on Figure 3-1 some of these stations are in close proximity to this project stations and a few are more far a field. For the eight stations, average fecal coliform values range from 77 to 118 colonies per 100 milliliters of sample (col/100 mL). Minimum values are 1 col/100 mL for all eight stations. Maximum counts range from 540 to 1,600 col/100 mL. The SRWMD also monitors for total coliform in the project area at four locations. Average total coliform counts at these locations range in average from form 503 to 763 col/100 mL. Minimum and maximum values range from 1 to 9 and 3,700 to 12,000 col/100 mL, respectively.

The SRWMD also analyzes for the three nutrient parameters monitored for this project, those being TKN, NO_x, and TP at four stations. TP average values are similar for these stations ranging from 0.106 to 0.128 mg/L. Minimum and maximum TP values range 0.006 to 0.038 and 0.288 to 1.2 mg/L, respectively. TKN, which is a combination of organic nitrogen and ammonia/ammonium nitrogen, has average values from 0.58 to 0.72 mg/L. Minimum values at the four stations are non-detectable concentrations at the detection limit of 0.05 mg/L. Maximum concentrations are from 1.56 to 5.90 mg/L. NO_x concentrations, on average, range from 0.33 to 0.68 mg/L. Minimum values are generally below method detection limits.

The complete supplemental water quality data set is in Appendix A .

4.0 RESULTS

The results of the 2009 study are presented in this section. Comparison of these results with the previous studies and assessment of the benefits of closing the OSTDS are presented in Section 5.0.

4.1 RAINFALL AND RIVER FLOW DATA

Approximately 25 miles upstream of the project area, USGS maintains a long-term river stage and flow gauging station near Wilcox, Florida (Station No. 02323500). Figure 4-1 presents the daily flow hydrograph at this station from October 1941 through August 2009. The highest daily flow observed at Wilcox was 84,700 cubic feet per second (cfs) in 1948. Table 4-1 presents the annual mean discharge values at Wilcox from 1942 to 2008. The annual mean discharge from 1942 through 2008 ranged from 3,275 cfs in 2002 to 24,560 cfs in 1948 (USGS, 2009).

SRWMD has maintained a rainfall gauging station in the vicinity of Wilcox and Fanning Springs (Station 2323500) from 1998 to present. Table 4-2 presents the monthly rainfall total for this period. This project's sampling was conducted between May 26 and July 13, 2009. River daily discharge and rainfall data are presented on Figure 4-2 for the sampling period. The dates of each sampling event are also displayed on this figure. During the sampling period, the highest daily rainfall was 3.56 inches on June 5. Peak river low during the sampling period occurred the following day, and appears to be the result of this rain event coupled with above average rainfall for the month of May at 5.22 inches compared to the historic average for May of 1.37 inches. Additionally, the cumulative rainfall for May and June 2009 at 17.49 inches was almost threefold greater than the historic May/June rainfall total at 6.47 inches (SRWMD, 2009).

Peak river flow during sampling occurred on June 6 at 9,670 cfs and gradually declined for the remainder of the sampling duration. The exception to this was a spike from approximately 6,100 cfs to 7,600 cfs during the week of June 21. This was probably due to approximately 3.5 inches of rain the previous week. Following this spike, flows continuously dropped to approximately 3,000 cfs in July.

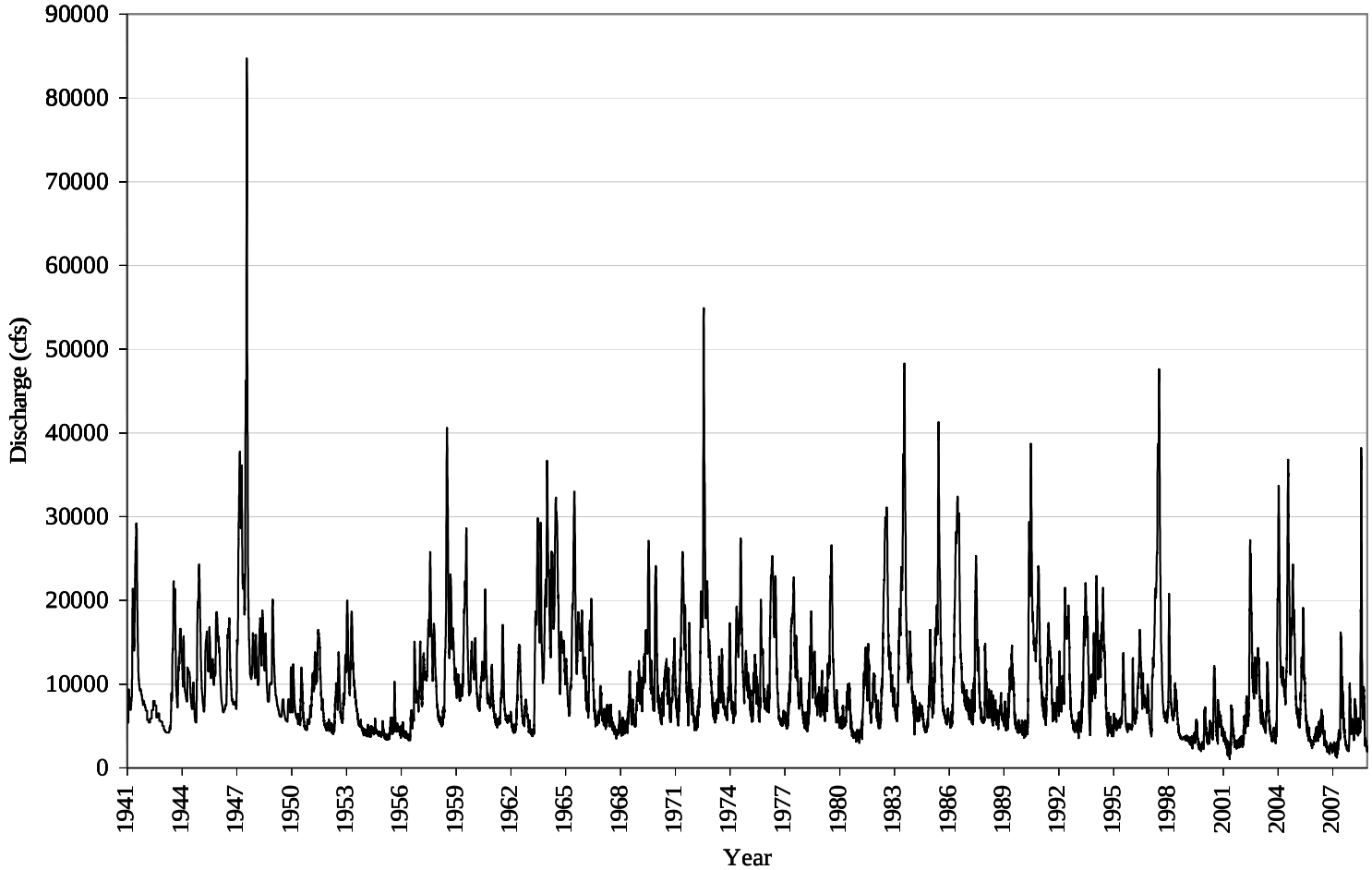

FIGURE 4-1.

SUWANNEE RIVER FLOW NEAR WILCOX AT USGS #02323500
FROM 1941-2009
Source: ECT, 2009.

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Table 4-1. Annual Mean Discharge of Suwannee River Near Wilcox at USGS Station No. 02323500

Water Year	Discharge (cfs)	Water Year	Discharge (cfs)
1942	12,340	1976	9,546
1943	6,229	1977	12,060
1944	9,954	1978	10,870
1945	11,230	1979	8,657
1946	12,500	1980	10,760
1947	9,856	1981	5,612
1948	24,560	1982	8,234
1949	12,980	1983	13,660
1950	7,600	1984	17,140
1951	6,704	1985	6,887
1952	9,179	1986	12,520
1953	7,496	1987	14,310
1954	9,290	1988	9,732
1955	4,291	1989	6,776
1956	4,640	1990	6,875
1957	6,201	1991	14,920
1958	13,210	1992	9,122
1959	13,990	1993	10,330
1960	12,930	1994	10,440
1961	10,590	1995	10,890
1962	7,142	1996	5,970
1963	7,172	1997	8,746
1964	15,050	1998	15,480
1965	19,270	1999	6,415
1966	15,040	2000	3,406
1967	9,549	2001	5,339
1968	5,301	2002	3,275
1969	6,335	2003	10,090
1970	13,300	2004	6,442
1971	9,080	2005	16,310
1972	11,920	2006	6,523
1973	15,560	2007	3,563
1974	8,554	2008	4,678
1975	12,760		

Source: ECT, 2009.
USGS, 2009.

Table 4-2. Monthly Total Rainfall at SRWMD Station No. 02323500 Near Wilcox/Fanning Springs

Month and Year	Rainfall (inches)	Month and Year	Rainfall (inches)	Month and Year	Rainfall (inches)	Month and Year	Rainfall (inches)
May-98	0.87	Mar-01	3.22	Jan-04	2.05	Nov-06	1.35
Jun-98	1.73	Apr-01	1.38	Feb-04	7.52	Dec-06	4.05
Jul-98	1.85	May-01	0.07	Mar-04	1.41	Jan-07	2.72
Aug-98	*	Jun-01	6.08	Apr-04	2.06	Feb-07	1.63
Sep-98	*	Jul-01	12.14	May-04	1.83	Mar-07	1.01
Oct-98	*	Aug-01	1.76	Jun-04	0.82	Apr-07	1.07
Nov-98	*	Sep-01	7.03	Jul-04	0.04	May-07	0.46
Dec-98	*	Oct-01	0.04	Aug-04	0	Jun-07	6.69
Jan-99	*	Nov-01	0.43	Sep-04	0	Jul-07	5.38
Feb-99	*	Dec-01	1.48	Oct-04	3.73	Aug-07	6.73
Mar-99	*	Jan-02	4.07	Nov-04	2.98	Sep-07	5.08
Apr-99	*	Feb-02	0.87	Dec-04	1.89	Oct-07	2.51
May-99	*	Mar-02	2.9	Jan-05	1.13	Nov-07	1.29
Jun-99	*	Apr-02	1.83	Feb-05	1.82	Dec-07	2.83
Jul-99	*	May-02	1.5	Mar-05	3.78	Jan-08	4.1
Aug-99	*	Jun-02	4.45	Apr-05	5.78	Feb-08	2.78
Sep-99	*	Jul-02	6.05	May-05	4.45	Mar-08	4.85
Oct-99	*	Aug-02	5.98	Jun-05	4.34	Apr-08	1.51
Nov-99	*	Sep-02	5.63	Jul-05	8.59	May-08	0.9
Dec-99	*	Oct-02	5.78	Aug-05	5.39	Jun-08	5.79
Jan-00	*	Nov-02	5.47	Sep-05	1.4	Jul-08	11.42
Feb-00	*	Dec-02	8.31	Oct-05	1.59	Aug-08	16.1
Mar-00	*	Jan-03	0.13	Nov-05	3.07	Sep-08	1.79
Apr-00	*	Feb-03	6.96	Dec-05	7.06	Oct-08	2.61
May-00	0.25	Mar-03	6.87	Jan-06	2.32	Nov-08	2.12
Jun-00	6.66	Apr-03	2.11	Feb-06	5.11	Dec-08	0.92
Jul-00	7.27	May-03	1.46	Mar-06	0.11	Jan-09	3.64
Aug-00	1.45	Jun-03	7.3	Apr-06	0.95	Feb-09	1.61
Sep-00	8.5	Jul-03	5.93	May-06	1.89	Mar-09	4.82
Oct-00	0.3	Aug-03	5.3	Jun-06	8.27	Apr-09	3.17
Nov-00	1.24	Sep-03	2.52	Jul-06	6.44	May-09	5.22
Dec-00	0.85	Oct-03	2.01	Aug-06	5.67	Jun-09	12.27
Jan-01	1.23	Nov-03	1.5	Sep-06	2.32	Jul-09	7.74
Feb-01	0.38	Dec-03	1.18	Oct-06	1.36		

* No data.

Source: ECT, 2009.
SRWMD, 2009.

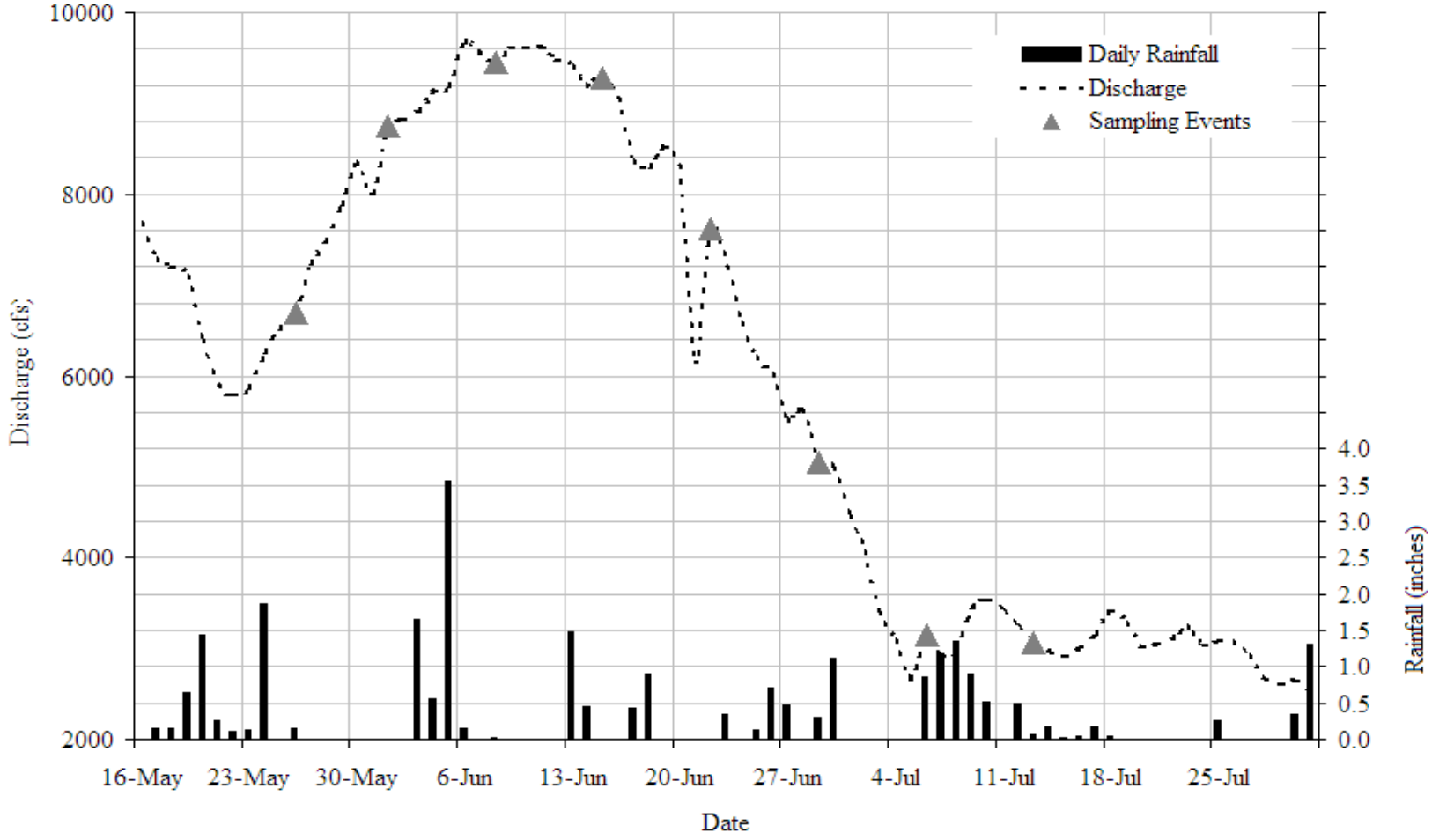

FIGURE 4-2.

SUWANNEE RIVER FLOW, DAILY RAINFALL, AND SAMPLING EVENTS IN MAY-JULY 2009

Source: ECT, 2009.

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4.2 WATER QUALITY DATA

Weekly water quality samples and *in situ* data were collected from May 26 through July 13, 2009. *In situ* measurements included temperature, specific conductance, pH, and DO. Water samples were analyzed for TKN, TP, NO_x, total and fecal coliform, salmonella, enterococci, and DNA source tracking. It should be noted that FDOH opted to discontinue sampling for TP after the fourth event and substitute DNA source tracking at Stations 2, 5, and 10. Also of note is that salmonella analyses were qualitative (presence/absence) not quantitative.

Initial presentation of data is provided as statistical summaries and grouped into two categories—canal stations and river stations. The rational for this grouping is based on the canal stations being near-field relative to the proximity to the previous locations of the OSTDS and river stations are far-field and include upstream control Station 10. Canal stations are Stations 2 through 6 and river station are 7 through 10. Additionally, data assessment utilized this grouping scheme in the earlier study and facilitates comparative analyses of the two databases. Station 1 is the monitor well.

In situ parameters are presented by station group in Table 4-3. Chemical and microbiological water quality sample parameters have been statistically summarized by individual canal and river stations in Tables 4-4 and 4-5, respectively. Table 4-6 provides the water quality sample statistical summary for the grouped canal and river stations, as well as the monitor well station. Tables of the complete raw data set for individual stations are in Appendix B.

4.2.1 *IN SITU* PARAMETERS

In situ measurements of pH, temperature, DO, and specific conductance were conducted at three depths in the water column: 1 ft below the surface (surface), mid-depth, and 1 ft above the bottom (bottom) at each surface water sampling station. Summary statistics for each of the parameter at the three depths at the river and canal station are provided in

Table 4-3. Summary Statistics of *In Situ* Parameters

Parameter	Station	Surface			Mid-Depth			Bottom			Vertical
		Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average
Specific Conductance (µS/cm)	River	271	167	413	264	167	386	261	167	371	265
	Canal	359	193	556	345	192	507	343	192	507	349
Dissolved Oxygen (mg/L)	River	5.12	4.25	6.29	5.13	4.28	6.23	5.14	4.28	6.23	5.13
	Canal	4.59	3.29	6.50	4.77	3.60	6.80	4.94	3.74	7.52	4.77
pH (su)	River	7.25	6.88	7.49	7.24	6.87	7.49	7.23	6.86	7.54	7.24
	Canal	7.26	6.89	7.57	7.28	6.90	7.59	7.27	6.90	7.61	7.27
Temperature (ºC)	River	26.73	23.62	28.30	26.76	23.62	28.30	26.79	23.63	28.30	26.76
	Canal	27.18	24.07	28.87	27.27	24.11	29.06	27.36	24.13	29.13	27.27

Note: ºC = degrees Celsius.
mg/L = milligrams per liter.
su = standard units.
µS/cm = microsiemans per centimeter.

Source: ECT, 2009.

Table 4-4. Summary of Water Quality Parameters for Canal Stations

Parameters	Average at Station					Minimum at Station					Maximum at Station				
	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6
Enterococci (colonies/100ml)	127	86	73[a]	236	105	41	53	8[a]	73	43	350	140	240[a]	570	210
Total Coliforms (colonies/100ml)	905	1352	938	1860	1810	1 U	1 U	100	1 U	1 U	1690	3080	2310	4160	4000
Fecal Coliforms (colonies/100ml)	94	56	115	107	75	26	32	41	49	38	380	80	300	270	113
Total Phosphorus (mg/L)	0.138	0.139	0.117	0.139	0.141	0.097	0.107	0.084	0.099	0.104	0.165	0.157	0.149	0.185	0.167
Total Kjeldahl Nitrogen (mg/L)	0.671	0.656	0.789	0.671	0.654	0.38	0.31	0.6	0.33	0.31	0.97	0.96	0.98	0.94	1.04
Nitrate-Nitrite (mg/L)	0.403	0.488	0.145	0.47	0.428	0.148	0.26	0.005	0.24	0.251	0.644	0.712	0.284	0.69	0.691

*Values excluded a suspected outlier of 1,150 from sampling Event 4.

Note: mL = milliliters.
mg/L = milligrams per liter.
U = analyzed but not detected.

Source: ECT, 2009.

Table 4-5. Summary of Water Quality Parameters for River Stations

Parameters	Average at Station				Minimum at Station				Maximum at Station			
	7	8	9	10	7	8	9	10	7	8	9	10
Enterococci (col/100ml)	42	33	31	35	14	17	15	10	77	47	52	77
Total Coliforms (col/100ml)	818	846	973	728	1 U	100	100	100	1850	2000	3080	2770
Fecal Coliforms (col/100ml)	39	32	26	36	12	8	6	10	68	72	63	99
Total Phosphorus (mg/L)	0.151	0.139	0.154	0.15	0.107	0.114	0.114	0.12	0.216	0.16	0.18	0.18
Total Kjeldahl Nitrogen (mg/L)	0.634	0.685	0.631	0.70	0.33	0.38	0.32	0.36	0.86	0.94	0.91	1.14
Nitrate-Nitrite (mg/L)	0.517	0.515	0.529	0.535	0.266	0.260	0.270	0.275	0.775	0.759	0.780	0.790

Note: mL = milliliter.
mg/L = milligrams per liter.
U = analyzed but not detected.

Source: ECT, 2009.

Table 4-6. Statistics for Water Quality Parameters at Canal, River, and Monitoring Well Stations

Parameters	Size	Average	Standard Deviation	Maximum	Minimum
Canal Stations					
Total Coliform (col/100 mL)	40	1373	1156	4160	1 U
Fecal Coliform (col/100 mL)	40	89	76	380	26
Enterococci * (col/100 mL)	40	73	79	240	8
Salmonella	Present 22.5% of time (9 out of 40)				
Total Phosphorus (mg/L)	20	0.135	0.029	0.185	0.084
Total Kjeldahl Nitrogen (mg/L)	40	0.69	0.22	1.04	0.31
Nitrate-Nitrite (mg/L)	40	0.39	0.2	0.71	0.01
Total N (mg/L) (calculated)	40	1.07	0.15	1.38	0.67
River Stations					
Total Coliform (col/100 mL)	32	841	738	3080	1 U
Fecal Coliform (col/100 mL)	32	33	23	99	6
Enterococci (col/100 mL)	32	35	18	77	10
Salmonella	Present 46.8 of time (15 out of 32)				
Total Phosphorus (mg/L)	16	0.149	0.029	0.216	0.107
Total Kjeldahl Nitrogen (mg/L)	32	0.66	0.22	1.14	0.32
Nitrate-Nitrite (mg/L)	32	0.52	0.19	0.79	0.26
Total N (mg/L) (calculated)	32	1.19	0.12	1.47	0.9
Monitoring Well					
Total Coliform (col/100 mL)	8	1690	2202	6000	200 U
Fecal Coliform (col/100 mL)	8	22	32	90	1 U
Enterococci (col/100 mL)	8	428	730	2100	1 U
Salmonella	8	Present 50% of time (4 out of 8)			
Total Phosphorus (mg/L)	4	0.581	0.293	1.01	0.374
Total Kjeldahl Nitrogen (mg/L)	8	1.25	0.75	2.95	0.54
Nitrate-Nitrite (mg/L)	8	0.06	0.06	0.17	0.01
Total N (mg/L) (calculated)	8	1.31	0.74	3.02	0.55

Note: col/100 mL = colonies per 100 milliliters.
mg/L = milligrams per liter.
U = analyzed but not detected at or above the method detection limit.

*Statistics exclude a suspected outlier value of 1150 reported from sampling Event 4.

Source: ECT, 2009.

Table 4-4. As *in situ* data collection during the monitor well sampling was done solely to establish adequate purging of standing ground water before sample collection and not to evaluate ground water quality, this data is not included in discussion of data analyses.

Viewing the surface water *in situ* data both vertically in the water column and spatially within the study area indicates there is not a large variation in the measurements. Spatially, the greatest difference when comparing the vertical averages of the canal and river stations is for specific conductance with canal stations at 349 microsiemens per centimeter (µS/cm) and the river stations at 265 µS/cm, which is an approximate 30 percent difference in values. The other three parameters vertical average only differ by 7 percent (DO) or less. Evaluating differences vertically in the water column by comparing the average surface and average bottom measurements for conductance values (271 vs. 261 µS/cm) indicates the canal stations only varied by 3 percent top to bottom, and only by 5 percent (359 vs. 343 µS/cm) at the river stations. Additionally, pH, temperature, and DO data have only relatively minor differences in the vertical with the largest difference being canal station DO at 8 percent, but pH and temperature vertical differences are less than 1 percent. This uniformity in data indicates waters are well mixed, show no evidence of a salt wedge intrusion during sampling, and supports using surface grab samples as a good representation of water quality through the water column.

4.2.2 NUTRIENT PARAMETERS

Nutrient parameters include TP, TKN, and NO_x. Total N was derived by summing TKN and NO_x. Each of these nutrients result is briefly described below, and are exhibited on Table 4-6.

4.2.2.1 <u>Total Phosphorus</u>

As discussed earlier, TP was only analyzed for the first 4 weeks. Analytical results show that the average TP concentration in the monitoring well was considerably higher at 0.581 mg/L as compared to canal and river values at 0.135 and 0.149 mg/L, respectively. Well minimum and maximum TP concentrations were 0.374 mg/L, and 1.010 mg/L, respectively. The maximum well TP of 1.010 mg/L is approximately five times the canal

and river station maximums. The river and canal stations TP values are quite similar, with the river concentrations being marginally higher in each statistical category.

4.2.2.2 Total Kjeldahl Nitrogen

The monitoring well TKN concentrations were approximately twice the canal and river average, minimum, and maximum values. The average well TKN concentration was 1.25 mg/L compared to canal and river averages of 0.69 and 0.66 mg/L, respectively. Canal and river statistical values were essentially identical, indicating spatial uniformity through the surface water monitoring stations.

4.2.2.3 Nitrate + Nitrite (NO_x)

The average NO_x was approximately 30 percent higher in the river stations at 0.52 mg/L than the Canal Stations at 0.39 mg/L. The monitor well had the lowest NO_x, which averaged only 0.06 mg/L over the sampling period. The maximum river and canal NO_x concentrations were 0.79 and 0.71 mg/L, respectively. The monitor well maximum concentration was 0.17 mg/L.

4.2.2.4 Total N

Total N was derived by adding TKN and NO_x. Average Total N was similar in both the canal and river Stations at 1.19 mg/L and 1.07 mg/L, respectively. The monitoring well's Total N average concentration was slightly higher at 1.31 mg/L. The maximum total N concentration was 3.02 mg/L at the well, compared to 1.38 and 1.47 mg/L at canal and river Stations, respectively.

4.2.3 NUTRIENT-DISCHARGE RELATIONSHIP

To explore the relationship between river discharge and nutrient parameters, the surface waters average values for TKN, NO_x, and total N were determined. These averages were calculated including all of the river and canal stations, but excluding the monitoring well station. Statistical analysis between the overall average values of the selected water quality parameters and average river discharge for the sampling day revealed the following: a positive correlation existed between discharge and TKN (i.e., TKN increased with the increased in the discharge); a negative correlation existed between discharge and

NO_x. The variations of TKN, NO_x, and Total N with the river flow are presented in Figure 4-3. It is apparent from the figure that the TKN increased with the flow and NO_x decreased with the flow, whereas there was no influence of flow on Total N.

The correlation coefficients (R^2), which measure the linear degree of association between the data values, are included in Figure 4-4.

4.2.4 MICROBIOLOGICAL PARAMETERS

Microbiological parameters measured in 2009 included total coliform, fecal coliform, enterococci, and salmonella. All of these parameters were expressed in terms of number of colonies present in 100 mL of sample (col/100 mL). The summary results of the microbiological data are included in Table 4-6.

4.2.4.1 Total Coliform

Total coliform in the monitoring well varied substantially over the sampling duration. Concentrations ranged from a minimum of below detection to 6,000 col/100 mL. The average well total coliform count was 1,690 col/100 mL. River stations total coliform average was approximately half of the monitor well at 841 col/100 mL. Canal stations average counts were comparable to the well at 1373 col/100 mL. River and canal stations also had wide variations in counts over the 8 weeks, ranging from below detection to a range of 3,000 to 4,000 col/100 mL.

4.2.4.2 Fecal Coliform

The average fecal coliform count was highest in the canal stations at 89 col/100 mL, compared to the river and well stations at 33 and 22 col/100 mL, respectively. The canal stations also exhibited the highest maximum fecal coliform count, at 380 col/100 mL compared to the river and well maximums of 99 and 90, respectively. Only the well had at least one instance of below detection for fecal coliform, as this bacteria was detected in all river and canal station samples over the 8-week sampling period.

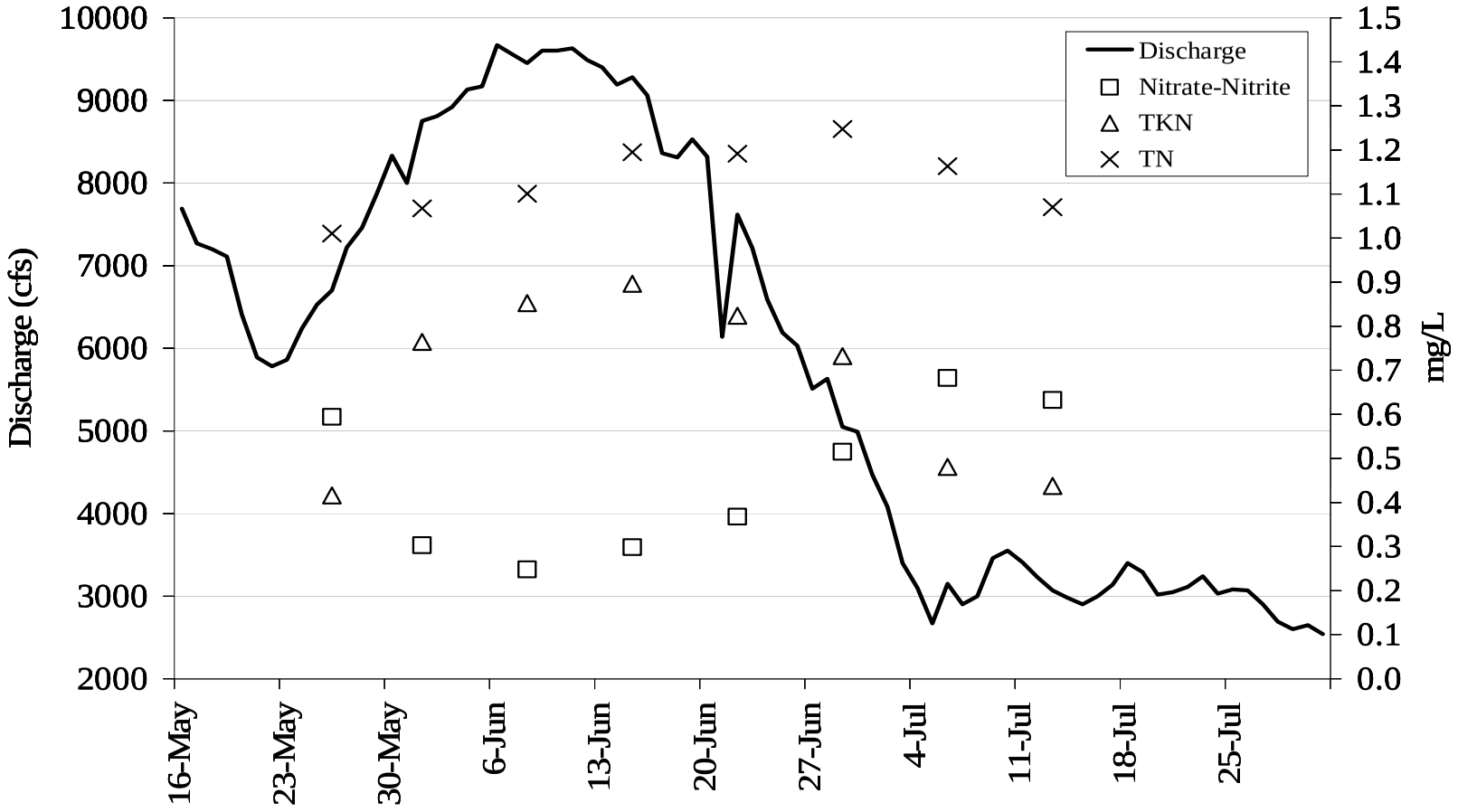

FIGURE 4-3.

VARIATION OF NUTRIENTS WITH THE RIVER DISCHARGE

Source: ECT, 2009.

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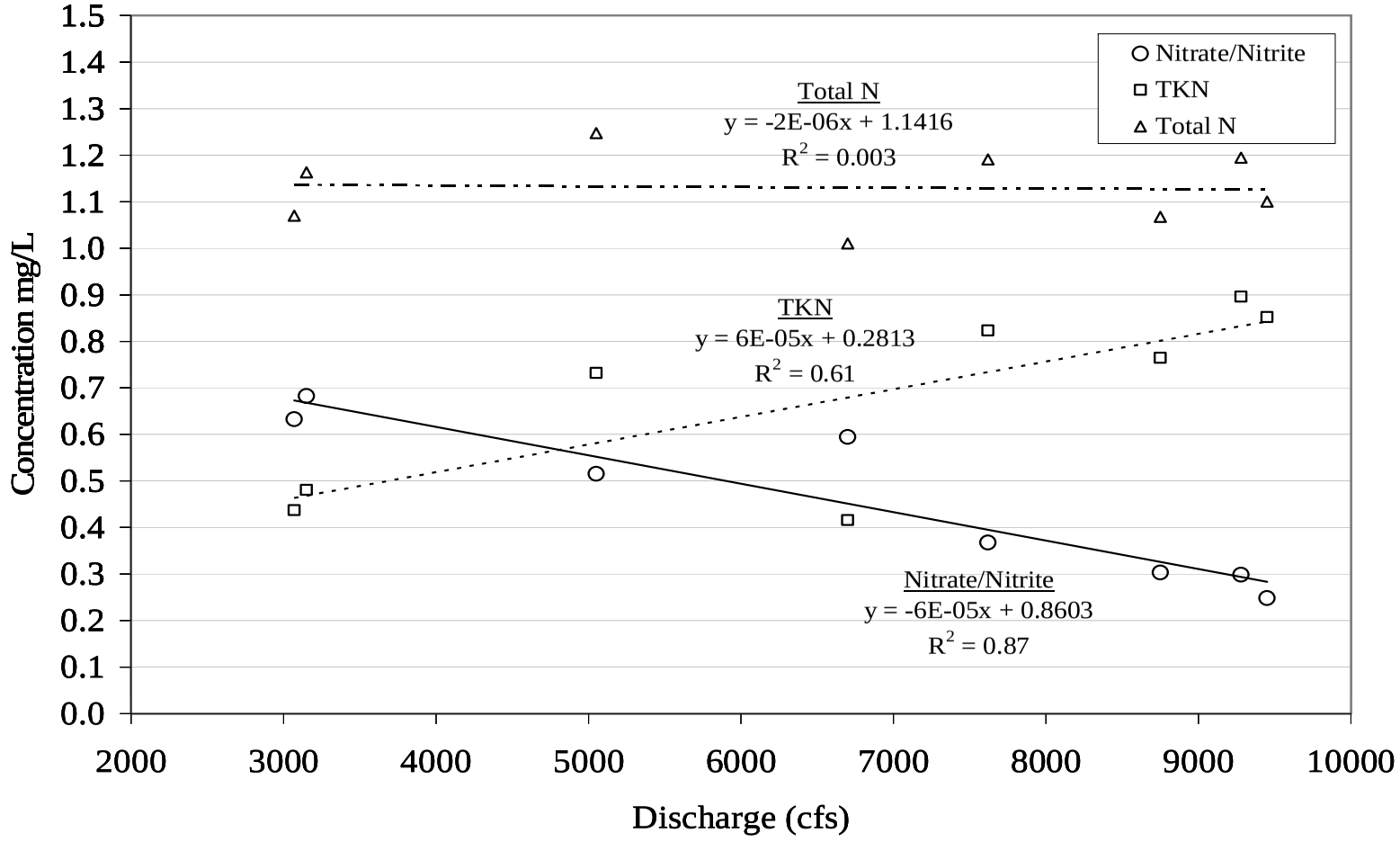

FIGURE 4-4.

RELATIONSHIP BETWEEN NUTRIENTS AND RIVER DISCHARGE

Source: ECT, 2009.

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4.2.4.3 Enterococci

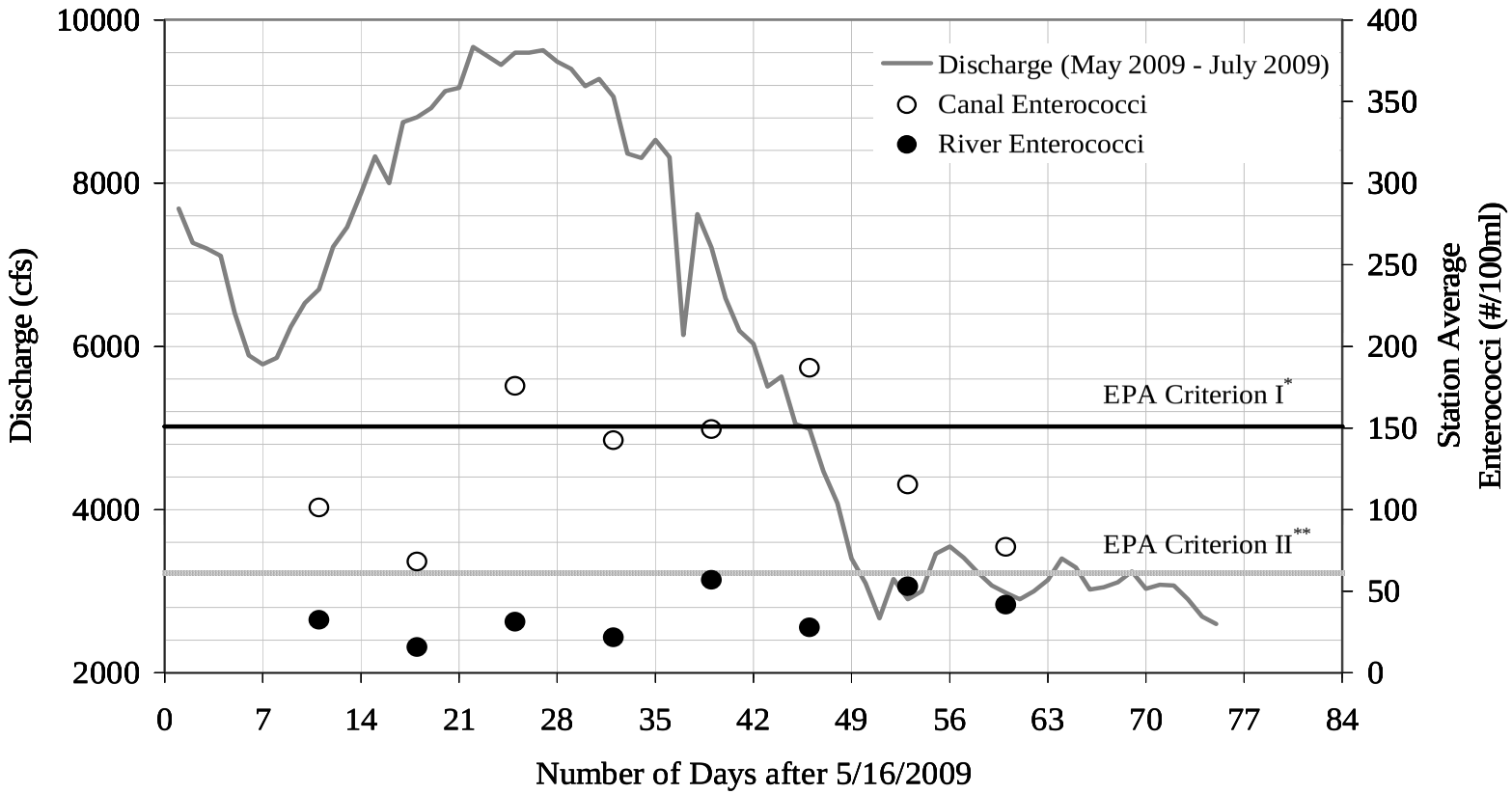
The enterococci bacteria were detected at significantly higher levels in the monitor wells as opposed to the surface water stations. The average well count was 428 col/100 mL, compared to the canal and river averages at 73 and 35 col/100 mL, respectively. The maximum well count was one to two orders of magnitude greater than the surface water stations at 2,100 col/100 mL as opposed to 240 and 77 col/100 mL for the canal and river stations, respectively. However it is suspected the 2,100 value may be a data outlier or the result of outside contamination. If this is the case, the maximum well count of 750 col/100 mL, is still greater than the surface water station maximum values.

The enterococci values were consistently higher in the canals than the river as shown in Figure 4-5. The canal station values suggested a weak correlation with river discharge as the values increased with river flow. The values at the river stations remained relatively constant as the river flow varied.

EPA has four criteria levels for body contact for enterococci levels. The most stringent is for beach areas at 61 counts/100 mL, and the most tolerant is for infrequent full body contact at a level of 151 counts/100 mL. These values are presented on Figure 4-4 for comparison with the results. As illustrated, the average enterococci values in the river comply with the most stringent criteria, but the canal values frequently exceed the least protective criteria.

4.2.4.4 Salmonella

Salmonella were analyzed qualitatively as presence or absence in the samples. Salmonella were present in the monitoring well 50 percent (4 out of 8) of the time. The results varied in the river and canal stations. In the river stations, salmonella were present 46.8 percent (15 out of 32) of the time as compared to 22.5 percent (9 out of 40) of the time in the canal stations. Salmonella in each sampling location during the sampling period is presented in Table 4-7. The higher salmonella occurrences in the river suggest that the canals are not the source of salmonella.



* Single sample maximum allowable Enterococci density for infrequently used full body contact recreation for freshwater (EPA, 1986)
** Single sample maximum allowable Enterococci density for the designated beach area (EPA, 1986)

FIGURE 4-5.

WEEKLY AVERAGE ENTEROCOCCI IN RIVER AND CANAL STATIONS

Source: ECT, 2009.

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Table 4-7. Salmonella Results

Station No.	Sampling Weeks								Percent Presence
	1	2	3	4	5	6	7	8	
1	O	O	X	X	O	X	X	O	50
2	O	O	O	O	O	X	O	X	25
3	O	O	X	O	O	O	O	X	25
4	O	O	O	O	O	X	X	O	25
5	O	O	O	O	X	X	O	X	37.5
6	O	O	O	O	O	O	O	O	0
7	O	O	X	X	X	X	X	X	75
8	O	O	X	X	X	O	O	X	50
9	O	O	O	X	X	X	O	X	50
10	O	O	O	O	O	O	O	X	12.5

Note: X = present.
O = absent.

Source: AEL, 2009.
ECT, 2009.

4.2.5 MICROBIOLOGICAL PARAMETERS—DISCHARGE RELATIONSHIP

Very weak negative correlations were found between total and fecal coliform with the river discharge. As these correlations were insignificant, graphical representation are not included in this report.

4.2.6 SOURCE TRACKING

Water samples from three locations (Stations 2, 5, and 10) were analyzed for *Enterococcus faecium* esp Human Gene Biomarker (HGB) to track the presence of human fecal contamination as opposed to other animal sources. The stations were selected in consultation with FDOH staff. Samples from Stations 2, 5, and 10 were collected on the final 4 weeks of sampling. Table 4-8 summarizes the DNA source tracking results. The results were inconsistent within and among the sampling locations. For example, the first samples collected were all negative for human DNA presence. The second and fourth round of sampling had identical results with Stations 5 and 10 results positive for human DNA and Station 2 negative. Whereas on the third round of sampling, Stations 5 and 10 that were positive in the rounds 2 and 4 were negative and the negative station (Station 2) was positive. Overall, HGB was detected 42 percent of the time with no appreciable difference between the canals and the river.

Table 4-8. DNA Source Tracking Analyses Results

Station No.	DNA Analytical Results for Sampling Weeks				Percent Positive (within Station)
	5	6	7	8	
2	N	N	P	N	25
5	N	P	N	P	50
10	N	P	N	P	50
% Positive (among stations)	0	67	33	67	

Note: P = positive for human DNA.
N = negative for human DNA.

Source: ECT, 2009.
Molecular, 2009

5.0 ANALYSIS AND DISCUSSION

5.1 SUMMARY OF 1998 REPORT RESULTS

For the previous town of Suwannee project conducted in 1996 to 1998, a study plan was implemented to examine the pre- and postconstruction water quality near the town of Suwannee to document potential improvements following closure of the OSTDS. The plan consisted of baseline monitoring of fecal coliform, *Salmonella* occurrence, NO_x, and TKN.

For microbiological sampling, the results showed that total and fecal coliform concentrations were relatively high throughout the entire study. The average fecal coliform counts in the canals of the town was about three times as high as the river and exceeded the Class III standard for fresh and marine water. It was believed that the heavy rains associated with El Niño during the postconstruction sampling obscured the positive effects on water quality brought about by the town of Suwannee switching to a WWTP, therefore, the postconstruction data will not be included in discussions of comparative results of the previous and current study in subsequent sections of this report.

Salmonella results were presented as a qualitative description (presence/absence) as is the case in the current study. The general trends observed during the earlier study were:

1. There were far more occurrences of *Salmonella* at the river stations than in the canal stations.
2. *Salmonella* was always present at the upstream control station (Station 10) and the main channel, downstream station (Station 8).
3. There were more occurrences of *Salmonella* during postconstruction monitoring in the canals than pre-construction (36.7 and 13.8 percent, respectively).
4. Pre- and postconstruction occurrences of *Salmonella* were comparable in the river.

5. There appeared to be a negative correlation between fecal coliform and *Salmonella* (i.e., as the amount of fecal coliform increased, the occurrence of *Salmonella* decreased).

Regarding NO_x results in the earlier study, the most notable observation was that pre-construction surface water stations total NO_x mean concentrations were nearly five times higher than the postconstruction mean concentrations (0.75 and 0.15 mg/L-N, respectively). This difference in part may have been an improvement due to the use of the WWTP, but was probably a dilution affect from the higher river flows during postconstruction sampling. Pre-construction average NO_x concentrations in the canals were marginally lower than the river stations at 0.727 and 0.876 mg/L, respectively. Postconstruction average NO_x canal concentrations were also lower than river concentrations at 0.133 and 0.163 mg/L, respectively.

The average surface water postconstruction TKN concentration was approximately one-third higher than the pre-construction concentrations, at 0.67 and 0.40 mg/L, respectively. The high TKN values were probably the result of high organic nitrogen from runoff during the extensive rainfall resulting from the El Niño event which approximately doubled the river flow from the previous year.

The results from the ground water sample near the septic tank drainfield (Station 1) indicated a significant reduction in NO_x values from pre- to postconstruction. The preconstruction values averaged 1.88 mg/L-N compared to the postconstruction values, a 15-fold reduction. The average TKN was also reduced from an average of 7.44 mg/L-N to 3.76 mg/L-N. Given the magnitude of well nitrogen, particularly TKN, in the ground water compared to surface water, it was apparent that the septic tank drainfield was the major source for nitrogen at the well and the statistics suggest that closure of the septic tank reduced the nitrogen levels in the ground water.

5.2 COMPARISON OF 1996 AND 2009 RESULTS

The primary goal of the water quality sampling program near the town of Suwannee was to document the water quality effects of installing a central wastewater treatment facility

and closing about 850 septic tanks. More specifically, the study was to evaluate if closing the septic tanks would reduce pollution and enhance the viability of oyster harvesting in Suwannee Sound. The baseline study for the program was completed in 1996 prior to closure of the septic tanks. The intent was to sample 1 year later to evaluate potential improvements. Unfortunately, the value of the postconstruction sampling was compromised by two factors: (1) the septic tank closure was delayed and not all tanks were closed prior to the 1997 sampling; and (2) 1997 was an El Niño year, and the river flows were two to three times greater which affected the results and limited the ability to compare with preconstruction values.

In a continued attempt to evaluate the affects of septic tank closure, the FDOH has funded this study to investigate if positive effects are measurable 12 years after the septic tanks were closed. The results of the monitoring effort were presented in Section 4; this section provides a comparison of these results with the 1996 preconstruction data.

5.2.1 ANCILLARY DATA

For a controlled study it is desirable to keep all variables constant except the study parameter. In this case, the study parameter was the effect of closing septic tanks on water quality. One of the key parameters that could affect or bias the study is river flow. The Suwannee River discharge flow for the sampling periods from 1996, 1997, and 2009 are presented in Figure 5-1 for comparison.

For the baseline or preconstruction year (1996) the river flow remained relatively constant. However, in 1997, because of El Niño, the river flow increased sharply which made it difficult to interpret preconstruction and postconstruction results. The river flow in 2009 was quite variable, but no large flow increases as observed in 1997 occurred. Consequently, the effects of river flow in adding bias to the data were probably small or certainly less than observed in the 1997 results.

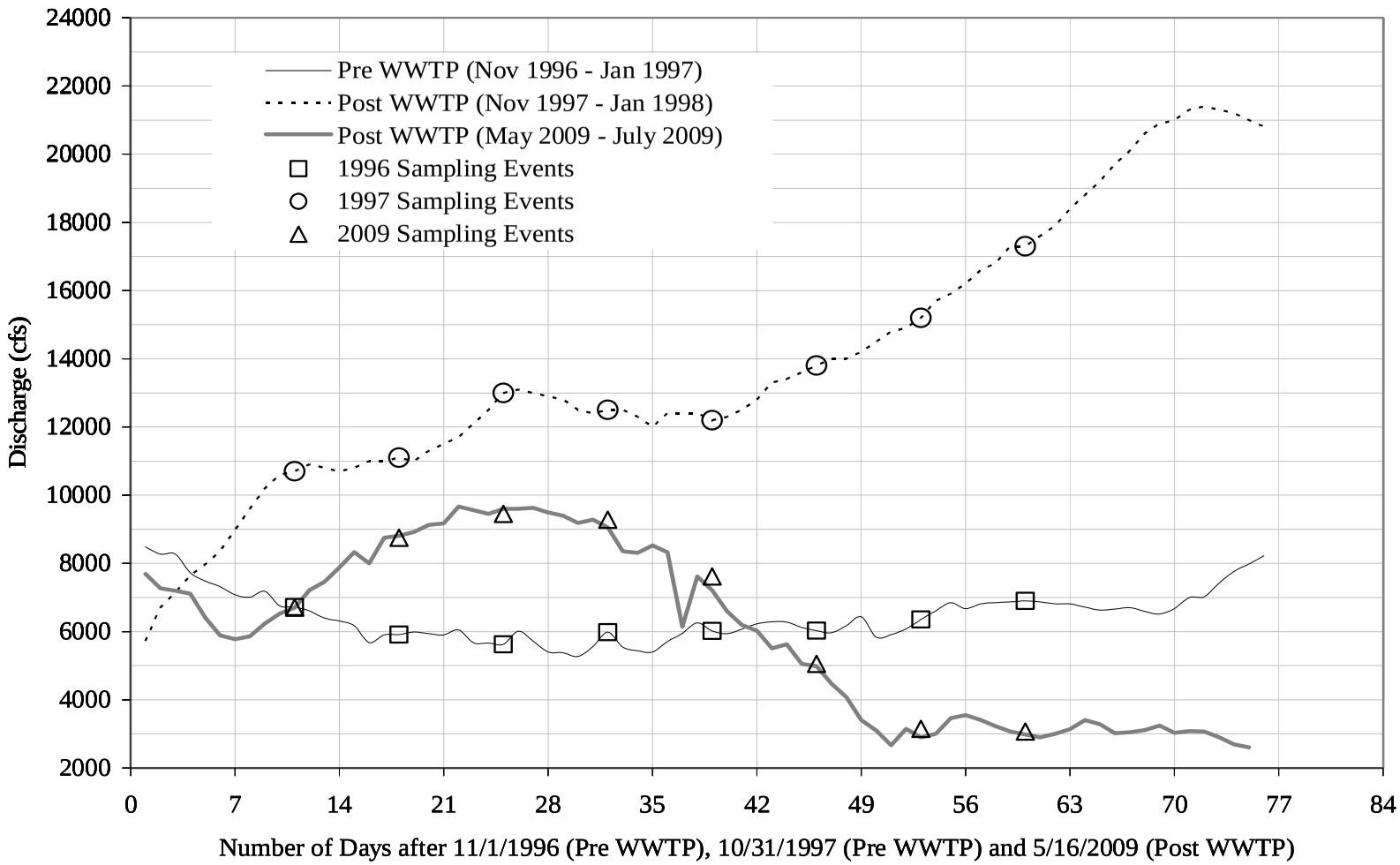

FIGURE 5-1.

RIVER DISCHARGES AND THE SAMPLING EVENTS DURING THE YEARS 1996, 1997, AND 2009

Source: ECT, 2009.

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The comparison of the 1996 and 1997 results were provided in the previous report (ECT, 1998) and will not be repeated. However, comparison of 1996 and 2009 also requires evaluation of other parameters that might influence the data comparison. During both sampling episodes, DO, pH, and temperature were routinely measured. The results are presented in Figure 5-2 and give the average values from measurements made at mid-depth for all stations for the entire sampling period. The results indicate the average DO decreased from 6.40 mg/L in 1996 to 4.95 mg/L in 2009, and the pH increased from 7.07 to 7.26. These changes, although relatively small, could have an influence on some of the parameters measured. The temperature difference, however, was quite large and averaged more than 7ºC higher in June-July 2009 than November to December 1996. Scheduling and funding deadlines required sampling to be completed in June-July. Consequently, the variability in temperature could not be avoided. The temperature difference could account for variability in some of the parameters, especially the microbiology. The higher water temperature in 2009 is undoubtedly responsible for the lower DO observed in 2009.

The variability in these ancillary data is presented to describe and illustrate other parameters that could influence the interpretation of the preconstruction and postconstruction results. Other than temperature, the influences are considered to be small.

5.2.2 NUTRIENTS

During the 2009 sampling, phosphorus was measured for the first 4 weeks to obtain general background information and is discussed in Section 4. Phosphorus was not measured in 1996 so preconstruction comparisons are not possible. Consequently, the nutrients' discussion will focus on NO_x and its relationship with TKN and total N.

Preliminary examination of the NO_x data indicated there was a correlation between NO_x and river flow. The weekly average values for the river stations and the canal stations are plotted against river flow and are shown in Figure 5-3. The figure illustrates the strong correlation between river flow and NO_x and also illustrates the difficulty in examining the influence of septic tank closure with such high variability with river flow.

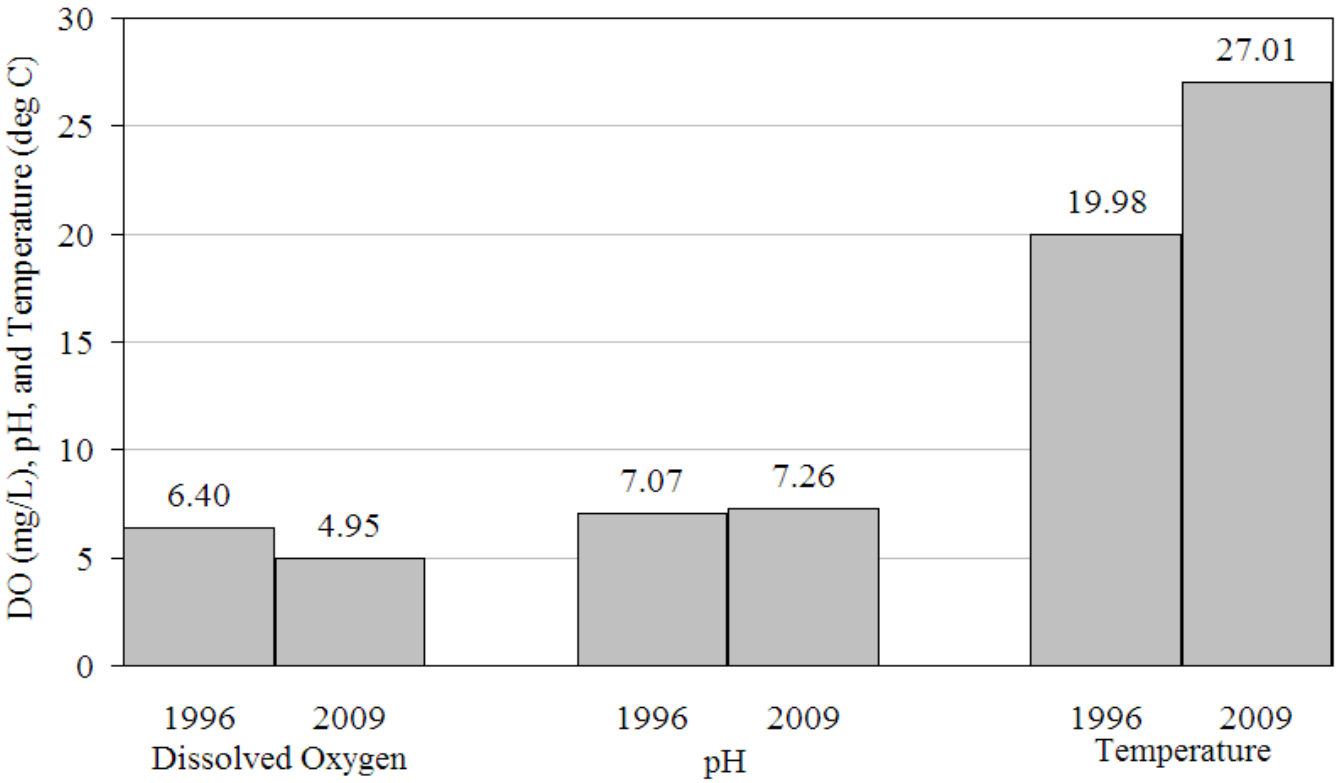

FIGURE 5-2.

COMPARISON OF *IN SITU* DATA DURING 1996 AND 2009 SAMPLING PERIODS

Source: ECT, 2009.

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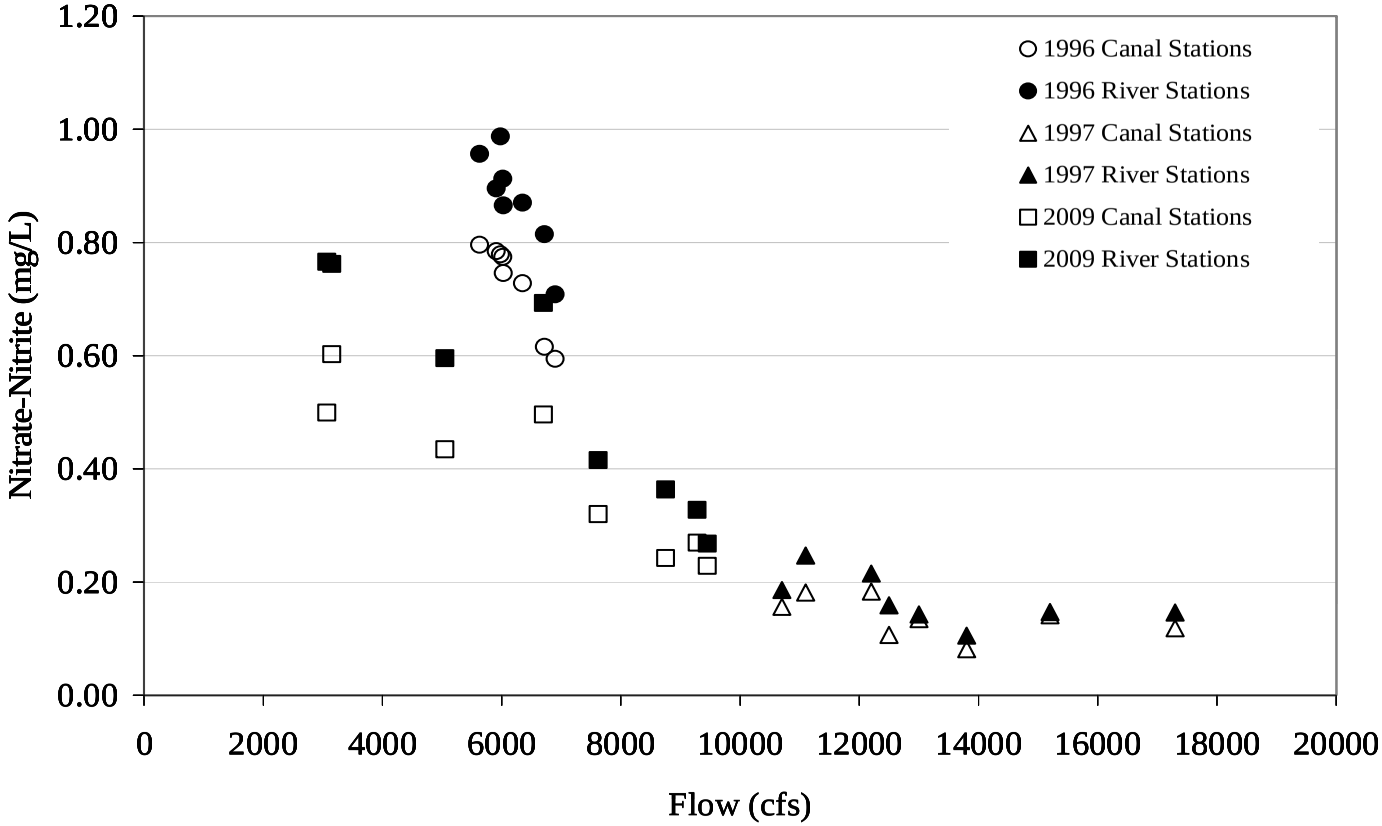

FIGURE 5-3.

NITRATE + NITRITE COMPARISON OF CANAL AND RIVER STATION AVERAGES IN 1996, 1997, AND 2009

Source: ECT, 2009.

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The figure also illustrates the high river flow conditions in 1997; consequently, the 1997 data were not examined further for comparison with the 1996, preconstruction data.

To further illustrate the relationship between river flow and NO_x, the values were plotted in Figures 5-4 (1996 data) and 5-5 (2009 data). The figures illustrate two points: (1) the consistently higher NO_x values in the river versus the canals, and (2) the highly correlated relationship between NO_x and river flow with NO_x decreasing with increasing river flow.

To further examine the 1996 data and the 2009 NO_x postconstruction data, the average values for the river stations and the canal stations were calculated and presented in Tables 5-1 and 5-2. The data for TKN, total N, and the coliform data are also summarized on these tables. As illustrated in Figure 5-4 and 5-5, the results indicate the NO_x was consistently lower in the canals than in the river for both years. Also, there was an overall reduction (average of all stations) in NO_x in 2009. However, the reduction could not be attributed to closing septic tanks because the reduction at the river stations (40 percent) was comparable to the reduction at the canal stations (47 percent).

For the other nitrogen species, TKN increased from 1996 to 2009, but the values observed in the river were comparable to the values in the canals in both 1996 and 2009. The increase in TKN was offset by the decrease in NO_x such that the total N remained nearly unchanged between 1996 and 2009 as shown in Figure 5-6. The reduction in NO_x and the increase in TKN observed in 2009 was probably the results of higher water temperatures and reduced DO in 2009, and the changes could not be attributed to removal of septic tanks.

5.2.3 MICROBIOLOGY

The following section compares the results of the microbiology from 1996 with the recent samples. Source tracking and enterococci analyses were not completed in 1996 and, consequently, are not presented here, but were discussed in Section 4.

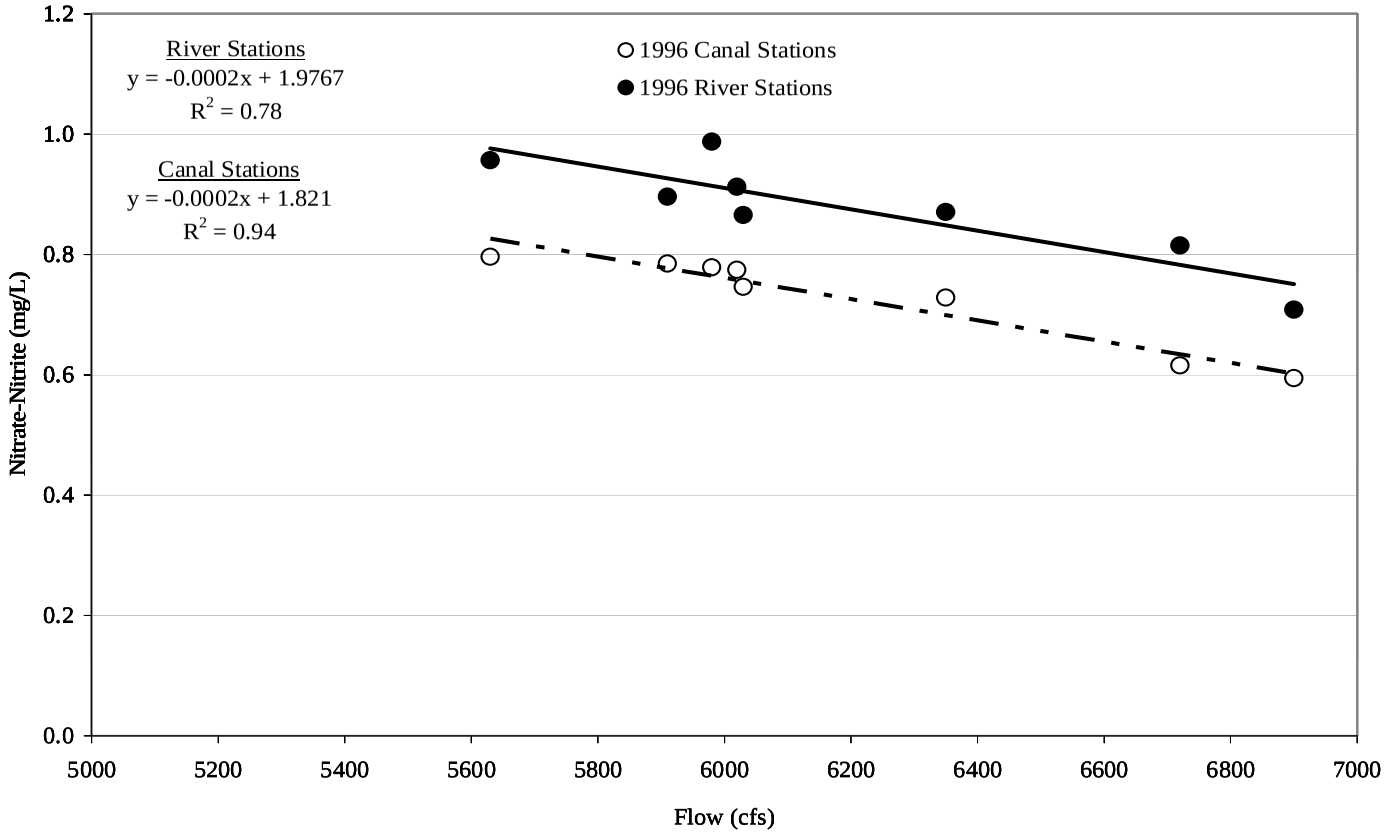

FIGURE 5-4.

NITRATE + NITRITE-FLOW RELATIONSHIP 1996 AVERAGE VALUES IN CANAL AND CONTROL STATIONS

Source: ECT, 2009.

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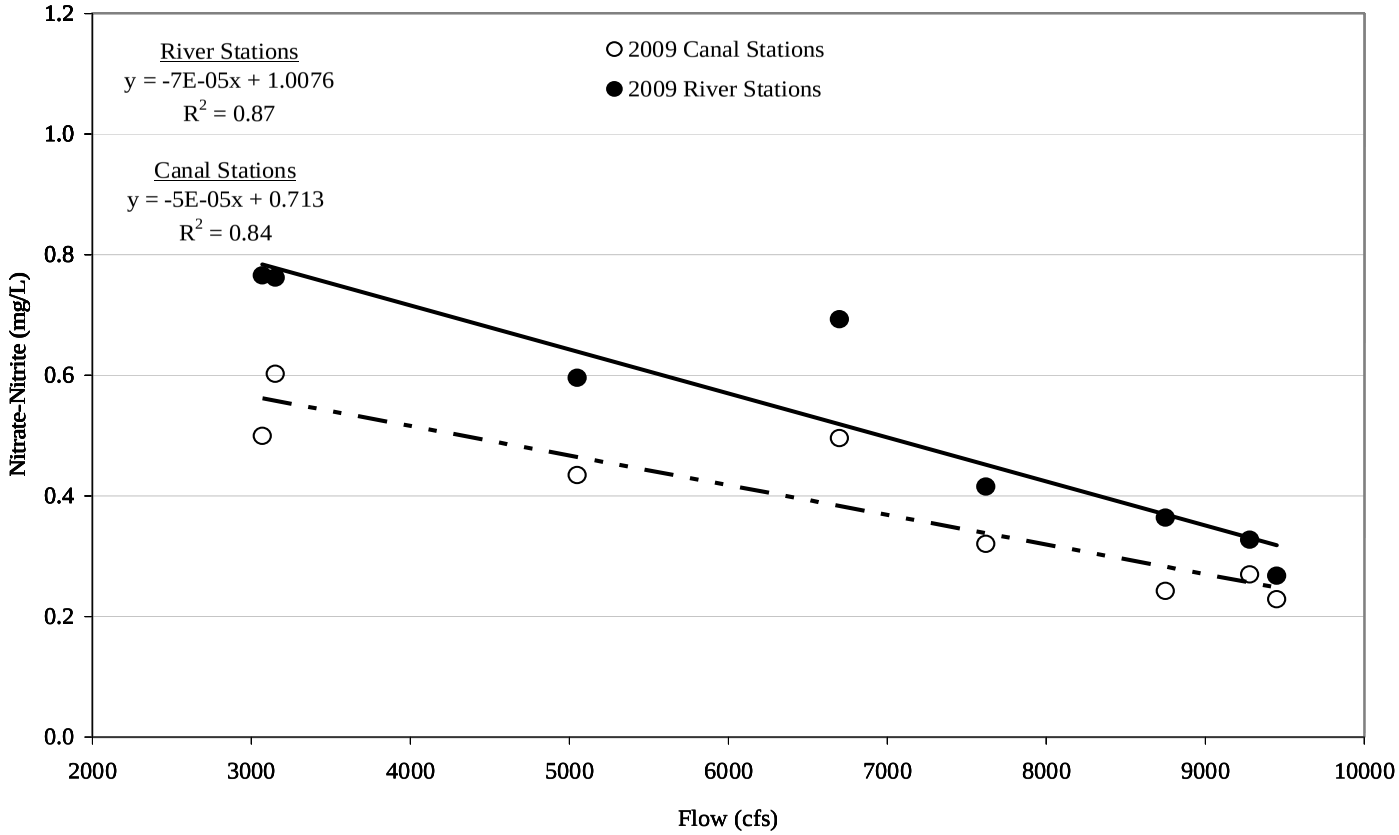

FIGURE 5-5.

NITRATE + NITRITE-FLOW RELATIONSHIP 2009 AVERAGE VALUES IN CANAL AND CONTROL STATIONS

Source: ECT, 2009.

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Table 5-1. Changes in average concentrations between the 1996 and 2009 sampling events. Data are presented for River Stations, Canal Stations, and combined River and Canal Stations (Overall)

Water Quality	River Stations		% change	Canal Stations		% change	Overall		% change
Parameters	1996	2009	from 1996	1996	2009	from 1996	1996	2009	from 1996
Fecal coliform	134	33	-75	485	89	-82	309	61	-80
Total coliform	170	841	394	537	1401	161	354	1121	217
Nitrate/Nitrite	0.88	0.52	-40	0.73	0.39	-47	0.80	0.46	-43
TKN	0.39	0.66	71	0.41	0.69	68	0.40	0.68	69
Total N	1.26	1.19	-6	1.14	1.07	-6	1.20	1.13	-6

Source: ECT, 2009.

Table 5-2. Differences in average concentrations between River and canal Stations in the years 1996 and 2009

Water Quality Parameters	1996 River Stations	1996 Canal Stations	% Difference	2009 River Stations	2009 Canal Stations	% Difference
Fecal coliform	134	485	262	33	89	170
Total coliform	170	537	216	841	1401	67
Nitrate/Nitrite	0.88	0.73	-17	0.52	0.39	-25
TKN	0.39	0.41	5	0.66	0.69	5
Total N	1.26	1.14	-10	1.19	1.07	-10

Source: ECT, 2009.

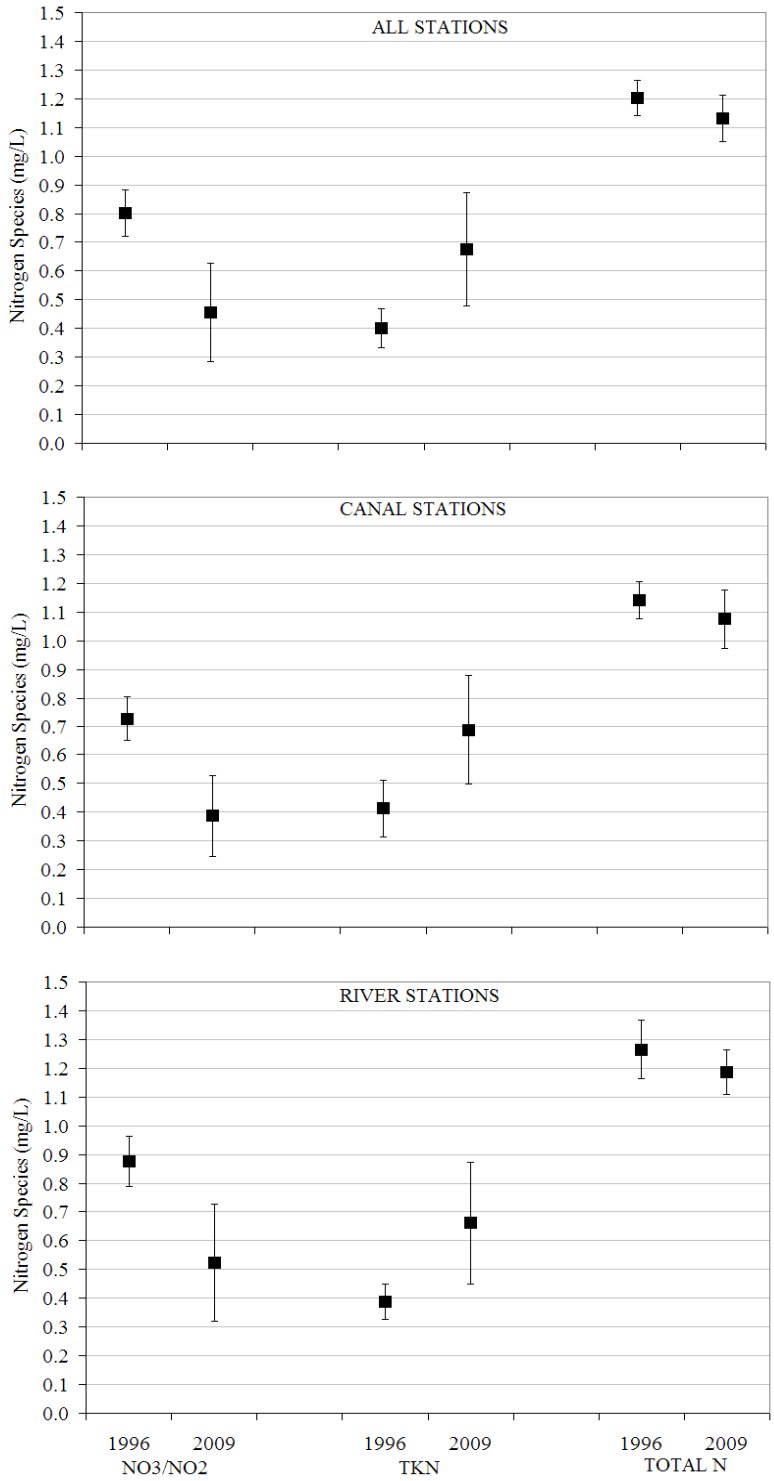

FIGURE 5-6.
COMPARISON OF NOX, TKN, AND TOTAL N BETWEEN 1996 AND 2009 (AVERAGE VALUES ARE SHOWN WITH ± STANDARD DEVIATION

Source: ECT, 2009.

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Salmonella

Salmonella samples were analyzed for presence/absence only, and the 2009 results are presented in Section 4. In 2009 salmonella was present in 46.8 percent of the river samples and only 22.5 percent of the canal stations. This indicates that salmonella issuing from the canals is not the primary source of salmonella in the river.

In 1996 salmonella was present in the river stations 75 percent of the time with 100 percent occurrence at Stations 8, 9, and 10, and no occurrence at Station 7. Salmonella was present in the five canal stations only 15 percent of the time in 1996. Consequently, the occurrence of salmonella decreased from 75 percent to 46.8 percent from 1996 to 2009; however, in the canal stations, the occurrence increased slightly from 15 percent in 1996 to 22.5 percent in 2009. The results indicate that during both studies the occurrence of salmonella was higher in the river than in the canals. Further, since the occurrences in the canals was slightly higher in 2009, there was no observed reduction resulting from septic tank closure. This conclusion, however, does not account for the unknown effects of the 7ºC difference in water temperatures between the two sampling events.

Coliforms

The average observed coliform values for both fecal and total coliforms for 1996 and 2009 and for all river and canal stations are presented in Table 5-1. As with the other parameters, the results from the 1997 sampling are not presented because of extremely high river flow that biased the data in 1999. Several key items are apparent in the data. The fecal coliform values are much higher in the canals than in the river in both 1996 (351 percent higher) and 2009 (170 percent higher) suggesting that the canals are a source of fecal coliforms to the river. This is not surprising given the concentration of fish, birds, and other animals in canal areas.

The data also indicate that there was a reduction in fecal coliforms in 2009 in both the canals (85 percent reduction) and the river station (75 percent reduction). However, since the reduction observed in the river stations is comparable to that observed in the canals, it cannot be concluded that the reduction is a benefit of closing the septic tanks. It is

probable that the seasonal variations affected the results since the 2009 data were collected in the summer, and the 1996 data were collected in late fall.

Similar to the fecal coliform data, the total coliform values were higher in the canals in both 1996 (216 percent higher) and 2009 (67 percent higher), again indicating that the canals are a source of coliforms to the river. However, contrary to the fecal coliform results, the total coliform counts increased in 2009 at both the river and canal stations. Consequently, closing the septic tanks did not reduce the total coliform values, and the increases observed were probably caused by seasonal variability.

5.2.4 STATISTICAL TREATMENT

The primary goal of the 2009 study was to evaluate and document any potential improvements in water quality from closing 850 septic tanks in the town of Suwannee and establishing a central wastewater treatment system. A simple *before and after* comparison was completed by changing river flows, rainfall, and water temperatures. Further, similar change in the test parameters were observed in the river (control) stations as observed in the canal stations. Consequently, separating regional or seasonal changes in the river basin from potential septic tank closure benefits was difficult.

The observed changes between 2009 and 1996 were discussed in the previous sections. The results indicated the differences between the concentrations of canal and river stations for a few of the indicator parameters were reduced in 2009 as compared to 1996 (refer to Table 5-1).

To help determine if these differences were attributable to septic tank closure, water quality data from the 1996 and 2009 sampling events were further analyzed using five indicator parameters including total and fecal coliforms, NO_x, TKN, and total N. For each sampling week, each indicator parameter was grouped as a canal station or river station. Averages of canal stations and river stations were calculated for each of the parameters and are presented in Table 5-3.

Table 5-3. Weekly Averages of River and Canal Stations and their Differences

1996															
	Fecal Coliform			Total Coliform			Nitrate/Nitrite			TKN			Total N		
Week #	River	Canal	**Differ-ence**	River	Canal	**Differ-ence**	River	Canal	**Differ-ence**	River	Canal	**Differ-ence**	River	Canal	**Differ-ence**
1	80	784	**704**	134	806	**672**	0.815	0.616	**-0.199**	0.423	0.528	**0.106**	1.237	1.144	**-0.094**
2	425	1138	**713**	498	1214	**717**	0.896	0.785	**-0.111**	0.400	0.502	**0.102**	1.296	1.287	**-0.009**
3	213	716	**504**	223	790	**568**	0.957	0.796	**-0.161**	0.313	0.292	**-0.021**	1.269	1.088	**-0.181**
4	138	458	**320**	230	534	**304**	0.988	0.779	**-0.209**	0.470	0.308	**-0.162**	1.458	1.087	**-0.371**
5	124	302	**179**	166	442	**276**	0.913	0.774	**-0.138**	0.428	0.390	**-0.038**	1.340	1.164	**-0.176**
6	31	138	**107**	37	144	**106**	0.866	0.746	**-0.120**	0.345	0.382	**0.037**	1.211	1.128	**-0.083**
7	37	287	**250**	35	318	**284**	0.871	0.728	**-0.142**	0.298	0.362	**0.065**	1.168	1.090	**-0.078**
8	25	57	**32**	40	52	**12**	0.708	0.594	**-0.114**	0.430	0.544	**0.114**	1.138	1.138	**0.000**
Mean	134	485	**351**	170	537	**367**	0.876	0.727	**-0.149**	0.388	0.414	**0.025**	1.265	1.141	**-0.124**

2009															
	Fecal Coliform			Total Coliform			Nitrate/Nitrite			TKN			Total N		
Week #	River	Canal	**Differ-ence**	River	Canal	**Differ-ence**	River	Canal	**Differ-ence**	River	Canal	**Differ-ence**	River	Canal	Differ-ence
1	54	119	**66**	75	40	**-35**	0.693	0.496	**-0.197**	0.390	0.442	**0.052**	1.083	0.938	**-0.145**
2	11	52	**41**	570	696	**127**	0.364	0.242	**-0.121**	0.795	0.734	**-0.061**	1.159	0.976	**-0.182**
3	18	83	**66**	570	1785	**1216**	0.268	0.229	**-0.039**	0.873	0.832	**-0.041**	1.140	1.061	**-0.079**
4	10	69	**59**	377	1385	**1008**	0.328	0.270	**-0.058**	0.893	0.900	**0.008**	1.220	1.170	**-0.050**
5	40	62	**23**	924	1216	**292**	0.415	0.320	**-0.095**	0.745	0.902	**0.157**	1.160	1.222	**0.062**
6	29	182	**154**	694	2372	**1679**	0.596	0.435	**-0.161**	0.743	0.722	**-0.021**	1.338	1.157	**-0.182**
7	71	78	**7**	2425	2342	**-83**	0.762	0.603	**-0.159**	0.478	0.484	**0.007**	1.240	1.087	**-0.153**
8	36	68	**32**	1097	1369	**273**	0.766	0.499	**-0.266**	0.385	0.490	**0.105**	1.151	0.989	**-0.161**
Mean	33	89	**56**	841	1401	**559**	0.524	0.387	**-0.137**	0.663	0.688	**0.026**	1.186	1.075	**-0.111**

Source: ECT, 2009.

In an attempt to assess the septic tank closure contribution to canal water with respect to river water background, the differences between the average concentrations of indicator parameters between the canal and river stations were determined for each of the eight weekly replicate sampling periods. These differences are also presented in Table 5-3.

A two-sample (paired) t-test was used to compare the eight replicate weekly means of differences for each of the indicator parameters. Of the five parameters tested, only fecal coliform was significantly different between the 1996 and 2009 replicate samples (see Table 5-4). This difference is the result of a larger change in the canal values as compared to the change in the river values in the 2009 versus 1996 samples (see Table 5-1). When the background variation in river water quality was considered, none of the remaining parameters were significantly different. In fact, two of the parameters, total coliforms and TKN, increased between 1996 and 2009. The large variation in river background can, at least in part, be accounted for by differences in river flow and seasonal (winter versus summer) temperature differences. Consequently, it remains undetermined if an improvement in fecal coliforms is the result of septic tank closure or a seasonal effect.

Table 5-4. Mean and Standard Deviation of the Differences in River and Canal Stations Averages in 1996 and 2009

	1996		2009		
Parameters	Mean	Standard Deviation	Mean	Standard Deviation	P
Fecal Coliform	351	262	56	45	0.017*
Total Coliform	367	259	559	654	0.502
Nitrate/Nitrite	-0.149	0.038	-0.137	0.075	0.732
TKN	0.025	0.095	0.026	0.075	0.993
Total N	-0.124	0.120	-0.111	0.085	0.856

*Indicates significant difference.

Note: P = value is the probability of being wrong in concluding that there is a true difference between the groups.

Source: ECT, 2009.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The goal of this study was to evaluate the long-term effects of closing about 850 OSTDS in the town of Suwannee and installing a central wastewater treatment system. The approach was to sample water quality in the Suwannee River and the canals within the town of Suwannee and compare the results with data collected in 1996 prior to OSTDS closures. Attempts were made to repeat the sampling study in 2009 as close as practical to the study in 1996 to enhance the comparability of the results.

The results did not suggest that there was large improvement in water quality in the canals between 1996 and 2009 that could be attributed to closing the OSTDS. Interpretation of the results, however, was difficult because of changing river flows, seasonal differences and variability in the river (control) stations. However, several specific observations were noted:

- Salmonella occurrences were higher in the river than in the canals in both 2009 and 1996 indicating the canals were not the primary source of salmonella. The occurrences of salmonella in 2009 were slightly higher than 1996.
- NO_x exhibited a strong correlation with river flow and decreased with increasing river flow. TKN increased with increasing river flow. There was consistently more NO_x in the river samples than in the canals.
- The source tracking results indicated human material was present about 42 percent of the time and about equally present in the canals and the river.
- The total and fecal coliform values were much higher in the canals than in the river in both 1996 and 2009. The fecal coliforms decreased from 1996 to 2009 in both the canals and the river stations whereas the total coliforms increased from 1996 to 2009. The higher values in the canals as compared to the river are probably from wildlife concentrated near the canals.
- Simple statistical comparison of the 2009 results with the 1996 results were complicated by large changes in the river (control) stations resulting from variability in river flow and possibly water temperature (seasonality).

Consequently, a more detailed statistical approach was used to filter the effects of changes in the control stations.

Using a statistical method to account for the variability in the river (control) stations, the only statistically significant observation was a reduction in fecal coliforms in the canals in 2009 as compared to 1996. This would indicate a benefit of closing the OSTDS. However, the 2009 sampling was conducted in the summer as opposed to late fall/winter in 1996 and the potential seasonal effects on fecal coliforms have not been assessed.

6.2 RECOMMENDATIONS

The difficulty to date in assessing the potential benefits of OSTDS closure in the town of Suwannee is controlling outside environmental influences that can mask any real changes that might be present. In 1997 the large increase in rainfall and river flow resulted in large changes in the river (control) stations. Similar large changes observed in the river station were apparent in the canals, but it could not be determined if the improvements resulted from general changes in water quality in the area or resulted from closing the OSTDS. Similarly in 2009, a significant reduction in fecal coliforms was apparent in the canals, but it was not certain if this was a direct result of OSTDS closures or a seasonal effect caused by warmer water or variation in wildlife occurrences.

Consequently, it is recommended that the sampling be repeated in November/December in an attempt to closely match the environmental conditions present during the baseline sampling in 1996. This should allow for two key comparisons:

- Comparison of the 1996 baseline conditions (pre-OSTDS closure) under the similar seasonal and river flow conditions.
- Comparison of the winter conditions with the 2009 summer conditions.

This should enhance the chances of identifying benefits of the OSTDS closure if they exist.

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APPENDIX A

SUPPLEMENTAL DATA

Hard copy not provided. Appendix may be viewed at:

https://209.208.21.121/thinclient/login.aspx (on certificate error, just continue)

FTP Account Information:

Username: 11fdoh081

Password: ect11fdoh081081

APPENDIX B

2009 WATER QUALITY SAMPLING RESULTS

Town of Suwannee Water Quality Sampling

Water Quality Analysis Results for *Entercocci*

Results are presented in colonies/100 ml

Sample Date	Event Number	Station ID									
		S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10
5/26/09	1	89	110	68	19	230	79	30	36	37	27
6/1/09	2	2100	56	78	33	87	87	14	23	15	11
6/8/09	3	750	84	82	70	570	73	40	37	29	19
6/15/09	4	9	120	120	1150	120	210	41	17	19	10
6/22/09	5	13	72	77	89	390	118	77	47	27	77
6/29/09	6	1U*	350	140	53	220	171	41	31	22	17
7/6/09	7	1	41	53	240	200	43	47	40	52	73
7/13/09	8	460	180	68	8	73	57	43	33	43	48

*U - analyte not detected at or above the method detection limit

Town of Suwannee Water Quality Sampling

Water Quality Parameters: *In-situ* measurements

STATION: S2

Parameters	Date-Time	5/26/2009			6/1/09 15:25			6/8/09 9:50			6/15/09 14:20			6/22/09 8:16			6/29/09 14:45			7/6/09 8:05			7/13/09 12:30		
Sampling Depth	ft	3	2	1	3.0	2.0	1.0	4.0	2.5	1.0	4.0	2.5	1.0	5.0	3.0	1.0	5.0	3.0	1.0	5.0	3.0	1.0	4.0	2.5	1.0
Specific conductance	uS/cm	606	602	606	328	357	372	192	192	192	235	230	190	356	385	372	806	502	461	555	546	535	844	573	555
Temperature	°C	24.19	24.23	24.22	26.07	26.74	27.04	25.35	25.39	25.44	27.77	27.96	28.51	28.17	28.39	28.49	28.21	28.89	29.09	28.28	28.22	28.20	27.02	27.49	28.37
pH	su	7.54	7.51	7.50	7.31	7.36	7.39	6.88	6.87	6.86	7.05	7.05	7.11	6.77	7.34	7.33	7.35	7.42	7.37	7.18	7.68	7.64	7.09	7.33	7.38
Dissolved Oxygen	mg/L	5.39	5.36	5.36	6.39	7.94	9.10	4.15	4.28	4.40	3.92	4.16	4.40	3.36	3.54	3.81	3.68	4.06	4.21	3.95	4.50	4.74	4.14	5.53	6.21

STATION: S3

Parameters	Date-Time	5/26/2009			6/1/09 15:40			6/8/09 10:14			6/15/09 14:44			6/22/09 8:31			6/29/09 15:00			7/6/09 8:20			7/13/09 12:42		
Sampling Depth	ft	4	2.5	1	2.0	1.5	1.0	5.0	3.0	1.0	4.0	2.5	1.0	5.0	3.0	1.0	4.0	2.5	1.0	5.0	3.0	1.0	3.0	2.0	1.0
Specific conductance	uS/cm	435	440	439	210	208	209	192	191	192	172	173	173	269	271	275	329	330	333	383	380	381	381	385	387
Temperature	°C	23.72	23.73	23.72	27.20	27.20	27.17	25.35	25.36	25.36	28.14	28.12	28.12	28.39	28.39	28.42	28.95	28.97	29.03	27.90	27.90	27.90	27.16	27.43	27.41
pH	su	7.64	7.51	7.51	7.38	7.35	7.24	6.85	6.86	6.86	7.15	7.11	7.06	7.26	7.22	7.20	7.32	7.30	7.29	7.53	7.54	7.53	7.46	7.40	7.36
Dissolved Oxygen	mg/L	5.13	5.07	5.12	5.89	5.90	5.95	4.30	4.13	4.02	4.48	4.64	4.66	3.99	4.11	3.90	4.29	4.39	4.25	4.46	4.45	4.57	4.97	5.25	5.17

STATION: S4

Parameters	Date-Time	5/26/2009 10:30			6/1/09 13:45			6/8/09 11:40			6/15/09 12:44			6/22/09 9:40			6/29/09 13:10			7/6/09 10:50			7/13/09 10:54		
Sampling Depth	ft	3	2	1	2.0	1.5	1.0	3.5	2.0	1.0	2.5	2.0	1.0	3.0	2.0	1.0	3.0	2.0	1.0	5.5	3.3	1.0	2.5	2.0	1.0
Specific conductance	uS/cm	420	413	411	409	410	410	374	370	370	247	245	245	246	246	246	368	366	366	364	368	370	360	359	359
Temperature	°C	24.91	25.08	25.15	27.19	27.18	27.15	26.05	26.21	26.37	28.41	28.54	28.83	29.43	29.64	29.73	28.61	28.67	28.78	28.65	28.79	28.95	27.92	28.01	28.29
pH	su	7.93	7.96	8.08	7.41	7.42	7.42	7.11	7.10	7.10	7.07	7.05	7.06	7.24	7.23	7.22	7.40	7.33	7.30	7.61	7.54	7.50	7.58	7.61	7.60
Dissolved Oxygen	mg/L	8.77	8.60	10.95	6.07	6.10	6.15	2.69	2.88	3.39	3.49	3.62	3.81	3.64	3.70	3.80	2.87	3.26	3.54	1.63	2.92	3.66	8.31	8.33	8.36

STATION: S5

Parameters	Date-Time	5/26/2009 8:50			6/1/09 15:17			6/8/09 9:32			6/15/09 14:05			6/22/09 8:04			6/29/09 14:33			7/6/09 7:55			7/13/09 0:20		
Sampling Depth	ft	3	2	1	2.0	1.5	1.0	4.0	2.5	1.0	3.0	2.0	1.0	5.0	3.0	1.0	4.0	2.5	1.0	5.0	3.0	1.0	3.0	2.0	1.0
Specific conductance	uS/cm	706	704	705	214	213	214	199	198	198	180	180	179	352	352	351	432	422	423	522	522	521	438	439	437
Temperature	°C	23.84	23.82	23.83	27.51	27.54	27.52	25.29	25.28	25.28	28.41	28.45	28.47	28.47	28.47	28.47	29.01	29.08	29.04	28.09	28.10	28.10	27.29	27.33	27.35
pH	su	7.33	7.37	7.38	7.26	7.24	7.23	6.87	6.86	6.86	7.14	7.08	7.01	7.09	7.05	7.06	7.27	7.27	7.25	7.35	7.34	7.39	7.33	7.31	7.31
Dissolved Oxygen	mg/L	4.84	5.05	4.95	5.69	5.74	5.72	4.24	4.25	4.22	4.40	4.45	4.52	3.99	3.96	3.98	4.83	4.70	4.71	4.41	4.43	4.43	5.05	5.11	5.00

STATION: S6

Parameters	Date-Time	5/26/2009			6/1/09 15:05			6/8/09 9:15			6/15/09 13:55			6/22/09 7:48			6/29/09 14:17			7/6/09 7:40			7/13/09 0:10		
Sampling Depth	ft	5	2.5	1	4.5	3.0	1.0	5.0	3.0	1.0	5.0	3.0	1.0	6.0	3.0	1.0	5.0	3.0	1.0	5.0	3.0	1.0	5.0	3.0	1.0
Specific conductance	uS/cm	375	375	374	251	265	268	189	189	188	174	171	172	235	231	223	279	283	288	358	359	362	365	365	362
Temperature	°C	23.7	23.7	23.71	26.99	27.16	27.22	25.17	25.18	25.21	27.87	27.88	27.90	28.57	28.57	28.59	28.68	28.72	28.78	28.12	28.09	28.11	27.02	27.01	27.10
pH	su	7.38	7.4	7.41	7.16	7.16	7.18	6.87	6.86	6.86	7.13	7.08	7.05	7.07	7.09	7.09	7.22	7.20	7.20	7.37	7.41	7.41	7.29	7.28	7.27
Dissolved Oxygen	mg/L	5.08	5.04	5.02	5.78	5.80	5.89	4.24	4.36	4.35	4.39	4.40	4.45	3.46	3.52	3.61	4.05	4.15	4.15	4.49	4.48	4.37	4.70	4.71	4.74

STATION: S7

Parameters	Date-Time	5/26/2009 9:30			6/1/09 15:55			6/8/09 10:49			6/15/09 15:05			6/22/09 9:05			6/29/09 13:35			7/6/2009 9:05			7/13/09 13:15		
Sampling Depth	ft	11	6	1	5.0	3.0	1.0	10.0	5.0	1.0	7.0	4.0	1.0	9.0	5.0	1.0	8.0	4.0	1.0	8	4.5	1	6.0	3.0	1.0
Specific conductance	uS/cm	391	384	377	182	182	181	219	217	215	207	185	181	314	289	272	338	323	322	630	521	468	404	381	383
Temperature	°C	23.78	23.79	23.79	26.63	26.61	26.70	25.61	25.80	25.81	28.02	28.20	28.35	28.37	28.38	28.43	28.65	28.66	28.66	27.92	27.94	27.96	26.97	27.22	27.34
pH	su	7.52	7.53	7.54	7.27	7.20	7.20	6.87	6.86	6.88	7.27	7.18	7.12	7.14	7.13	7.15	7.31	7.39	7.35	7.51	7.58	7.68	7.38	7.42	7.42
Dissolved Oxygen	mg/L	5.33	5.35	5.35	6.40	6.39	6.32	4.49	4.67	4.64	4.84	4.93	4.99	4.23	4.17	4.24	4.81	4.84	4.82	5.12	5.13	5.09	5.33	5.39	5.45

STATION: S8

Parameters	Date-Time	5/26/2009 9:20			6/1/09 16:10			6/8/09 10:30			6/15/09 14:52			6/22/09 8:47			6/29/09 13:20			7/6/09 8:40			7/13/09 13:01		
Sampling Depth	ft	5	3	1	9.0	5.0	1.0	8.0	4.0	1.0	6.0	3.5	1.0	8.0	4.0	1.0	7.0	4.0	1.0	7.0	4.0	1.0	6.0	3.0	1.0
Specific conductance	uS/cm	337	336	336	207	196	197	194	192	191	168	167	167	228	227	227	289	288	286	377	375	372	341	340	340
Temperature	°C	23.65	23.67	23.70	26.90	26.95	27.02	25.30	25.35	25.49	27.84	27.97	28.09	28.26	28.26	28.28	28.44	28.44	28.45	27.92	27.91	27.91	26.80	26.89	27.01
pH	su	7.58	7.55	7.53	7.15	7.21	7.18	6.89	6.88	6.86	7.20	7.09	7.08	7.21	7.16	7.18	7.34	7.40	7.37	7.60	7.56	7.56	7.44	7.44	7.44
Dissolved Oxygen	mg/L	5.27	5.33	5.33	6.16	6.11	6.21	4.44	4.34	4.57	4.94	4.96	4.98	4.26	4.37	4.32	5.09	5.03	5.09	5.74	5.54	5.46	5.54	5.46	5.53

Parameters	Date-Time	STATION: S9																							
		5/26/2009 8:25			6/1/09 14:50			6/8/09 8:47			6/15/09 13:45			6/22/09 7:30			6/29/09 14:05			7/6/09 7:30			7/13/09 11:59		
Sampling Depth	ft	15	7.5	1	14.0	7.0	1.0	16.0	8.0	1.0	13.0	7.0	1.0	16.0	8.0	1.0	14.0	7.0	1.0	15.0	8.0	1.0	15.0	7.0	1.0
Specific conductance	uS/cm	306	305	305	169	168	169	181	181	181	159	159	159	199	199	199	267	267	267	323	323	323	315	316	315
Temperature	°C	23.51	23.50	23.50	26.09	26.08	26.08	25.20	25.20	25.21	27.27	27.28	27.28	28.08	28.08	28.07	28.02	28.04	28.06	27.75	27.75	27.76	26.36	26.35	26.37
pH	su	7.36	7.41	7.40	7.11	7.07	7.08	6.86	6.82	6.82	7.08	7.01	6.98	7.08	7.09	7.07	7.30	7.30	7.27	7.40	7.37	7.45	7.34	7.38	7.36
Dissolved Oxygen	mg/L	5.73	5.60	5.61	6.38	6.21	6.17	4.58	4.69	4.61	4.95	4.95	4.98	4.26	4.25	4.26	4.86	4.85	4.86	4.82	4.85	4.86	5.57	5.57	5.54

Parameters	Date-Time	STATION: S10																							
		5/26/2009 8:15			6/1/09 14:35			6/8/09 8:25			6/15/09 13:30			6/22/09 7:05			6/29/09 13:45			7/6/09 7:15			7/13/09 11:45		
Sampling Depth	ft	22	11	1	10.0	5.0	1.0	22.0	11.0	1.0	22	11.5	1	23.0	11.0	1.0	23.0	12.0	1.0	23.0	12.0	1.0	23.0	11.0	1.0
Specific conductance	uS/cm	306	306	305	166	166	166	181	181	180	158	158	159	200	200	200	269	269	269	323	324	322	315	315	315
Temperature	°C	23.52	23.51	23.52	26.01	26.00	26.02	25.18	25.19	25.20	27.23	27.27	27.34	28.04	28.03	28.03	27.94	27.94	27.95	27.63	27.61	27.61	26.35	26.36	26.36
pH	su	7.42	7.35	7.33	7.10	7.07	7.00	6.91	6.90	6.86	7.25	7.13	7.09	7.09	7.08	7.04	7.33	7.31	7.30	7.40	7.42	7.45	7.38	7.39	7.39
Dissolved Oxygen	mg/L	5.29	5.31	5.31	6.22	6.19	6.20	4.61	4.69	4.72	4.99	5.01	5.00	4.24	4.34	4.29	4.96	4.98	5.00	4.92	4.94	5.01	5.54	5.62	5.60

ft - feet
uS/cm - microsiemens per centimeter
°C - degrees Celsius
su - standard units
mg/L - milligrams per liter

Source: ECT, 2009.

Town of Suwannee Water Quality Analysis Results
Enterococcus faecium esp Human Gene Biomarker (HGB)
for Human Fecal Contamination*

Sampling Station	DNA Analytical Results*			
	6/22/2009	6/29/2009	7/6/2009	7/13/2009
S-2	X	X	O	X
S-5	X	O	X	O
S-10	X	O	X	O

*Detection Method - Polymerase Chain Reaction (PCR) DNA Analytical Technology

Note: X = HGB negative.
O = HGB positive.

Town of Suwannee Water Quality Analysis Results

Station 1

Water Quality Parameters	Units	Sampling Dates							
		5/26/2009	6/1/2009	6/8/2009	6/15/2009	6/22/2009	6/29/2009	7/6/2009	7/13/2009
Enterococci	colonies/100ml	89	2100	750	9	13	1U	1	460
Fecal Coliforms	colonies/100ml	1U	50	90	3	9	1U	10U	20
Nitrate-Nitrite	mg/L	0.068	0.011	0.169	0.038	0.018	0.014	0.056	0.115
Salmonella	colonies/100ml	Absent	Absent	Present	Present	Absent	Present	Present	Absent
Total Coliforms	colonies/100ml	600	6000	2000	200U	200U	616	200U	4000
Total Kjeldahl Nitrogen	mg/L	2.95	0.54	0.64	0.96	1.19	1.38	1.2	1.14
Total Phosphorus	mg/L	1.01	0.412	0.374	0.529	---	---	---	---

Station 2

Water Quality Parameters	Units	Sampling Dates							
		5/26/2009	6/1/2009	6/8/2009	6/15/2009	6/22/2009	6/29/2009	7/6/2009	7/13/2009
Enterococci	colonies/100ml	110	56	84	120	72	350	41	180
Fecal Coliforms	colonies/100ml	82	26	68	42	47	380	59	48
Nitrate-Nitrite	mg/L	0.573	0.148	0.259	0.249	0.33	0.456	0.644	0.562
Salmonella	colonies/100ml	Absent	Absent	Absent	Absent	Absent	Present	Absent	Present
Total Coliforms	colonies/100ml	1U	1000	924	770	462	1690	1390	1000
Total Kjeldahl Nitrogen	mg/L	0.45	0.9	0.81	0.97	0.72	0.67	0.38	0.47
Total Phosphorus	mg/L	0.097	0.14	0.165	0.149	---	---	---	---

Station 3

Water Quality Parameters	Units	Sampling Dates							
		5/26/2009	6/1/2009	6/8/2009	6/15/2009	6/22/2009	6/29/2009	7/6/2009	7/13/2009
Enterococci	colonies/100ml	68	78	82	120	77	140	53	68
Fecal Coliforms	colonies/100ml	71	39	52	32	80	80	44	47
Nitrate-Nitrite	mg/L	0.652	0.359	0.26	0.328	0.381	0.497	0.711	0.712
Salmonella	colonies/100ml	Absent	Absent	Present	Absent	Absent	Absent	Absent	Present
Total Coliforms	colonies/100ml	1U	400	2000	924	200U	3080	1850	2460
Total Kjeldahl Nitrogen	mg/L	0.31	0.75	0.96	0.8	0.91	0.79	0.38	0.35
Total Phosphorus	mg/L	0.107	0.157	0.142	0.149	---	---	---	---

Station 4

Water Quality Parameters	Units	Sampling Dates							
		5/26/2009	6/1/2009	6/8/2009	6/15/2009	6/22/2009	6/29/2009	7/6/2009	7/13/2009
Enterococci	colonies/100ml	19	33	70	1150	89	53	240	8
Fecal Coliforms	colonies/100ml	59	63	49	170	41	300	135	100
Nitrate-Nitrite	mg/L	0.005	0.066	0.134	0.163	0.2	0.284	0.277	0.028
Salmonella	colonies/100ml	Absent	Absent	Absent	Absent	Absent	Present	Present	Absent
Total Coliforms	colonies/100ml	100	1000	462	616	400	2310	2000	616
Total Kjeldahl Nitrogen	mg/L	0.71	0.6	0.72	0.98	0.97	0.72	0.71	0.9
Total Phosphorus	mg/L	0.084	0.089	0.147	0.149	---	---	---	---

Station 5

Water Quality Parameters	Units	Sampling Dates							
		5/26/2009	6/1/2009	6/8/2009	6/15/2009	6/22/2009	6/29/2009	7/6/2009	7/13/2009
Enterococci	colonies/100ml	230	87	570	120	390	220	200	73
Fecal Coliforms	colonies/100ml	270	49	210	63	64	72	63	65
Nitrate-Nitrite	mg/L	0.629	0.359	0.24	0.301	0.355	0.498	0.69	0.69
Salmonella	colonies/100ml	Absent	Absent	Absent	Absent	Present	Present	Absent	Present
Total Coliforms	colonies/100ml	100	1U	1540	4000	2460	1850	4160	770
Total Kjeldahl Nitrogen	mg/L	0.33	0.71	0.94	0.86	0.87	0.72	0.52	0.42
Total Phosphorus	mg/L	0.099	0.185	0.134	0.137	---	---	---	---

Station 6

Water Quality Parameters	Units	Sampling Dates							
		5/26/2009	6/1/2009	6/8/2009	6/15/2009	6/22/2009	6/29/2009	7/6/2009	7/13/2009
Enterococci	colonies/100ml	79	87	73	210	118	171	43	57
Fecal Coliforms	colonies/100ml	113	81	38	39	80	80	90	81
Nitrate-Nitrite	mg/L	0.62	0.28	0.251	0.307	0.335	0.438	0.691	0.505
Salmonella	colonies/100ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Total Coliforms	colonies/100ml	1U	1080	4000	616	1540	2930	2310	2000
Total Kjeldahl Nitrogen	mg/L	0.41	0.71	0.73	0.89	1.04	0.71	0.43	0.31
Total Phosphorus	mg/L	0.104	0.16	0.134	0.167	---	---	---	---

Station 7

Water Quality Parameters	Units	Sampling Dates							
		5/26/2009	6/1/2009	6/8/2009	6/15/2009	6/22/2009	6/29/2009	7/6/2009	7/13/2009
Enterococci	colonies/100ml	30	14	40	41	77	41	47	43
Fecal Coliforms	colonies/100ml	68	12	29	15	54	45	50	40
Nitrate-Nitrite	mg/L	0.691	0.372	0.266	0.338	0.389	0.565	0.739	0.775
Salmonella	colonies/100ml	Absent	Absent	Present	Present	Present	Present	Present	Present
Total Coliforms	colonies/100ml	1U	770	1000	308	924	462	1850	1230
Total Kjeldahl Nitrogen	mg/L	0.38	0.8	0.63	0.86	0.81	0.75	0.51	0.33
Total Phosphorus	mg/L	0.107	0.216	0.132	0.149	---	---	---	---

Station 8

Water Quality Parameters	Units	Sampling Dates							
		5/26/2009	6/1/2009	6/8/2009	6/15/2009	6/22/2009	6/29/2009	7/6/2009	7/13/2009
Enterococci	colonies/100ml	36	23	37	17	47	31	40	33
Fecal Coliforms	colonies/100ml	66	10	21	8	25	29	72	25
Nitrate-Nitrite	mg/L	0.683	0.356	0.26	0.322	0.406	0.594	0.739	0.759
Salmonella	colonies/100ml	Absent	Absent	Present	Present	Present	Absent	Absent	Present
Total Coliforms	colonies/100ml	100	800	616	400	770	1080	2000	1000
Total Kjeldahl Nitrogen	mg/L	0.38	0.73	0.94	0.89	0.65	0.88	0.61	0.4
Total Phosphorus	mg/L	0.114	0.16	0.132	0.149	---	---	---	---

Station 9

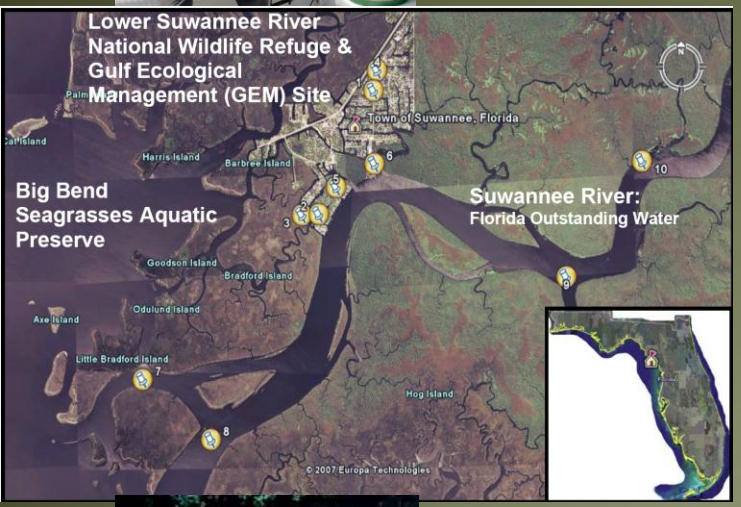
Water Quality Parameters	Units	Sampling Dates							
		5/26/2009	6/1/2009	6/8/2009	6/15/2009	6/22/2009	6/29/2009	7/6/2009	7/13/2009
Enterococci	colonies/100ml	37	15	29	19	27	22	52	43
Fecal Coliforms	colonies/100ml	47	10	11	6	23	18	63	33
Nitrate-Nitrite	mg/L	0.713	0.363	0.27	0.322	0.432	0.6	0.78	0.75
Salmonella	colonies/100ml	Absent	Absent	Absent	Present	Present	Present	Absent	Present
Total Coliforms	colonies/100ml	100	308	462	600	770	924	3080	1540
Total Kjeldahl Nitrogen	mg/L	0.32	0.77	0.78	0.91	0.71	0.75	0.36	0.45
Total Phosphorus	mg/L	0.114	0.18	0.147	0.175	---	---	---	---

Station 10

Water Quality Parameters	Units	Sampling Dates							
		5/26/2009	6/1/2009	6/8/2009	6/15/2009	6/22/2009	6/29/2009	7/6/2009	7/13/2009
Enterococci	colonies/100ml	27	11	19	10	77	17	73	48
Fecal Coliforms	colonies/100ml	33	11	10	12	56	23	99	46
Nitrate-Nitrite	mg/L	0.685	0.364	0.275	0.328	0.434	0.624	0.79	0.779
Salmonella	colonies/100ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present
Total Coliforms	colonies/100ml	100	400	200	200	1230	308	2770	616
Total Kjeldahl Nitrogen	mg/L	0.48	0.88	1.14	0.91	0.81	0.59	0.43	0.36
Total Phosphorus	mg/L	0.12	0.18	0.147	0.154	---	---	---	---

U - analyzed but not detected at the reported detection limit.
mg/L - milligrams per liter

Source: AEL, 2009; ECT, 2009.



Evaluation of Water Quality Around the Town of Suwannee, Florida, and Comparison to Historic Data Contract COQOT

Prepared for:

FLORIDA DEPARTMENT OF HEALTH

Division of Environmental Health
Bureau of Onsite Sewage Programs
Tallahassee, Florida

Prepared by:

ECT
Environmental Consulting & Technology, Inc.

3701 Northwest 98th Street
Gainesville, Florida 32606
ECT No. 081081-0300

September 2009

Project Team

- ECT
  - Larry Danek
  - Gary Dalbec
  - Shirish Bhat
  - Lee Smith
- Department of Health—Division of Environmental Health, Bureau of Onsite Sewage Programs
  - Elke Ursin
  - Eberhard Roeder
  - Paul Booher

Agenda

- Project team
- Project goals and objectives
- Project history
- Sampling plan
- 2009 results
- Comparison to 1996 results
- Conclusions
- Recommendations

Project Goal

Evaluate the impacts of closing 850 onsite sewage treatment and disposal systems (OSTDS) in the Town of Suwannee

Project Objectives

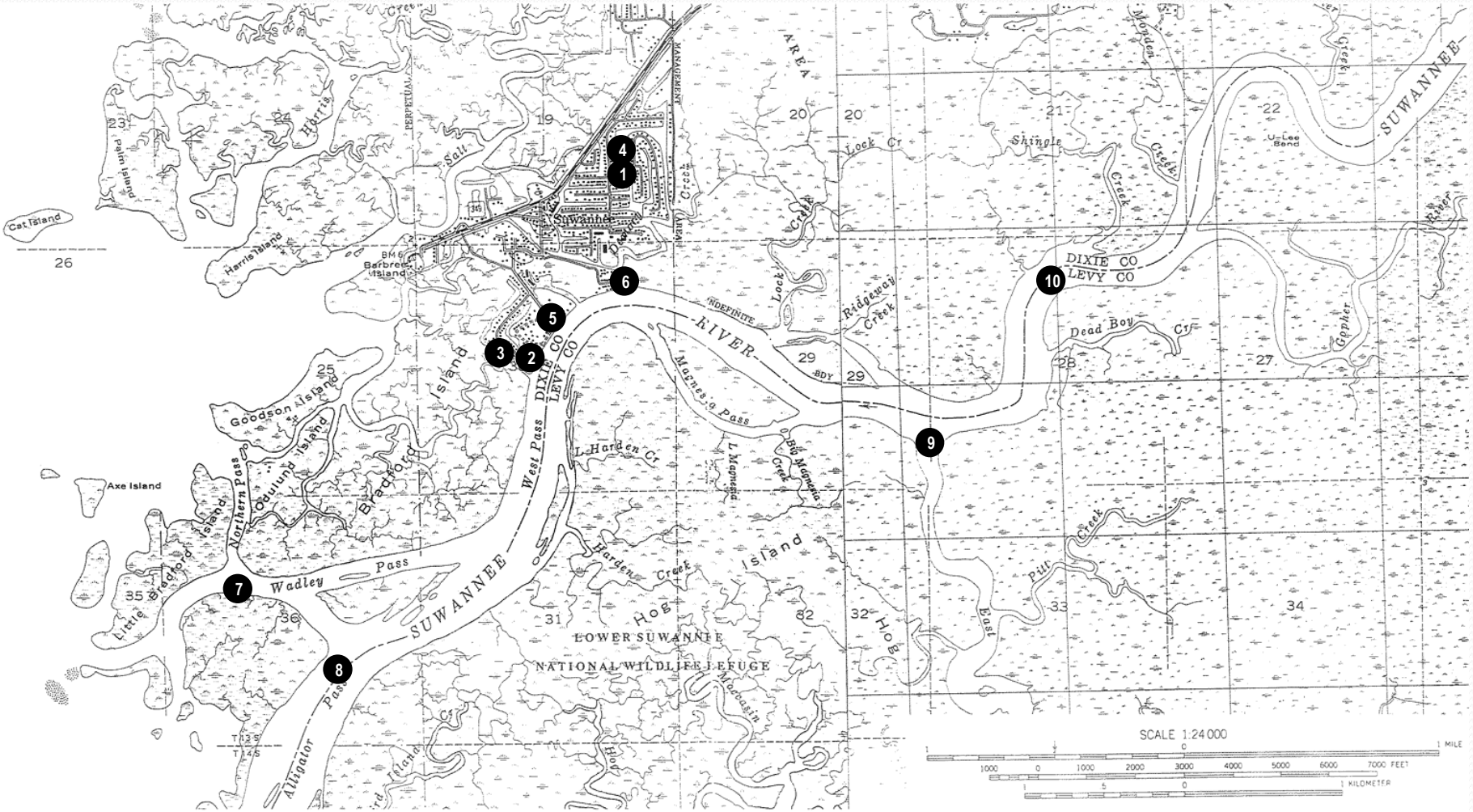
- Identify and obtain supplemental data
- Repeat the 1996 sampling protocol
- Modify the sample parameter list as necessary
- Add DNA source tracking
- Compare river stations with canal stations
- Compare the 2009 results with the 1996 results

1996
2009

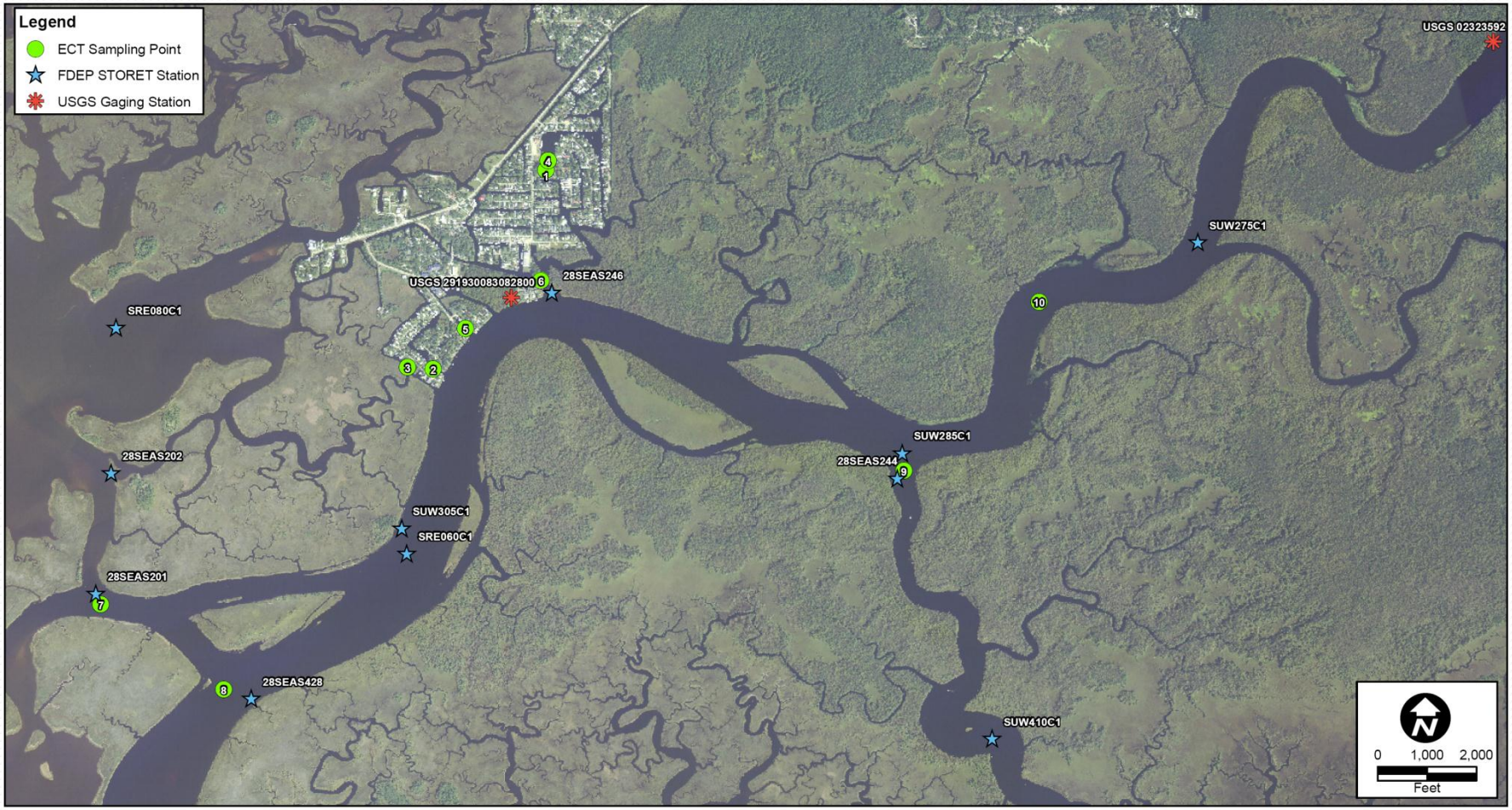
History

- Baseline study conducted in 1996
- OSTDS closed 1997 to 1998
- El niño event in 1997
- Pre- and postconstruction comparisons difficult
- Large changes observed in control stations and canal stations
- Study repeated in 2009

Sampling Plan—Locations



Sampling Plan—STORET, ECT, and USGS Stations



Sampling Plan—Stations

Station 1

Station 2

Sampling Plan—Stations

Station 3

Station 4

Sampling Plan—Stations

Station 5

Station 6

Sampling Plan—Stations

Station 7

Station 8

Sampling Plan—Stations

Station 9

Station 10

Sampling Plan—Components

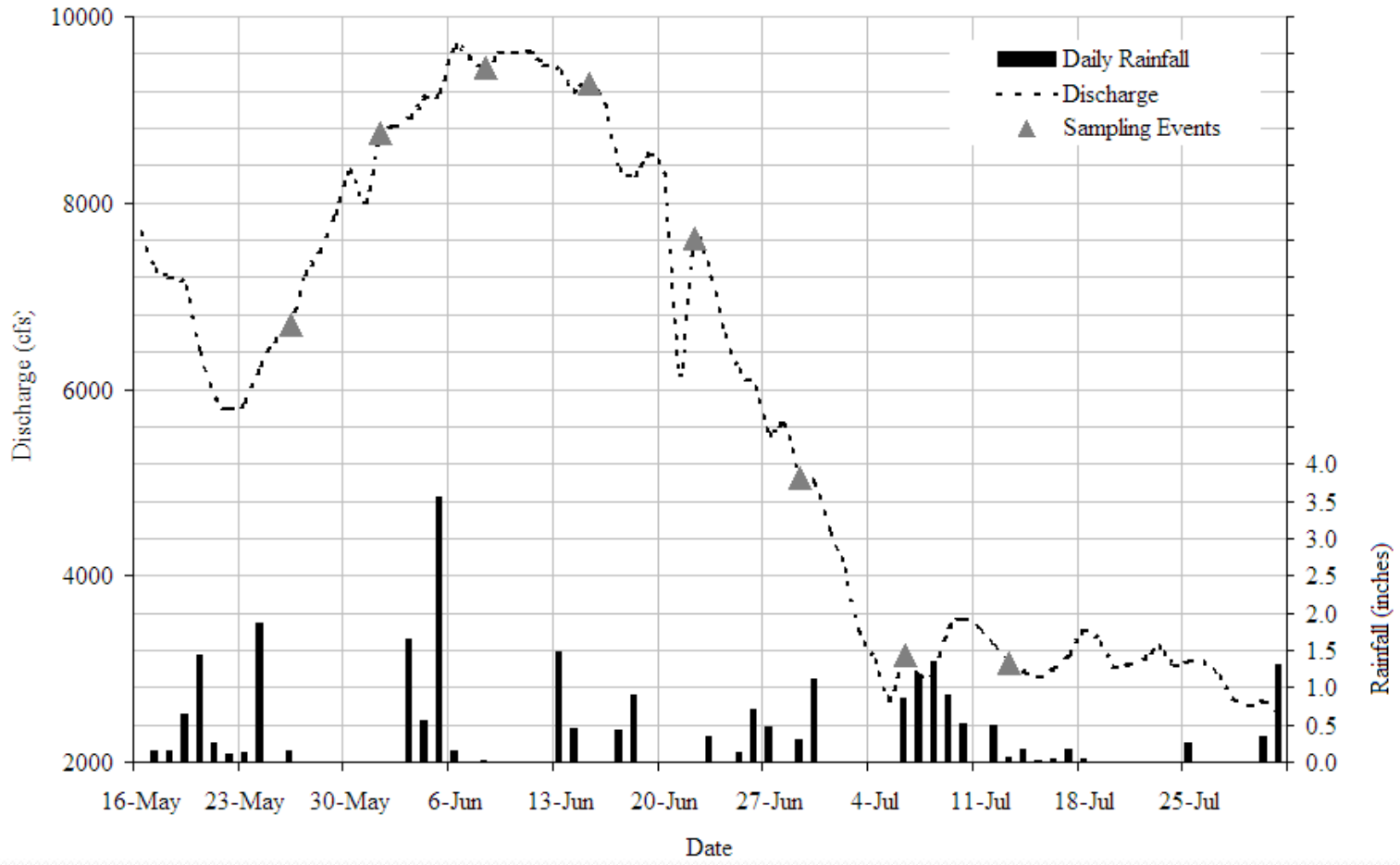
- Quality assurance project plan (QAPP)
- 10 stations: 4 river, 5 canal, 1 well
- 8 weekly events
- Sampled at low tide
- Sampled on Monday
- In situ parameters

Sampling Plan—Parameters

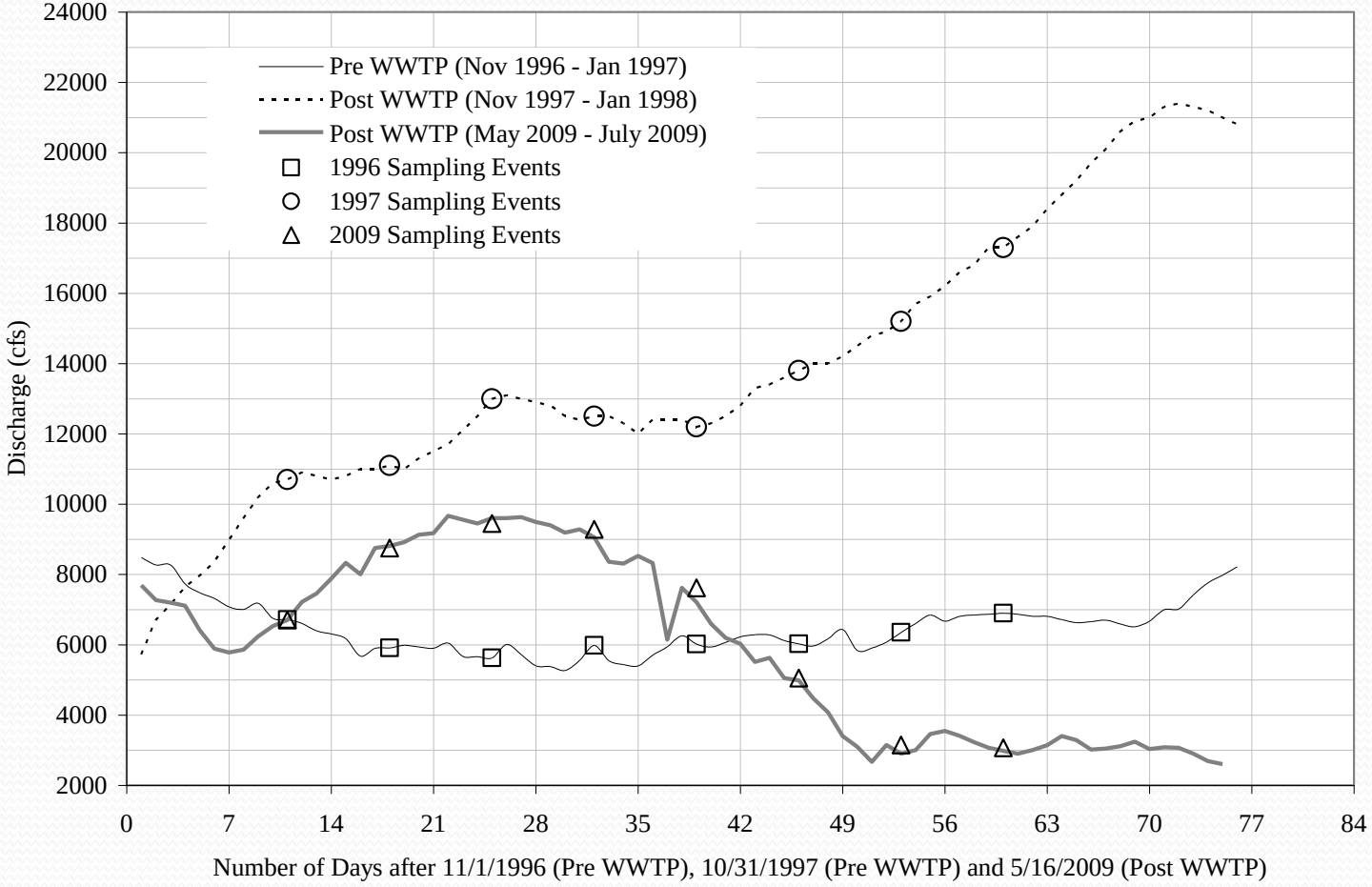
Parameter	Analytical Method
Total coliform	Standard Method 9222 B
Fecal coliform	Standard Method 9222 D
Enterococci	EPA 1600
Salmonella	Standard Method 9260 B
Nitrate + nitrite	EPA 353.2*
Total Kjeldahl nitrogen	EPA 351.2*
Total phosphorus	EPA 365.1
DNA source tracking	Human Enterococci identification

*Revision 2.0, 1993.

2009 Results—Flow, Daily Rainfall, and Sampling Events



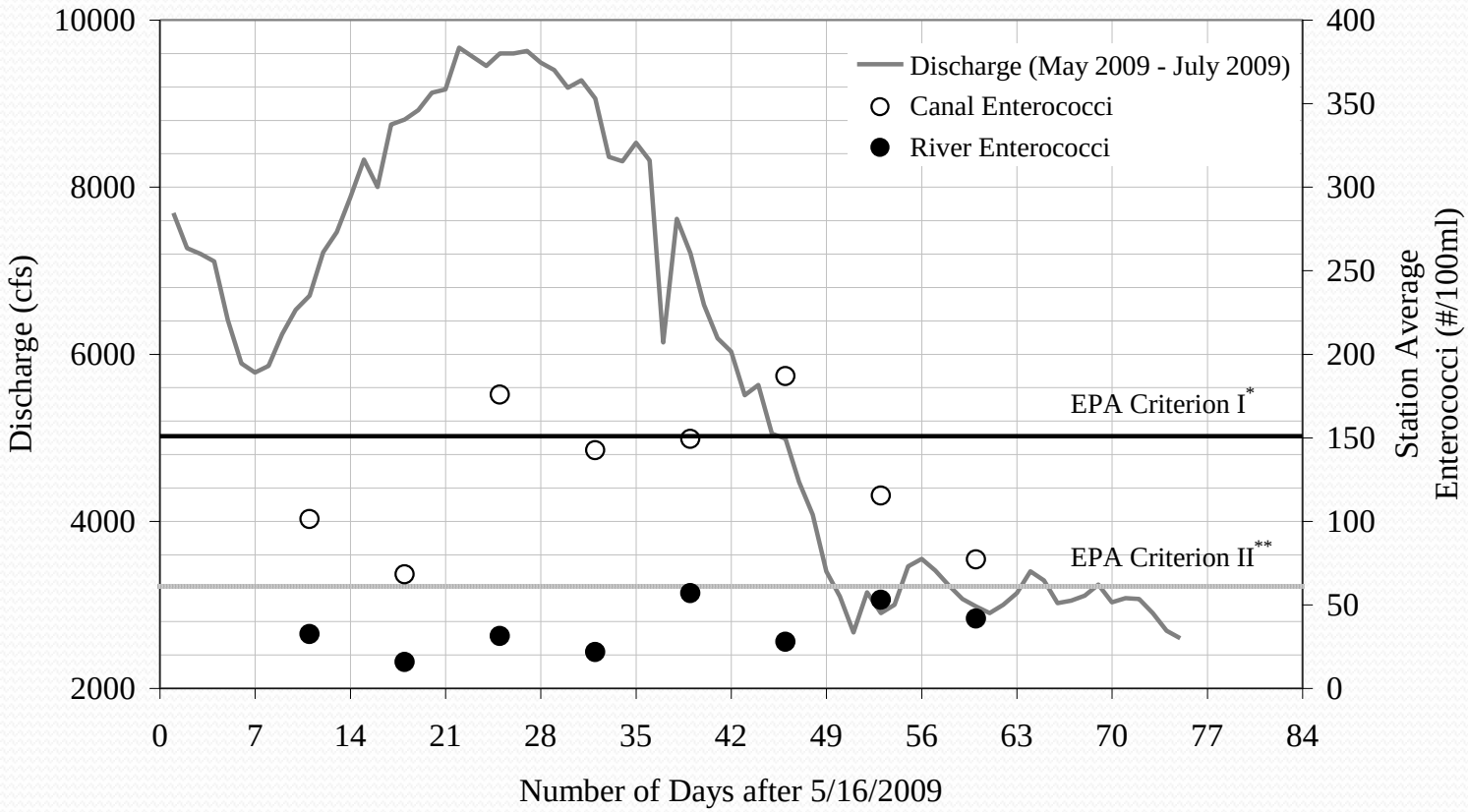
2009 Results—Discharges and Sampling Events (1996, 1997, and 2009)



2009 Results—Water Quality Parameters

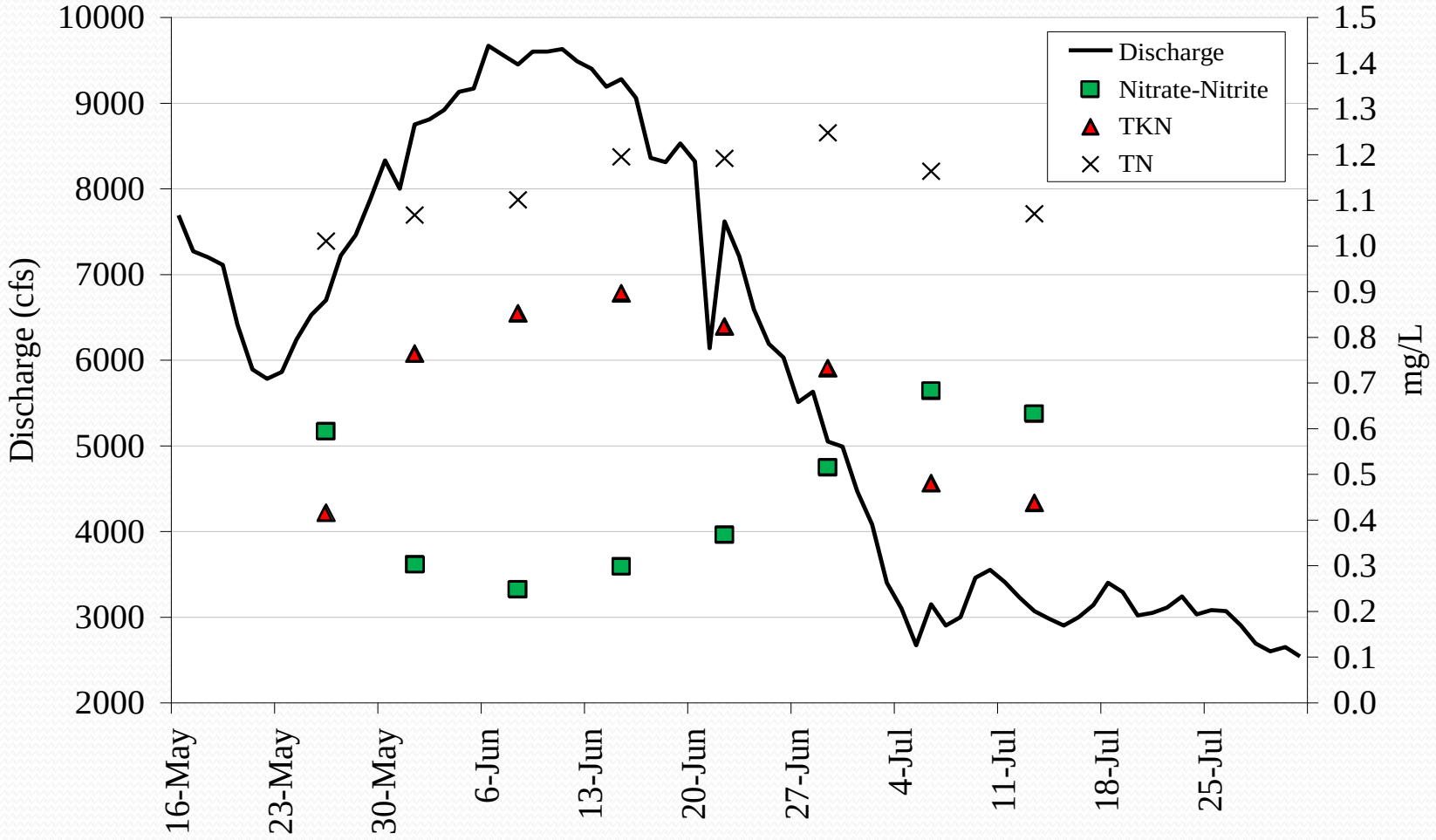
Parameters	Size	Average	Standard Deviation	Maximum	Minimum
Canal Stations					
Total coliform (col/100 mL)	40	1,373	1,156	4,160	1 U
Fecal coliform (col/100 mL)	40	89	76	380	26
Enterococci (col/100 mL)	40	73	79	240	8
Salmonella		Present 22.5% of time (9 out of 40)			
Total phosphorus (mg/L)	20	0.135	0.029	0.185	0.084
Total Kjeldahl nitrogen (mg/L)	40	0.69	0.22	1.04	0.31
Nitrate + nitrite (mg/L)	40	0.39	0.2	0.71	0.01
Total nitrogen (mg/L) (calculated)	40	1.07	0.15	1.38	0.67
River Stations					
Total coliform (col/100 mL)	32	841	738	3,080	1 U
Fecal coliform (col/100 mL)	32	33	23	99	6
Enterococci (col/100 mL)	32	35	18	77	10
Salmonella		Present 46.8 of time (15 out of 32)			
Total phosphorus (mg/L)	16	0.149	0.029	0.216	0.107
Total Kjeldahl nitrogen (mg/L)	32	0.66	0.22	1.14	0.32
Nitrate + nitrite (mg/L)	32	0.52	0.19	0.79	0.26
Total nitrogen (mg/L) (calculated)	32	1.19	0.12	1.47	0.9
Monitoring Well					
Total coliform (col/100 mL)	8	1,690	2,202	6,000	200 U
Fecal coliform (col/100 mL)	8	22	32	90	1 U
Enterococci (col/100 mL)	8	428	730	2100	1 U
Salmonella	8	Present 50% of time (4 out of 8)			
Total phosphorus (mg/L)	4	0.581	0.293	1.01	0.374
Total Kjeldahl nitrogen (mg/L)	8	1.25	0.75	2.95	0.54
Nitrate + nitrite (mg/L)	8	0.06	0.06	0.17	0.01
Total nitrogen (mg/L) (calculated)	8	1.31	0.74	3.02	0.55

2009 Results—Weekly Average Enterococci



* Single sample maximum allowable Enterococci density for infrequently used full body contact recreation for freshwater (EPA, 1986)
** Single sample maximum allowable Enterococci density for the designated beach area (EPA, 1986)

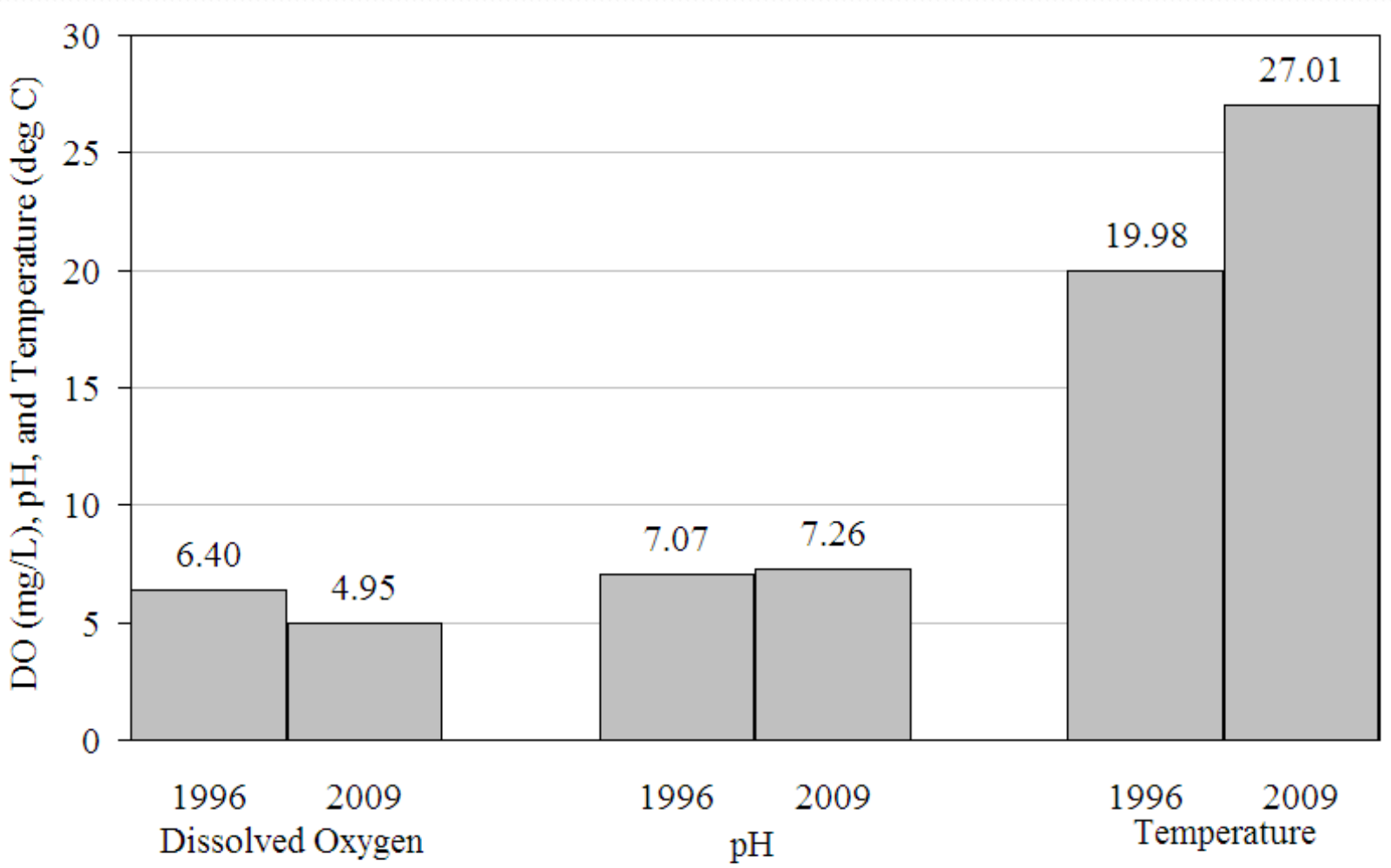
2009 Results—Variation of Nutrients



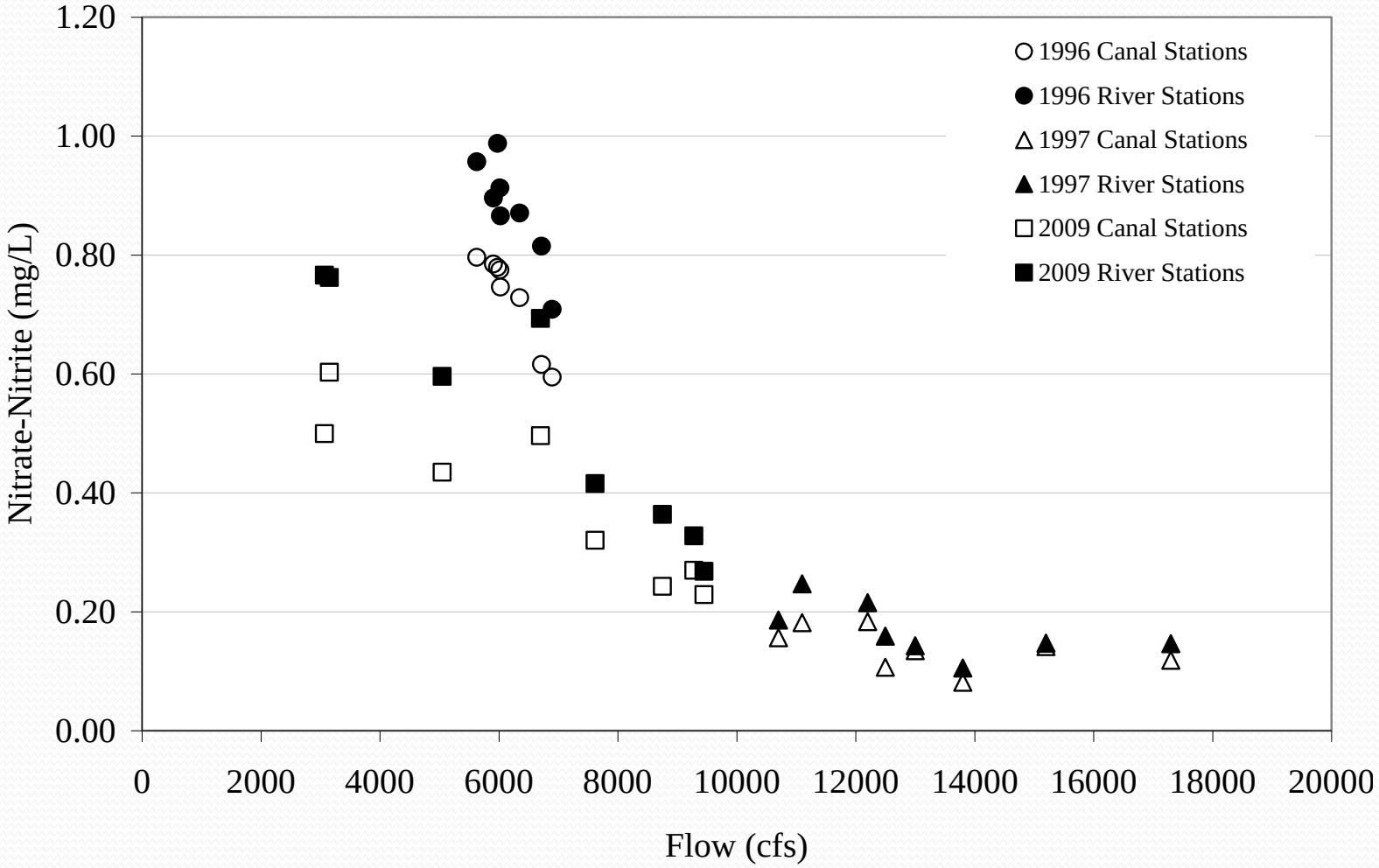
2009 Results—DNA Source Tracking Analyses Results

Station Number	DNA Analytical Results for Sampling Weeks (for Human DNA)				Percent Positive (Within Station)
	5	6	7	8	
2	Negative	Negative	Positive	Negative	25
5	Negative	Positive	Negative	Positive	50
10	Negative	Positive	Negative	Positive	50
Percent positive (among stations)	0	67	33	67	

Comparison to 1996 Results—In Situ Data



Comparison to 1996 Results—Nitrate + Nitrite



Comparison to 1996 Results—Changes in Average Concentrations

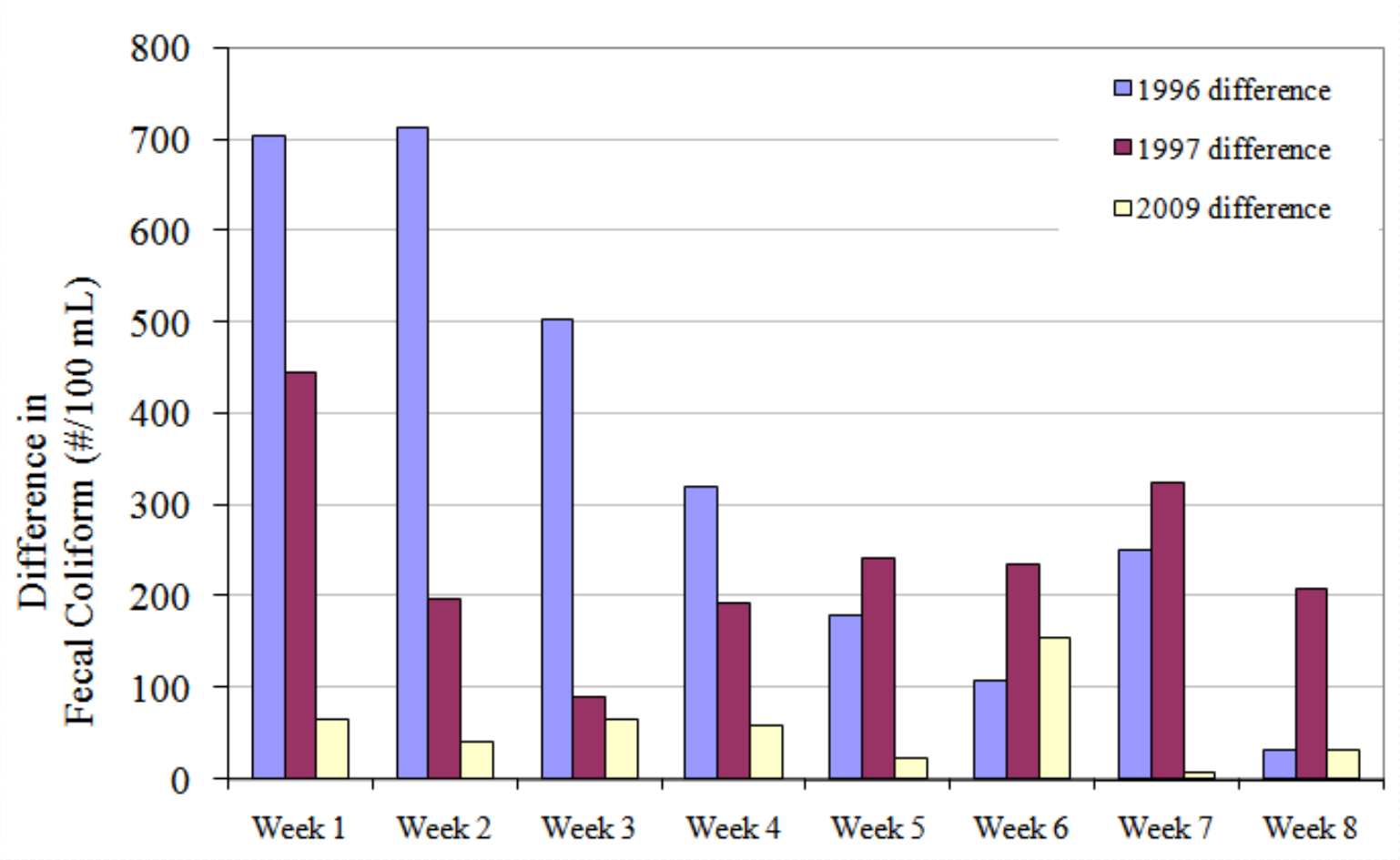
Water Quality Parameters	River Stations			Canal Stations			Overall		
	1996	2009	Percent Change	1996	2009	Percent Change	1996	2009	Percent Change
Fecal coliform	134	33	-75	485	89	-82	309	61	-80
Total coliform	170	841	394	537	1401	161	354	1121	217
Nitrate + nitrite	0.88	0.52	-40	0.73	0.39	-47	0.80	0.46	-43
TKN	0.39	0.66	71	0.41	0.69	68	0.40	0.68	69
Total nitrogen	1.26	1.19	-6	1.14	1.07	-6	1.20	1.13	-6

Comparison to 1996 Results—Statistical Tests for Difference Between Water Quality Parameters

Parameters	Value* ± Standard Error		Statistical Test
	1996	2009	
Canal Stations			
Fecal coliform	350† ± 82	65† ± 12	Wilcoxon Signed Rank test, p <0.001
Total coliform	350† ± 83	1000† ± 183	Paired t- test, p <0.001
Nitrate + nitrite	0.75† ± 0.02	0.35† ± 0.03	Wilcoxon Signed Rank test, p <0.001
TKN	0.37† ± 0.02	0.72† ± 0.03	Paired t- test, p <0.001
Control Stations			
Fecal coliform	48† ± 31	27† ± 4	Wilcoxon Signed Rank test, p <0.01
Total coliform	60† ± 35	693† ± 130	Paired t- test, p <0.001
Nitrate + nitrite	0.88† ± 0.02	0.50† ± 0.03	Wilcoxon Signed Rank test, p <0.001
TKN	0.40† ± 0.02	0.72† ± 0.04	Paired t- test, p <0.001

*For Wilcoxon Signed Rank tests, values are medians; for Paired t- tests, values are means.
†Indicates significant differences between water quality parameter values between 1996 and 2009.

Comparison to 1996 Results—Difference in Fecal Coliform Concentrations (Canal – River)



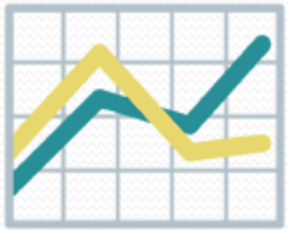
Comparison to 1996 Results—Differences in River and Canal Stations

Parameters	1996		2009		P*
	Mean	Standard Deviation	Mean	Standard Deviation	
Fecal coliform	351	262	56	45	0.017†
Total coliform	367	259	559	654	0.502
Nitrate + nitrite	-0.149	0.038	-0.137	0.075	0.732
TKN	0.025	0.095	0.026	0.075	0.993
Total nitrogen	-0.124	0.120	-0.111	0.085	0.856

*Probability of being incorrect in concluding there is a true difference between the groupings.
†Significant difference.

Conclusions

- Salmonella occurrences were higher in the river than in the canals. The occurrences of salmonella in 2009 were slightly higher than 1996.
- Nitrate + nitrite exhibited a strong correlation with river flow. There was consistently more nitrate + nitrite in the river samples than in the canals.
- The source tracking results indicated human material was present approximately 42 percent of the time and approximately equally present in the canals and the river.
- The total and fecal coliforms were much higher in the canals than in the river. The fecal coliforms decreased from 1996 to 2009, whereas the total coliforms increased.
- Simple statistical comparison of the 2009 results with the 1996 results were complicated by large changes in the river (control) stations.
- There was a significant reduction in fecal coliforms in the canals as compared to the river stations from 1996 to 2009.
- There was no large improvement in water quality in the canals between 1996 and 2009 that could be attributed to closing the OSTDS.



Recommendations

- Seasonal and river flow variability complicated the impact analysis
- Large variations in the river (control) stations masked the changes in the canal (test) stations
- Repeat the study in November/December to decrease the environmental variables
- Repeat the parameter list
- Additional study would provide:
  - Comparison 1996 preconstruction data under similar environmental conditions
  - Comparison of winter conditions with the 2009 summer conditions