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

DATE AND TIME: **January 4, 2012 at 10:00 a.m. ET**

PLACE: Florida Department of Health Southwood Complex
4042 Bald Cypress Way, Room #240P
Tallahassee, FL 32399

Or via conference call / web conference:
Toll free call in number: 1-888-808-6959
Conference code: 7427896255
Website: http://connectpro22543231.na5.acrobat.com/rrac/

This meeting is open to the public

AGENDA: FINAL

1. Introductions and Housekeeping
2. Review Minutes of Meeting November 15, 2011
3. Nitrogen Study Update
4. Update on 319 Grant: Performance of Advanced Onsite Sewage Treatment and Disposal Systems
5. Other Business
6. Public Comment
7. Closing Comments, Next Meeting, and Adjournment

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

Draft Minutes of the Meeting held at the Southwood Office Complex, Tallahassee, FL
November 15, 2011

In attendance:

- **Committee Members and Alternates:**
  - **In person:**
    - Carl Ludecke (vice-chairman, member, Home Building Industry)
    - Mike McInarnay (alternate, Septic Tank Industry)
    - Bill Melton (member, Consumer)
    - Clay Tappan (chairman, member, Professional Engineer)
  - **Via teleconference:**
    - Quentin (Bob) Beitel (alternate, Real Estate Profession)
    - Kim Dove (member, Division of Environmental Health)
    - Tom Higginbotham (alternate, Division of Environmental Health)
    - Kriss Kaye (alternate, Home Building Industry)
    - Tom Miller (member, Local Government)
    - Eanix Poole (alternate, Consumer)
    - David Richardson (alternate, Local Government)
    - John Schert (member, State University System)
  - **Absent members and alternates:**
    - Wayne Crotty (alternate, Septic Tank Industry)
    - John Dryden (alternate, State University System)
    - Bob Himschoot (member, Septic Tank Industry)
    - Jim Peters (alternate, Professional Engineer)
    - Environmental Interest Group (no appointed member/alternate)
    - Restaurant Industry (no appointed member/alternate)
- **Visitors:**
  - **In person:**
    - Damann Anderson (Hazen and Sawyer)
    - Roxanne Groover (FOWA)
    - Keith Hetrick (FHBA)
    - Richard Hicks (DEP)
    - Steve Meints (FOWA)
    - Lee Smith (ECT)
  - **Via teleconference:**
    - Sonia Cruz (FEHA)
    - Sara Fowler
    - Woo-Jun Kang
    - Kathryn Lowe (CSM)
    - Maria Pecoraro (Rep. Nelson)
    - Andrea Samson
    - Pam Tucker
- **Department of Health (DOH), Bureau of Onsite Sewage Programs:**
  - **In person:**
    - Gerald Briggs, Bureau Chief
    - Kara Loewe, Distributed computer Systems Consultant
    - Eberhard Roeder, Professional Engineer
    - Elke Ursin, Environmental Health Program Consultant
  - **Via teleconference:**
    - Ed Williams, Environmental Health Program Consultant

1. **Introductions** – Eight out of ten groups were present, representing a quorum. The groups that were not represented were the Environmental Interest Group and the Restaurant Industry which are both vacant groups. Chairman Tappan called the meeting to order just after 10:00 a.m. Introductions were made and some housekeeping issues were discussed.

   Changes to the committee since the last meeting were that Patti Sanzone and Sam Averett, who have both been with the RRAC for a long time, have left the committee. Wayne Crotty is replacing Sam Averett as the alternate for the Septic Tank Industry and a letter has been sent to the Sierra Club requesting that a new member and alternate be recommended for appointment. Quentin Beitel asked that the department contact the Florida Restaurant and Lodging Association again to see if there is any interest in having someone fill the vacant position. The groups that have terms expiring in January 2012 are the Department of Health, the Septic Tank Industry (which have already sent in their nominations), and the Environmental Interest Group.

   Motion by Bill Melton, seconded by Quentin Beitel, to send a letter of thanks to Patti Sanzone and Sam Averett for all the hard work they have done over the years. All were in favor with none opposed and the motion passed unanimously.

2. **Review of previous meeting minutes** – The minutes of the September 8, 2011 meeting were reviewed.

   Motion by Bill Melton, seconded by John Schert, to approve the minutes as presented. All were in favor with none opposed and the motion passed unanimously.

3. **Nitrogen Study**

   a) **Funding Update** – Elke Ursin stated that one of the reasons this meeting was scheduled was to make sure that RRAC understands what the current funding needs are for this project and to get everyone on the same page. Elke Ursin presented an update on what has happened since the September meeting. There was a TRAP meeting on October 11, 2011 where Elke Ursin presented an update on the nitrogen study. TRAP moved to write a letter to the legislature to request the funding needed to finish the project. Gerald Briggs presented an update on the study on November 10, 2011 at the Wekiva Commission meeting and they are going to write a letter in support of the project as well. Gerald Briggs gave an update on the funding to the committee. He mentioned a letter that Damann Anderson mailed to the Department and the committee members, and that in this letter there was a request for the Department to guarantee the funding for the project. He stated that there is no way for the Department to guarantee the funding because the state works on a year to year budget. Even if all of the cash were in the bank today there would be still be the possibility of a sweep of that trust fund. The Department is dependent on Legislative action every year for both cash allocation and budget appropriation. He outlined the funding history of the project with the first funding year in 2008 being $1,000,000 from DEP's trust fund to DOH's Grants and Donations Trust Fund, which was later reduced to $900,000. Then $2,000,000 of cash and budget was transferred to DOH in 2010. The 2011 appropriation gave budget authority but no additional cash. There is sufficient cash and sufficient budget authority for this fiscal year (end June 2012). The remaining funding will need to be addressed in the Legislature, as it has been done in previous years. Elke Ursin explained why the appropriation amount of $2,725,000 is different from the requested funds of $2,200,000. The extra $525,000 was carry-over funds that were estimated to not be spent as of August of

2010 when the legislative budget proposals were drafted. Staff members have worked with Keith Hetrick on a spreadsheet that has been provided to the budget office downtown, and the Department's budget office has sent a spreadsheet showing the breakdown of funds in the Grants and Donations Trust Fund. The spreadsheet showing the breakdown of funds in the Grants and Donations Trust Fund was passed out and posted online during the meeting. Gerald Briggs stated that the Legislative Progress Report that is to be discussed later during the meeting will be the vehicle for the Department to tell the Legislature where they are with the study and what funding is needed so that they can respond during the legislative session. Quentin Beitel asked who determines how the funds from the Grants and Donations trust fund are spent and Gerald Briggs stated that much of it is outlined in the Florida Statutes. Maria Pecoraro said that Chairman Constantine stated that in his conversations with the Appropriations Chair in the Senate that the funds would be allocated in an appropriate manner and that the study will have the money it needs to complete the final tasks. Damann Anderson stated that it is difficult for him to subcontract work for this project not knowing if the funds will be available. Maria Pecoraro stated that Damann's group contracted with the state and the state operates on a year to year budget. She also stated that this is a high priority project for several members of the Legislature and the Governor is interested in the results of this study, so that the funding will likely not be taken away. Gerald Briggs stated that the Legislative Progress Report requests that the remaining $2.2 million cash be put into the trust fund. Maria Pecoraro stated that this specification needs to be made in the report and she also suggested that RRAC writes a letter to the legislature outlining the problems with the current budget authority process and addressing why a cash allocation is needed. Gerald Briggs stated that the trust fund cash issue was sent downtown last week to Brian Clark with the Healthcare Appropriation Subcommittee in the House. Bill Melton asked whether the misunderstanding was that there was money in the trust fund that could be absorbed from other areas and used for this project. Gerald Briggs stated that he did not know for sure but that they may have looked at the balance of the trust fund and felt that there were sufficient dollars in there to cover this project. The table that was sent downtown showing how the money is split out in the trust fund included several accounts that are restricted. This leaves less than $1 million as non-restricted, and these dollars fund programs such as the Safe Drinking Water Act, biomedical waste programs, contractor registration, and other programs.

Carl Ludecke made a motion, seconded by Mike McInarnay, to have RRAC write a letter outlining the following points:

1. **RRAC's continued support for the project.**
2. **That the project is and has been going on now for slightly under three years.**
3. **That it is a three to five year project.**
4. **That the project was initially scoped at $5 million.**
5. **That the project is on schedule (for the most part, but for cash authorization delays) and within budget.**
6. **That the RRAC supports concluding this study as originally scoped.**
7. **That the one-year non-recurring approach to funding this project has caused delays in progress and is inefficient.**
8. **That the Legislature should find a way or use a mechanism to set-aside the remaining amount of money (i.e. $2.2 million) needed to concluded the project overall, over the next two fiscal years.**

There was a discussion on how long it might take to get this letter out, and there is a target date of the week of December 5, 2011. The thought is that these points will be incorporated into the executive summary of the progress report. All were in favor, none opposed, and the motion passed.

b) **Discussion on Legislative Progress Report** – Two versions of the report were sent out to RRAC members in their meeting packets: one with the tracked changes from the last Legislative report, and a version with the changes accepted. The committee discussed several edits to the document. Maria Pecoraro asked that a list be included in the report of the items that will have a cost breakdown. She also asked on whether there are any patents on the materials that are being used and Damann Anderson said that there were patents on some of the proprietary technologies, but he did not know of any on the materials themselves. Eberhard Roeder stated that there are several related patents that overlap with each other, and he does not know where this project fits into this. To fully answer this question will require consultation with a patent attorney.

Bill Melton made a motion, seconded by Carl Ludecke, for staff to make the changes to the Legislative Progress Report on the Nitrogen Reduction Strategies Study as discussed during the meeting, email the revised version of the report to RRAC, and route the document to executive staff for final approval. All were in favor, none opposed,

4. **Update on 319 Grant: Performance of Advanced Onsite Sewage Treatment and Disposal Systems** – Elke Ursin gave an update on the project. This project is to assess water quality protection by advanced (ATU, PBTS, etc.) throughout Florida. An amendment was executed in September 2011 which updated the budget spreadsheet. The grant period is now over, having ended on September 30, 2011. The final invoice and final progress report will be sent to DEP in the next week or so once all of the payments have cleared. Both Elke Ursin and Eberhard Roeder discussed some of the results for Task 1, which was a study to characterize the variability of grab samples over the course of a day, compare grab and time-composite samples, and to assess the variability of results between repeat visits for a selection of systems in Monroe County. Comments on the draft Task 1 report should be sent to Elke Ursin by November 22nd. The report will be finalized by November 30th and will include sections for the executive summary, discussion, results and conclusions, references, and appendices. Elke Ursin presented on the progress that has been made on the remaining tasks associated with this project. The database task is complete with 16,595 identified advanced systems. The database description has been developed, summary statistics will be finalized, and will be submitted by November 30th. The survey of interest groups task has been completed and has been discussed at previous meetings. The sampling task has been completed as well. There was a final sample size of 1,014 systems. Approximately 600 systems have had a final permit review done, with still quite a bit of review remaining to be done. There were samplers from Charlotte, Lee, Monroe, Volusia, and Wakulla counties. Elke Ursin stated that samplers that worked on this project were extremely helpful and she stated that this project would not have been possible without their help and they all did a great job. A total of 554 systems were sampled, with 28 of them sampled twice, and 2 were sampled 3 times. A total of 644 samples were taken from various points along the treatment train and analyzed by the lab for various parameters (alkalinity, cBOD5, TKN, Nitrate-Nitrite, TSS, TN, and TP). A total of 252 fecal samples were taken and analyzed. Detailed field evaluations were performed at each sample site. There is a task looking at management practices that is currently ongoing. A database was created

linking program evaluations over the past ten years with the survey results for regulators and system owners/users. There will also be links made between the county program evaluation, county survey information, and the sample results. Analysis on this has begun, and will be completed and summarized in the final task report and in a case study booklet format. The final project report is anticipated to be written after all the data entry and data analysis has been completed. The draft report will be presented to the RRAC for review prior to finalization and submission to DEP.

5. **Other Business** – During the October 11, 2011 TRAP meeting, the TRAP voted to approve the 2011 RRAC research priorities. Elke Ursin stated that work on these priorities, as well as work on the Alternative Drainfield Products project, will begin once the 319 project has been completed.

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

7. **Closing Comments, Next Meeting, and Adjournment** – Potential dates for the next RRAC meeting were discussed. Upcoming meeting topics are and update on the nitrogen study and a discussion on the 319 grant report on the performance of advanced OSTDS in Florida. Quentin Beitel suggested having another RRAC meeting before the legislative session in January. January 4^{th} and 5^{th} were discussed as possible dates. Elke Ursin will send an email out to the RRAC members to determine the date that works for the most people.

Bill Melton made a motion, seconded by Carl Ludecke, to adjourn at 1:21 p.m. All were in favor, none opposed, and the motion passed.

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

Approved Minutes of the Meeting held at the Southwood Office Complex, Tallahassee, FL
January 4, 2012

In attendance:

- **Committee Members and Alternates:**
  - **In person:**
    - Craig Diamond (member, Environmental Interest Group)
    - Carl Ludecke (vice-chairman, member, Home Building Industry)
    - Bill Melton (member, Consumer)
    - Eanix Poole (alternate, Consumer)
  - **Via teleconference:**
    - Quentin (Bob) Beitel (alternate, Real Estate Profession)
    - Taylor Brown (alternate, Division of Environmental Health)
    - Wayne Crotty (member, Septic Tank Industry)
    - Susan McKinley (alternate, Restaurant Industry)
    - David Richardson (alternate, Local Government)
    - John Schert (member, State University System)
  - **Absent members and alternates:**
    - Paul Davis (member, Division of Environmental Health)
    - John Dryden (alternate, State University System)
    - Tom Higginbotham (alternate, Division of Environmental Health)
    - Bob Himschoot (alternate, Septic Tank Industry)
    - Kriss Kaye (alternate, Home Building Industry)
    - Tom Miller (member, Local Government)
    - Jim Peters (alternate, Professional Engineer)
    - Geoff Luebkemann (member, Restaurant Industry)
    - Clay Tappan (chairman, member, Professional Engineer)
- **Visitors:**
  - **Via teleconference:**
    - Damann Anderson (Hazen and Sawyer)
    - Josefin Hirst (Hazen and Sawyer)
    - Mary Howard (Seminole CHD)
    - Maria Pecoraro (Rep. Nelson)
    - Patti Sanzone (DEP)
    - Maurice Tobon
    - Pam Tucker
- **Department of Health (DOH), Bureau of Onsite Sewage Programs:**
  - **In person:**
    - Eberhard Roeder, Professional Engineer
    - Elke Ursin, Environmental Health Program Consultant

1. **Introductions** – Nine out of ten groups were present, representing a quorum. The group that was not represented was the Professional Engineers. Vice-Chairman Ludecke called the meeting to order at 10:05 a.m. Introductions were made and some housekeeping issues were discussed.

   Changes to the committee since the last meeting were that Craig Diamond is the new member for the Environmental Interest Group, Wayne Crotty is the new member and Bob Himschoot is now the alternate for the Septic Tank Industry, Paul Davis is the new member with Tom Higginbotham and Taylor Brown as the alternates for the Florida Department of Health, and Geoff Luebkemann is the new member with Susan McKinley as the alternate for the Restaurant Industry. Kim Dove, the Department of Health member, and Mike McInarnay, the Septic Tank Industry alternate have both left the committee and thank you letters have been sent from the Department of Health. Thank you letters from the RRAC were sent to Patti Sanzone and Sam Averett, per a motion at the last RRAC meeting.

2. **Review of previous meeting minutes** – The minutes of the November 15, 2011 meeting were reviewed.

   Motion by Bill Melton, seconded by Susan McKinley, to approve the minutes as presented. All were in favor, with Craig Diamond abstaining, and none opposed and the motion passed unanimously.

3. **Nitrogen Study Update** – Elke Ursin presented an update on the status of the letters of support for the nitrogen study. She stated that a support letter was drafted and sent to Lee Constantine, the Chairman of the Wekiva River Basin Commission. The Technical Review and Advisory Panel sent a letter of support to Senator Alexander, Speaker Cannon, Representative Grimsley, President Haridopolos, Senator Hays, Representative Hooper, Representative Hudson, Senator Negron, and Representative Williams on January 3, 2012. The RRAC letter of support is being drafted by Clay Tappan. Elke Ursin also stated that a presentation by Damann Anderson has been accepted on the nitrogen study at the University of Florida Water Institute Symposium on February 16, 2012. The Legislative Progress Report on the nitrogen study was sent on December 21, 2011 to the Governor, Speaker of the House, and President of the Senate. Quentin Beitel complimented the staff for putting this report together on a timely basis. Damann Anderson presented on some of the progress on the study since the last RRAC meeting in November. The last sampling event has been completed for the mound system at the Gulf Coast Research and Education Center (GCREC). Analysis of the data will show the soil and groundwater fate and transport of nitrogen around the existing mound system. A literature review was completed and data set specifications were made for a simulation model of bioreactor filtration treatment of onsite wastewater. This model will predict the performance of the tank-based systems tested at GCREC under the Passive Nitrogen Removal II (PNRS II) study. Design and construction has been completed for the passive in-situ in-ground test systems at the GCREC test facility. Damann Anderson went over some details on the construction of the soil and groundwater test facility. He stated that the PNRS II tank-based systems that were at the GCREC test facility have been tested and they are in the process now of developing the criteria to design those type of systems to be installed at individual homes. The next phase of work at the GCREC facility was to look at in-ground systems which are more of a drainfield system for passive nitrogen removal where nitrification occurs in one layer of soil and denitrification occurs in another. Two pilot scale in-ground systems have been constructed for testing. They are also developing test criteria to install these types of systems at individual homes. Also, four different in-situ systems were built to look at groundwater fate and transport of nitrogen. With these four systems they are looking at the difference between drainfields receiving nitrified

effluent versus conventional septic tank strength effluent as well as the difference between receiving drip irrigation versus a gravel trench. Josefin Hirst went through the soil and groundwater test facility construction progress report showing several photos of the construction. Damann Anderson explained how the pilot scale in-ground systems are constructed. There is nitrification expected to occur in the sand above the liner, then there is a layer of lignocellulosic and sand on the liner which is where some saturation occurs and the wastewater collects at the bottom of the liner and goes into a pipe which flows into a tank that is filled with sulphur and effluent for denitrification. The final denitrified effluent flows out of the tank into an Infiltrator chamber. Craig Diamond asked what the anticipated life-span is of the ligno material and Damann Anderson stated that that is one of the questions to be answered with the research but the hope is to design a system that will work for 15-20 years. Carl Ludecke asked whether this in-ground system could be installed under a drainfield in a non-mounded situation and Damann Anderson stated that if the groundwater is deeper this could be installed without a mound. Carl Ludecke stated that he wanted to make it clear that there is a simpler way to install these systems but that what Damann and his group are working on now is testing and developing the criteria for these in-ground systems. Eanix Poole asked how deep the ligno material was and Damann Anderson stated that the liner is a "V" shape, so the depth is variable but is about 10-12 inches in the middle tapering off at the outside edges. Damann Anderson stated that they have made good progress on this and that this will yield interesting results. In the next month or two they will be ready to install tank-based systems at homes sites now that the pilot testing has been done. Carl Ludecke stated that it is important for everyone to understand how far this project has come along. Quentin Beitel asked whether there is a no-pump passive system at the facility and Damann Anderson stated that there is no way to do that at the facility because of the groundwater but that one will be installed at an actual home site.

4. **Update on 319 Grant: Performance of Advanced Onsite Sewage Treatment and Disposal Systems** – Elke Ursin gave an update on the project. This project is to assess water quality protection by advanced (ATU, PBTS, etc.) systems throughout Florida. The grant period is now over, having ended on September 30, 2011. The final invoice and final progress report has been sent to DEP. Final reports have been submitted for the Monroe Diurnal and Seasonal Variability of Advanced Systems as well as the final report on the Database of Advanced Systems outlining the database development, database structure, and summary statistics.

   The executive summary of the Monroe County report was included in the presentation but not discussed in great detail as most of this had been discussed at the November meeting, had been sent to the RRAC, and is posted online. Eanix Poole complimented staff for a nice job on this report. Quentin Beitel asked if there has been any feedback from the agencies that received the report and Patti Sanzone stated that the report was submitted to EPA last Friday and that the study was done for DOH's information and there was no expectation that EPA or DEP will come back with comments. Craig Diamond asked if this report will be shared with the Areas of Critical State Concern Program and DOH staff indicated that that would be a good idea and will send it to them. Eanix Poole brought up an observation he made while reading this report along with another report done in Wakulla County by DEP and FSU. He sees that very few systems are meeting the nitrogen and phosphorus standards that are enacted by local governments. He was wondering how the RRAC should respond to that as it involves so many different interest groups. He stated that these systems should meet the nutrient standards that they are expected to meet and are not. Damann Anderson stated that a lot of reports, not just in Florida, are showing the same thing: that the systems are not performing in the field. He stated that there are lots of issues and it is expensive to address. That is one of the reasons he is in favor of passive systems. Eanix Poole stated that the strength of the waste in the field is higher than NSF testing strength. Damann Anderson stated that the performance standard has to be measured and there is no real requirement to monitor these systems. He suggests monitoring quarterly for the first year and if the result is not in compliance then do more monitoring. This will weed out the systems that do not work. If the results are in compliance, then the monitoring requirement could be reduced. Bill Melton stated that sampling used to be a requirement but was taken out. Damann Anderson stated that it is very difficult to get the more complicated nutrient reducing systems to work without monitoring. He said that people will be spending a lot of money and will not get the results. Eb Roeder stated that the cost of these advanced system is variable, they are often less than $10,000 in Wakulla. One of the questions this study hopes to answer is whether it is the technology that is the problem or whether it is the usage of the systems, for example when they are turned off. He stated that the systems that are working remove three-quarters of the nitrogen but with a high influent strength they do not meet the performance standard. He said there are many factors at play and that one of the things that will be looked at with this study is whether the activated sludge systems perform differently from the fixed media systems.

Elke Ursin presented on some of the results of the summary statistics on the project database. Approximately 16,595 advanced systems were identified from four main sources (DOH's Environmental Health Database, Carmody, county health department databases, and innovative permit files). Over 60% of the advanced systems in Florida are contained in Monroe, Charlotte, Brevard, Franklin, and Lee counties. The samplers that were utilized from the county health departments for this project were located in each of these counties except for Franklin County, which was sampled by a DOH employee from Wakulla County who also sampled most of the rest of the state; and Brevard County, which was sampled by several employees from Volusia County. Elke Ursin went into some of the geocoding results which basically showed that the addresses in the database were good physical addresses. She also showed some statistics on how many of the records were associated with either a construction permit number, operating permit number, or both. Having these numbers increases the likelihood that there is further information on a system (i.e. type and size of system installed, when system was installed). She showed a table on the frequency of the type of advanced system, which demonstrated that the vast majority of the advanced systems in the state are aerobic treatment unit (ATU) systems. Of the systems that had a final system approval date, 75% were installed within 2-5 years of January 1, 2010. About 56% of the systems had technology information. Eighty-eight percent of these systems utilized extended aeration. The top five manufacturers in Florida are Consolidated, Aqua-Klear, Hoot, Norweco, and Clearstream.

Elke Ursin presented on the progress that has been made on the remaining tasks associated with this project. Data entry is ongoing with several bureau staff assisting. As of December 20, 2011 395 out of over 1,000 records need data entry and 707 records need a quality control review. There is a task looking at management practices that is currently ongoing. A database was created linking program evaluations over the past ten years with the survey results for regulators and system owners/users. There will also be links made between the county program evaluation, county survey information, and the sample results. Analysis on this has begun, and will be completed and summarized in the final task report and in a case study booklet format. The final project report is anticipated to be written after all the data entry and data analysis has been completed. The draft report will be presented to the RRAC for review prior to finalization and submission to DEP.

5. **Other Business** – Quentin Beitel requested that an update be given at the next RRAC meeting on the Carmody system: who's using it, the quality of the data, etc. Elke Ursin stated that she will see whether Scott Carmody might be able to come to the next meeting and if not will make sure there is someone from DOH staff to discuss some of this.

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

7. **Closing Comments, Next Meeting, and Adjournment** – Quentin Beitel reminded RRAC members that the Legislature will start meeting next week and recommended that RRAC members contact legislators regarding the nitrogen study. The next RRAC meeting will occur at some point in the future, with a date to be determined via email. The meeting adjourned at 11:12 a.m.

Task 1: Monroe County detailed study of diurnal and seasonal variability of performance of advanced systems

Final Report

for

DEP Agreement G0239
Department of Health Assessment of Water Quality Protection by Advanced Onsite Sewage Treatment and Disposal Systems: Performance, Management, Monitoring Project

By Eberhard Roeder

November 30, 2011

Executive Summary

This study reports on samples from aerated onsite sewage treatment systems in the Florida Keys. Over the course of the study between February 2007 and June 2009 we obtained grab and composite samples from 40 treatment systems in Monroe County at different frequencies. The samples were analyzed for carbonaceous biochemical oxygen demand (cBOD5), total suspended solids (TSS), total nitrogen (TN), total phosphorus (TP), less frequently for total alkalinity, and occasionally for fecal coliforms and by some screening tests. The objectives of this task were to validate a sampling protocol for use in Task 4 of this grant agreement by characterizing the variability of grab samples over the course of a day, to compare grab sample results to time-composite sample results, and to assess longer term or seasonal variability. A secondary objective was to gather data on the influent and effluent concentrations of treatment systems to begin assessing the performance of such treatment systems. Experiences and conclusions from this study can be categorized into two groups: (1) Validation of a sampling protocol and (2) Preliminary assessments on the treatment effectiveness of treatment systems based on the sampling protocol.

Validation of a Sampling Protocol

- Occasional spurious high concentrations were reported, in many cases for one analyte but not for others in the same sample. While this may influence means, median concentration results are less impacted by this and appear generally reliable. Review of sample results on the background of typical results and communication with the laboratory appear to be a way to resolve some of these. The conditions for such interaction were much improved for Task 4.
- Relative to target concentrations, results from analysis of blanks indicated that the approach to sampling using peristaltic pumps was successful. For Task 4, flushing volumes were increased in an attempt to further reduce TN in equipment blanks, which had been detected most frequently.
- TSS appeared to be the most variable parameter in replicate samples from an intermediate container with a median relative standard deviation of 12%, but for cBOD5, TN, and TP this measure was 3% and less. Concerns about samples obtained from intermediate containers are thus less warranted for nutrient analyses than for TSS analyses.
- Detailed characterization of the treatment systems and sampling locations are very important. Particularly in treatment systems with multiple treatment steps, “influent” and “effluent” need further qualification, and may be ambiguous to a sampler encountering the treatment system or to a data analyst. In the present study this required some reclassification during data analysis from “influent” to “intermediate”. For Task 4, data fields for sample location description were more extensive, and a screen for the validity of “influent” samples was developed.
- The operational and maintenance conditions of a treatment system need to be better characterized if one wants to distinguish between technical limitations of treatment and shortcomings due to operator error or lack of maintenance. The assessment protocol for Task 4 included a more detailed assessment, including characterization if the power was on, observation of problems and the dissolved oxygen concentration as a measure of aeration.
- Assessments of variability between grab samples during each event showed that TSS had the highest variability, while TP and total alkalinity had the least, followed by TN. The first grab sample of a sampling event tended to be about 20% higher in TSS and 10% in cBOD5 than subsequent grab samples. This difference did not exist for nutrient species. Given that the emphasis of the project is on nutrient treatment effectiveness, grab sampling appeared appropriate for Task 4.
- There was no overall bias found between the effluent composite and average of grab samples during the same event, even though for any event there could be differences. These differences were the least for total alkalinity, TP, TN and nitrate, with more than 50% of events showing a relative difference of less that 10%.

- The between event variability as expressed by relative standard deviations, is at least twice as large as the within event variability for all parameters, except for TSS.
- Analysis for differences by weekday showed no consistent results. Flow measurements for a subset of systems, but not for all measurements, appeared to decrease from Monday through Thursday. Grab but not composite effluent sample results for TSS and cBOD5 indicated a decrease from Sunday through Thursday, but this was at least partly due to differences in the occurrence of first grab samples on each day.
- Differences in concentrations between the wet/hot and dry/cold seasons were not significant.
- Visual/olfactory assessments appeared to be able to discriminate a threshold-value of TSS (visual) and possibly TSS, ammonia, and TKN (olfactory). During Task 4, the assessment protocol was refined to use more standardized terminology.
- The Hach DR/890 colorimeter showed good agreement with laboratory nitrate and ammonia measurements and less so for ortho-phosphate compared to total phosphorus. In all cases there was an indication of between study-phase variability. To address these issues the recording forms for Task 4 were revised to better capture dilution and conversion factors.
- Taylor kits provided good agreement with laboratory measurements for total alkalinity. Task 4 relied largely on Taylor kits for this measurement, with some additional laboratory measurements for confirmation. Chlorine measurements by Taylor kit could not be independently assessed. They were utilized occasionally during the implementation of Task 4 to assess the effectiveness of chlorination devices.

Preliminary Assessment of Treatment Systems

- Maintenance and operation of treatment systems appear to be important variables that were not systematically characterized in this study. Both the sampling results of processes that require replenishment of materials and anecdotes by the samplers indicated that this is an important, but not quantified, element of performance variability.
- Typical influent concentrations of cBOD5 and TSS were consistent with domestic sewage, and total phosphorus slightly elevated. TN concentrations were about twice as high as concentrations during a study that established the feasibility of current treatment standards and as the septic tank effluent concentrations provided in Florida performance-based treatment system regulations as point of comparison. Overall, 50% of influent composite samples showed a TN concentration between 47 and 94 mg/L, compared to 15 and 43 mg/L for the effluent.
- Overall, the addition of a phosphorus reduction treatment step, usually a media filter, improved treatment for TSS, cBOD5, nitrite-nitrogen, and total phosphorus. Systems without that treatment step had median concentration results similar to an earlier survey of ATUs in the Keys.
- Among the phosphorus treatment approaches sampled there were significant differences in effluent concentrations. While overall, total phosphorus was significantly reduced, the Keys treatment standard was not met in most cases, even for the better performing approaches.
- Within the treatment systems sampled, nitrification appeared to be a limiting step to nitrogen reduction. The sampling events with the most nitrified effluent achieved typically about a 75% reduction compared to their influents, while the events with the least nitrified effluent only achieved a typical TN-reduction of about 28% and did not eliminate cBOD5. Events with intermediate nitrification showed intermediate TN-reduction and some indications of occasional alkalinity limitation.
- 25% of the obtained fecal coliform samples exceeded the secondary grab sample standard of 400 cfu/100 mL. Nearly half of the obtained chlorine measurements did not meet the system-required chlorine residual. Such observations confirm that aerobic treatment alone is not sufficient to meet secondary fecal coliform standards. The chlorine measurements also point to the need for monitoring the effectiveness of chlorination units.

Table of Contents

List of Tables

List of Figures

1 INTRODUCTION

Grab samples are commonly used to assess treatment results of onsite sewage treatment and disposal systems (OSTDS) in the field. Testing of installed systems in the field is usually done by taking a few individual grab samples over a time period that can extend for years. Compilations of field sampling results (e.g. Groves et al., 2005; Roeder and Brookman, 2006) have indicated that the variability of field data is much larger than variability of standardized test center results. The most common testing standards for aerated onsite sewage treatment systems are NSF-40 for cBOD5 and TSS removal and NSF-245 for nitrogen reduction. These utilize frequent 24-hour flow composite samples from treatment systems installed at a test center and loaded for six months under defined conditions (NSF International, 2000; 2007). One question is if the difference between grab samples and composite samples is important relative to other sources of field variability. The Florida Department of Health (FDOH) and Monroe County Health Department (MCHD) initiated a study to measure treatment results of a sample of aerated treatment units. The field work of the study was completed in three phases from early 2007 to mid-2009. The objectives of the part of the study described here were to characterize the variability of grab samples over the course of a day, to compare grab sample results to time-composite sample results, and to assess the variability of sampling results between repeat visits at the same treatment unit. A secondary objective was to gather data on the influent and effluent concentrations of treatment systems. Preliminary results of this study have been presented previously (Roeder and Brookman, 2008, 2009 on data from the first phase of the study; Roeder and Brookman, 2010 on aspects of nitrogen reduction assessment). This report expands on these previous summaries and discusses the complete results of the study.

1.1 Acknowledgements

This study benefited from the cooperation of many people. Particularly appreciated here are the cooperation of the participating owners, the implementation of the study by William Brookman, the sampling efforts by Joe Aretz, Deborah Chesna, Gary Lichtler, Jane Parthemore, Mark Terrill, and Pam Weeks, the assistance with data entry and quality control by Elke Ursin, Susan Polangin, and Debra Roberts, and the direction of the Onsite Sewage Research Review and Advisory Committee. Funding was from the Florida Onsite Sewage Research Fund and Monroe County Health Department as a matching contribution to DEP Agreement G0239: Department of Health Assessment of Water Quality Protection by Advanced Onsite Sewage Treatment and Disposal Systems: Performance, Management, Monitoring Project.

2 METHODOLOGY

2.1 Phases of the Study

The study included three phases. In the first phase, from February 2007 through mid-October 2007, samples were analyzed for cBOD5, TSS, nitrate, nitrite, ammonia, total Kjeldahl nitrogen, and total phosphorus; during the second phase from mid-October 2007 through May 2008, total alkalinity and occasional fecal coliform and enterococci analyses were added. The third phase, January through June 2009, added treatment systems, dropped the microbiological analyses early in the phase, and added more replicates and blanks. Additional details on sampling procedures were documented in a sampling protocol document.

2.2 System Selection

The study included samples from volunteer owners for two permitting classes of aerated onsite treatment units installed in the Florida Keys: onsite wastewater nutrient reduction systems (OWNRS) and interim systems. Interim systems are aerobic treatment units approved in Florida based on certification by NSF. They are intended to serve as interim wastewater treatment option until central sewer is extended to the property. OWNRS are a type of performance-based treatment system; engineer-designed systems that usually include an aerobic treatment unit and a separate media filter to remove phosphorus, and are intended as a long-term wastewater solution. In the following, all systems that only include an aerated treatment step are categorized as ("I") for interim systems. All systems that included a phosphorus reduction step are categorized as ("P") for performance-based. Limitations in the access of sampling points resulted in some performance-based treatment systems being sampled before the phosphorus treatment step.

During the first two phases of this project, all systems sampled served single family residences ("R"). These systems had to be serving residences inhabited by permanent residents (homestead exemption) and possess a current maintenance contract, which is required by Florida regulations. System selection was based on volunteers who responded to a request from MCHD to all OWNRS-owners and a random sample of interim system owners whose systems fulfilled these requirements. Some owners lost interest during the study period and declined continuing participation. During the third phase, in 2009, additional single family residences and commercial establishments ("C") were recruited by MCHD to increase the number of systems and types of facilities on which data were gathered. System characterizations based on permit records and field observations are contained in Appendix A. Monthly water billing records were obtained from the water utility for the year 2007 to estimate water use.

The system selection ensured that systems were maintained according to regulatory requirements. That is, owners had contracts with a maintenance entity to maintain their systems, and an operating permit existed for each system, which is the main mechanism for the health department to track maintenance and operation of a system. Data on the extent and quality of maintenance and inspections actually performed by the maintenance were not directly gathered during this study.

2.3 Sampling

Sampling occurred from February 2007 to June 2009. Effluent sampling points were in most cases pump compartments or modified P-traps. The Florida Department of Health has suggested these as a suitable location for a sampling port (FDOH, 2000). Influent samples were obtained from the most upstream accessible tank or compartment. This included some compartments that subsequent analysis indicated were influenced by the aeration. 24-hour time-composite samples in one-hour intervals were obtained by an auto-sampler for effluents and, where accessible, influents. Grab samples were obtained at the same location using another auto-sampler with peristaltic pump several times during staff working hours separated by at least one hour and typically two hours to represent possible monitoring grab samples.

The following types of blank samples were taken: field blanks were taken with grocery-bought distilled water and with tap water. The tap water samples, while not strictly blanks, were aimed at measuring the background concentrations of the water supply feeding the sewage treatment systems. Field equipment blanks with distilled water were taken during the second half of the third phase, starting in May 2009.

Over the course of the project replicates were taken. During the initial two phases of study, replicates were taken occasionally, about once a week. During the third phase, replicates were taken both of the composite effluent sample and of the first effluent grab sample. The replicates were taken in the following manner: the peristaltic pump collected sufficient samples in an intermediate container for two sets of samples. The intermediate container was inverted several times. Then the sample containers were filled. The two sets of samples were sent to the lab with the same shipment. Replicates amounted to about 10% of samples.

Samples were stored in ice, and shipped by courier service to a NELAP-accredited laboratory. The laboratory returned a copy of the chain of custody with the sampling results to Monroe County Health Department.

2.4 Analysis

The laboratory analyzed the samples for the following parameters: total alkalinity, (EPA310.1) (only in Phase 2 and 3), carbonaceous biochemical oxygen demand after 5 days ($cBOD_5$) (SM5210B), total suspended solids (TSS) (EPA160.2), ammonia nitrogen (EPA350.1), total Kjeldahl nitrogen (TKN) (EPA351.2), nitrate nitrogen and nitrite nitrogen (SM4500 NO3-F, or EPA300.0), total nitrogen (TN) (calculated), and total phosphorus (TP) (EPA365.4). During Phase 2 and the first part of Phase 3, some samples, generally the last grab sample of an event, were analyzed by a local NELAP-accredited lab for fecal coliform and enterococci.

To assess the feasibility of alternative methods of analysis, two approaches to screening tests were evaluated: field testing kits, and visual/olfactory assessment. Field testing kits included a field colorimeter (Hach DR/890) that allowed analyses for nitrate-nitrogen (high range, Test'n'Tube, Chromotrophic Acid Method), ammonia-nitrogen (High Range, Test'n'Tube, Salicylate method) and reactive or ortho-phosphorus (EPA Method 365.2), a Taylor-kit that was used as additional screening test for alkalinity, free chlorine, and pH, and, for a brief period of time, an indicator strip. Visual/olfactory assessments included assessments of clarity and color, and of smell. These analyses were performed less frequently than the laboratory analysis, usually on a replicate of one sample per sampling event.

The laboratory provided lab reports, which were entered manually into a project database (MS-ACCESS) that also was used to gather system information. Except for consistency checks between analytes, the laboratory data were accepted as provided. A person different from who had entered the data performed quality control of the entered data. Further processing and data analyses were performed in MS-ACCESS, MS-EXCEL, and SPSS 17.0.

For the purposes of analysis, the value of the detection limit was generally used in the following for results that were below the detection limit. The differences between duplicate and original results and between time-composite and grab samples were characterized by the relative deviation. The variability of grab samples over the course of a day and of multiple samples over the course of the study was characterized by the relative standard deviation. Results were characterized in two ways: relative difference (2^{nd} sample-1^{st} sample)/(0.5*(2^{nd} sample + 1^{st} sample); and relative standard deviation (standard deviation/average, or for two samples, abs(relative difference/sqrt(2)). The distribution of relative differences allows an assessment if systematically the first sample results in lower or higher measurements than the second sample. The relative standard deviation provides an indication how close together the two values are.

To assess qualitatively if concentrations of different analytes were related, Pearson correlation coefficients between the ranks of analytical results or deviation measures were determined. Such a correlation indicates if relatively large values (high rankings) of one parameter are associated with relatively large values of another parameter. Additionally, graphing and linear correlations in Excel were employed to screen for relationships between parameters. Two aspects of the variability of grab samples were assessed: how variable are grab samples over the course of a day, and how different is the average of grab samples from the time-composite sample obtained over the 24-hour time period?

3 VARIABILITY ASSESSMENTS

3.1 Blanks

Table 1 shows the results of blank analyses, grouped by equipment blanks with DI water, field blanks with DI water, and field blanks with tap water. Equipment blanks showed in all cases below detection limit for TSS and nitrite-nitrogen. In most cases, cBOD5 (92%), nitrate-nitrogen (69%) and total phosphorus (69%), and total alkalinity (62%) were below the detection limits as well. In contrast, most samples contained quantifiable amounts of ammonia (54%), TKN (69%), and total nitrogen (85%). While quantifiable, the concentrations were in most cases much below one mg/L. Of note is that the first three equipment blanks showed the highest concentrations for nitrogen and phosphorus species, with total nitrogen up to about four mg/L and total phosphorus up to 0.8 mg/L. Two explanations appear plausible: the initial equipment blanks were obtained using tap or drinking water instead of distilled water; or the samplers improved the cleaning and sampling procedures after the first three equipment blanks. An argument for the first explanation is that results are fairly consistent with the results for tap water (see below). An argument against the second explanation is that sampling results of the first equipment blanks were only received three weeks after sampling, two weeks after subsequent equipment blanks, therefore no information on high concentration results was available when the improvement would have occurred.

While not all five field blanks using distilled water achieved results below detection limit, the nitrate/nitrite species in addition to cBOD5 and TSS were all below detection limit, all total phosphorus results were below the PQL, but TKN was detected three times, in amounts up to 0.66 mg/L.

Tap water field blanks were mostly free of detectable levels of TSS (58%), nitrite (56%) and total phosphorus (56%). Usually samples were close to about 2 mg/L for cBOD5 and TSS. Median nitrate-nitrogen, TKN, total nitrogen concentrations, and total alkalinity were 2.7, 0.8, 3.5 and 45 mg/L, respectively. One observation that the large number of samples allowed was how frequently unusually large concentration results are returned from the lab. The occurrence of large concentrations of five times the median or more occurred occasionally (>5%) for cBOD5 and nitrite-nitrogen, and rarely (<5%) for TKN, total nitrogen, total phosphorus, and TSS.

The highest rank order Pearson correlation coefficients were 0.66 between nitrate-nitrogen and total nitrogen, 0.52 between TP and TSS, followed by 0.48 between ammonia-nitrogen and TKN and 0.44 between TKN and total nitrogen. The correlations between nitrogen species are plausible, given that total nitrogen is a value calculated from nitrate, nitrite, and TKN, ammonia is part of TKN, and nitrate-nitrogen in the tap water samples is usually present at the highest concentration of the three. The second correlation suggests a joint appearance of some TSS and TP, such as suspended solids containing phosphorus, in tap water. The lack of strong correlations otherwise suggests that occasional or rare spikes in concentration results occur largely independent from each other and represent noise in the obtained data.

Table 1. Statistics of blanks (concentrations in mg/L)

	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TOTAL NITROGEN	TOTAL PHOSPHORUS	TOTAL ALKALINITY (CaCO3)
Equipment Blanks									
Count	13	13	13	13	13	13	13	13	13
Max	2.61	2	0.59	3	0.026	2.02	4.19	0.79	47
Fraction with "I"	0.00	0.00	0.15	0.15	0.00	0.08	0.00	0.00	0.00
Fraction with "U"	0.92	1.00	0.31	0.69	1.00	0.23	0.15	0.69	0.62
Median	2.00	2.00	0.10	0.05	0.03	0.19	0.19	0.04	5.00
75-percentile	2.00	2.00	0.22	0.10	0.03	0.55	0.55	0.15	10.00
Distilled Water Field Blanks									
Count	4	5	5	5	5	5	5	5	3
Max	4.6	2	0.05	0.05	0.053	0.66	0.66	0.19	62
Fraction with "I"	0.00	0.00	0.40	0.00	0.00	0.20	0.20	0.40	0.00
Fraction with "U"	0.75	1.00	0.60	1.00	1.00	0.40	0.40	0.60	0.00
Median	2.00	1.00	0.04	0.05	0.04	0.26	0.12	0.04	46.00
Tap Water Blanks									
Count	92	93	93	93	93	93	93	91	61
Max	39	10	1.6	12(1)	2.64	8.8	12	5.1	66
Fraction with "I"	0.00	0.00	0.04	0.00	0.17	0.02	0.01	0.18	0.00
Fraction with "U"	0.38	0.58	0.08	0.12	0.56	0.09	0.04	0.56	0.00
Average	4.67	1.70	0.48	2.51	0.14	1.04	3.50	0.19	45.49
25-percentile	2.00	1.00	0.28	2.3	0.03	0.49	3.00	0.035	41.00
Median	2.00	2.00	0.50	2.66	0.05	0.82	3.50	0.08	45.00
75-percentile	2.88	2.00	0.65	2.89	0.09	1.00	3.84	0.14	47.00
95-percentile	20.00	2.80	0.92	3.58	0.57	2.71	4.90	0.33	61.00

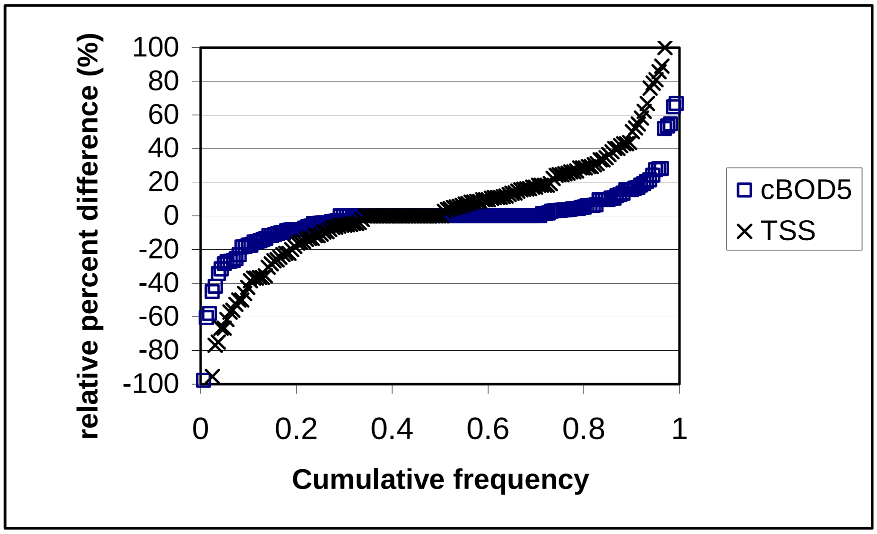
(1) This result was associated with a lab report of TN=2.6 mg/L, indicating an inconsistency of reported results

3.2 Replicates

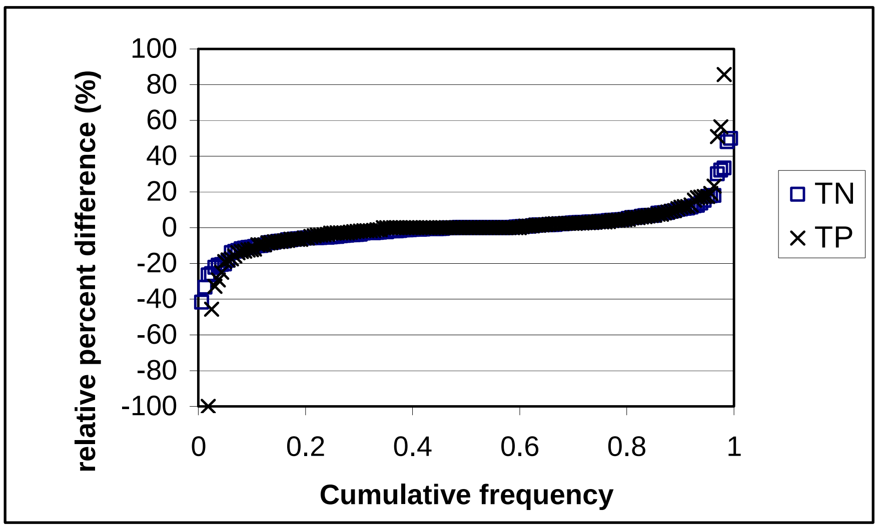
Comparisons of analytical results between samples and their replicates showed that TSS had the highest variability, while nutrient samples had very low variability. Figure 1 shows the cumulative distribution of relative percent differences for cBOD5, TSS, TN, and TP. Table 2 shows characteristics of both the relative percent difference and the relative standard deviation for the analytes. For these analyses, it was assumed that the difference between two samples qualified as “U” was zero, even though the numerical value associated with the “U” may have been different, e.g. due to different dilution factors in the analysis.

The average relative percent difference is close to zero relative to the standard deviation of these differences and the median difference as a typical value is zero for all analytes. Therefore, no bias in measurements is apparent. The relative standard deviations show that the average for nitrite, nitrate, total nitrogen and total alkalinity is less than five percent. For cBOD5 and TP the average relative standard deviation is less than 10%, while for TSS, ammonia and TKN it is between 13 and about 20%. It is interesting to note that the variability of TN appears to be much less than the variability of ammonia and TKN, even though TKN is a component of TN and therefore the two could be expected to vary together. Differences in the distribution of large deviations become apparent when considering the fraction of samples that had a relative standard deviation of 20% or less. This fraction is for total alkalinity: 100%; TN: 96%; nitrite-N: 95%; nitrate-N: 95%; TP: 94%; cBOD5: 92%; TKN: 82%; ammonia-N: 81%; and TSS: 65%.

A Pearson regression analysis of ranks of relative percent differences deviations of each analyte against the ranks of relative percent differences of other analytes and against the date of sampling was performed to assess if there was a pattern in deviations. The only large correlation was between TKN and total nitrogen (0.72) and the second highest was between nitrate-nitrogen and total nitrogen (0.43) (see Table 3). Such a correlation is not unexpected as TKN and nitrate-nitrogen are components of total nitrogen. The lack of strong correlations between any of the other analytes indicates that the relative deviations for analytes are independent of each other. The difference between the observed association between TP and TSS for tap water blanks and the lack of such an association between replicate samples suggests that the fraction of TSS that causes the high variability between replicates does not contain noticeable amounts of TP.



a)



b)

Figure 1. Cumulative distribution of relative percent differences between samples and their replicates for a) cBOD5 and TSS, and b) TN and TP.

Table 2. Statistics of deviations between replicate samples

	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
Count	160	162	161	162	162	161	161	161	149
Relative % difference									
Average	-0.7	5.2	-7.1	-0.9	-1.8	-1.8	-0.1	0.0	-0.6
standard deviation	18.6	44.1	43.2	20.1	21.0	37.9	11.2	25.9	6.5
5-percentile	-27.2	-61.3	-100.0	-10.5	-12.5	-40.2	-18.4	-18.2	-9.5
25-percentile	-4.5	-10.5	-6.3	-1.1	0.0	-8.2	-5.0	-3.0	-1.7
Median	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75-percentile	3.2	24.3	4.3	0.9	0.0	7.7	3.4	3.2	0.0
95-percentile	24.2	78.6	26.1	8.1	7.4	41.0	15.2	17.4	7.2
Relative standard deviation (%)									
Average	6.9	20.1	14.8	4.5	4.3	13.7	4.9	7.3	2.3
standard deviation	11.1	24.1	27.2	13.5	14.3	23.1	6.2	16.8	3.9
5-percentile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25-percentile	0.0	4.1	1.2	0.0	0.0	1.7	1.0	0.0	0.0
Median	2.5	12.1	3.8	0.8	0.0	5.7	3.0	2.2	0.4
75-percentile	9.4	26.2	10.0	2.9	1.7	14.6	6.0	6.0	2.9
95-percentile	32.1	67.2	83.9	14.9	20.1	69.1	18.2	32.3	12.7

Table 3. Pearson correlation coefficients between ranks of relative percent differences between replicates for analytes, and between the ranks and date

	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.	Date
CBOD5	1.00	0.03	-0.01	-0.06	0.01	0.10	-0.04	0.09	-0.04	0.09
TSS	0.03	1.00	-0.04	-0.08	0.03	0.13	0.00	-0.11	-0.06	0.15
AMMONIA-N	-0.01	-0.04	1.00	0.09	-0.04	0.03	0.07	0.06	0.01	0.01
NITRATE-N	-0.06	-0.08	0.09	1.00	0.05	0.06	0.43	-0.06	-0.04	0.02
NITRITE-N	0.01	0.03	-0.04	0.05	1.00	0.01	0.09	0.01	-0.07	0.08
TKN	0.10	0.13	0.03	0.06	0.01	1.00	0.72	0.21	0.06	-0.07
TOTAL_NITROGEN	-0.04	0.00	0.07	0.43	0.09	0.72	1.00	0.31	0.10	-0.08
TOTAL_PHOSPHORUS	0.09	-0.11	0.06	-0.06	0.01	0.21	0.31	1.00	-0.03	-0.18
TOTAL ALK.	-0.04	-0.06	0.01	-0.04	-0.07	0.06	0.10	-0.03	1.00	-0.03

3.3 Overall Distribution of Influent and Effluent Concentrations

This section describes the concentration results of the obtained samples. Sample locations were categorized into influent; intermediate, or effluent. The intermediate category was created to address samples that did not represent untreated septic sewage, based on two criteria: system construction did not include a pretreatment tank, or high levels of nitrate were found in a sample otherwise consistent with sewage. The analysis for most samples included cBOD5, TSS, nitrogen species, total phosphorus, and total alkalinity. Analysis of bacteriological samples occurred rarely, only twenty times, and a separate subsection will discuss these results.

3.3.1 Influent Composite Samples

Initial review of the obtained influent samples indicated the need for further screening according to the following criteria: For systems where the construction records indicated that there was no pretreatment tank present, “influent” samples were reclassified as an “intermediate” sample, regardless of concentrations; Samples that showed total nitrogen above 10 mg/L and nitrate and nitrite above 3 mg/L indicated some aerobic treatment influence and were also reclassified as “intermediate” samples, for four systems this resulted in some influent samples being included and some reclassified as intermediate samples. The systems for which these occurred were tanks with an aerobic treatment insert, which may or may not have included a baffle wall to separate a pretreatment compartment from the aeration compartment.

Other noteworthy special considerations were the following: The laboratory had analyzed the first influent sample with a cBOD5 reporting limit of 300 mg/L and the result was less than this value. For this result an exception was made from the convention to use the reporting limit as measured effluent concentration and it was excluded from the statistics. Two samples showed above 5 mg/L nitrate but low TKN and TP, which indicated that the influent was very close to pure tap water, these samples were included as influent sample.

In the following, only time composite influent samples, without considerations of grab samples or replicates, are summarized. There were only three influent grab samples, for two of those influent composite samples were also obtained during the same event.

Summary statistics of influent samples are shown in Table 4. Several observations are of note:
TSS and nitrate have a standard deviation much larger than the mean and a mean that is much larger than the median. In both cases this stems from a few samples with very high concentrations. For TSS, an explanation of this could consist of the sample containing scum or sludge, that is, material that is present but that is usually not sampled and retained by the primary treatment compartment. For nitrate, the two samples with the outlying high concentrations were associated with low TKN and TP concentrations and indicative of a high fraction of tap water.

cBOD5, nitrite, and TP show standard deviations on the same order as the mean and means that are about 50-100% higher than the median. For cBOD5, the two highest concentrations are associated with samples that also have very high TSS concentrations. cBOD5 distribution is also influenced by the laboratory’s use of a detection limit of 60 mg/L for most samples, which more than a quarter of the samples did not exceed. Total phosphorus variability is influenced by a few high values that are associated in three of seven cases with high TSS-values, and two low values that are associated with samples similar to tap water. Nitrite variability was caused largely by variations in the detection limit due to differences in dilution of samples

Ammonia, TKN, total nitrogen, and total alkalinity show standard deviations smaller than the mean and a mean that is within 20% of the median. This indicates a limited effect of particularly high concentrations.

The effect of removing a few samples with very high concentrations can be seen in Table 4b: By excluding three samples with very high solids content (TSS>1000 mg/L), which may represent difficulties in sampling from the clear zone, two samples that appeared to be tap water dominated, and six samples from systems that included recirculation, both averages and standard deviations of TSS, nitrate and cBOD5 were markedly lowered. The highest total phosphorus value of 98 mg/L was not associated with high concentrations of any of the other analytes, and continued to skew the average results. Other nutrient concentrations and total alkalinity did not change much, and the interquartiles and medians remained roughly the same. Based on a median test, there were not significant differences between the influent measurements for residential PBTS, ATUs and commercial PBTS for cBOD5, TSS, TKN, TN, TP, and total alkalinity.

Looking at the six influent samples from systems with recirculation in isolation (Table 4c), their median values are generally similar to the influent concentrations overall. Even the values for TKN and total nitrogen, which appear to be somewhat lower, and cBOD5 and TSS, which appear to be somewhat higher, were not significantly different as determined by the median test.

Table 4. Summary statistics of composite influent samples: a) all influent samples; b) influent samples without high solids concentrations (>1000 mg/L), tap water, and recirculation; c) influent samples with recirculation

a) all influent samples

		CBOD5*	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
N	Valid	49	50	50	50	50	50	50	49	39
Mean		146.4898	250.2400	53.54460	.51800	.20340	82.66660	83.00000	16.66449	375.538
Std. Deviation		150.09804	610.57202	40.617567	1.293862	.264183	60.487644	60.093293	19.883239	245.6132
Minimum		60.00	14.00	.200	.047	.025	.830	1.800	.960	59.0
Maximum		780.00	3700.00	220.000	7.000	.980	290.000	290.000	98.000	1400.0
Percentiles	5	60.0000	20.4000	.55550	.04700	.02500	1.57500	7.46200	1.64000	77.000
	25	60.0000	40.0000	31.72250	.04925	.03900	46.51500	46.51500	7.55000	270.000
	50	99.0000	64.0000	49.00000	.19000	.09400	73.44500	73.44500	10.00000	300.000
	75	175.0000	135.0000	63.25000	.47000	.20000	94.25000	94.25000	14.50000	460.000
	95	630.0000	1745.0000	138.00000	3.58850	.94000	233.50000	233.50000	68.00000	1000.000

*one cBOD5 result below a reporting limit of 300 mg/L was excluded from analysis.

b) influent samples without high solids concentrations (>1000 mg/L) tap water, and recirculation

		CBOD5*	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
N	Valid	38	39	39	39	39	39	39	38	28
Mean		122.2895	117.4872	55.68385	.25272	.16421	80.80538	80.89410	15.96395	389.286
Std. Deviation		85.96728	156.94650	40.212588	.328943	.235855	54.873544	54.796139	19.669758	246.8913
Minimum		60.00	24.00	.200	.047	.025	1.800	1.800	2.300	120.0
Maximum		520.00	710.00	220.000	1.460	.980	290.000	290.000	98.000	1400.0
Percentiles	5	60.0000	24.0000	7.30000	.04700	.02500	13.00000	14.00000	3.06000	142.500
	25	60.0000	40.0000	34.00000	.04700	.03900	49.20000	49.20000	7.57500	270.000
	50	98.5000	64.0000	50.00000	.09400	.09400	76.00000	76.00000	10.00000	310.000
	75	152.5000	110.0000	69.00000	.25000	.13000	94.00000	94.00000	14.25000	460.000
	95	254.0000	640.0000	120.00000	1.20000	.94000	220.00000	220.00000	77.10000	1116.500

c) influent samples with recirculation

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
N	Valid	6	6	6	6	6	6	6	6	6
Mean		132.6667	116.6667	40.08500	.20067	.21833	62.77667	62.86000	9.83167	291.667
Std. Deviation		51.70171	65.79564	15.220097	.157311	.209473	18.8329	18.959121	2.082791	42.1505
Minimum		60.00	24.00	23.000	.050	.026	40.160	40.160	6.200	240.0
Maximum		180.00	190.00	58.000	.470	.500	86.420	86.920	12.000	360.0
Percentiles	5	60.0000	24.0000	23.00000	.05000	.02600	40.16000	40.16000	6.20000	240.000
	25	81.0000	48.0000	24.50000	.08000	.07400	41.07500	41.07500	8.15000	262.500
	50	144.0000	130.0000	38.75500	.17200	.11200	66.29000	66.29000	10.49500	280.000
	75	180.0000	175.0000	57.25000	.30500	.47750	78.69500	78.82000	11.25000	330.000
	95	180.0000	190.0000	58.00000	.47000	.50000	86.42000	86.92000	12.00000	360.000

3.3.2 Intermediate Composite Samples

The grouping of intermediate samples encompasses samples from a variety of locations before the final treatment step. These samples were taken as far upstream in the treatment process train as the samplers were able to access. This included aeration chambers, clarifiers, or relatively stagnant compartments preceding but in connection with the aeration chamber. One way to assess the importance of sampling influent from a pretreatment tank rather than the upper end of a treatment system is to compare influent results to intermediate samples. Generally, the influent concentrations should be higher than intermediate concentrations. Table 5a summarizes the overall intermediate concentrations. Of the 51 samples, 7 had high solids concentrations (>1000 mg/L) associated with them. While these samples may accurately reflect the solids concentration, for example if the sample was obtained from an aeration chamber, they appear not well comparable to other samples. Table 5b shows the effect of removing these samples from the statistics. cBOD5, TSS, TKN, TN and TP show a marked reduction in means and standard deviations, but a lesser reduction in the median. In both tables, the summary statistics indicate that these samples show the influence of aerobic treatment. Over 75% of all samples or about 90% of the samples without high solids had cBOD5 results at or below the laboratory reporting limit of 60 mg/L. More than 80% of samples show nitrate-N in excess of 3 mg/L and only two had below detectable levels of this analyte. The presence of nitrate as an indicator of aeration points most clearly to the effect of aeration in this sample group. But TKN is still a prominent constituent of total nitrogen, exceeding 10 mg/L in somewhat over half of the samples.

One particular distinction in the data is that a few samples were taken from after the aerobic treatment at the beginning of the phosphorus reduction media tank. These sample locations stemmed from the inaccessibility of the compartments containing the aerobic treatment unit to the samplers at two systems. The differences between samples further up the treatment train, such as in aerobic treatment units (Table 5c), and the samples from the two systems (Table 5d) where the upper end of the P-media was sampled was only significant for TP using the median test. This is counterintuitive, given that the purpose of the samples was to sample the partially treated effluent prior to total phosphorus reduction. A possible reason for the reduction of total phosphorus measured could be that the sample consisted of ponded effluent that was in contact with the phosphorus adsorption media.

Table 5. Statistics of intermediate composite samples, i.e. samples that were taken at the beginning of the treatment train: a) all samples; b) excluding samples with TSS >1000 mg/L; c) samples taken in aerobic treatment unit tanks; d) sample taken at the beginning of a phosphorus reduction filter tank

a) all samples

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
N	Valid	49	49	50	51	51	50	50	50	32
Mean		91.4490	777.8571	10.81980	19.39557	1.66749	64.98920	85.70400	20.49322	128.531
Std. Deviation		140.47243	2287.92957	25.790763	19.884928	4.636731	125.171022	123.528269	38.209321	211.4002
Minimum		2.00	1.20	.039	.094	.025	.070	3.280	.035	5.0
Maximum		940.00	14000.00	150.000	103.200	27.000	763.450	763.450	240.000	990.0
Percentiles	5	2.0000	2.0000	.04615	1.57800	.02500	.46000	10.08500	.08330	5.000
	25	60.0000	9.8000	.40500	4.70000	.13000	3.98500	23.83000	5.40000	14.000
	50	60.0000	46.0000	1.95000	15.32000	.33000	18.54000	42.01500	8.50000	57.500
	75	60.0000	370.0000	6.45000	29.00000	1.31000	85.44000	106.46000	23.00000	155.000
	95	335.0000	5800.0000	72.25000	65.32200	11.30000	298.83900	306.63650	88.75000	827.500

b) excluding samples with TSS >1000 mg/L

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
N	Valid	42	42	43	44	44	43	43	43	26
Mean		54.5476	128.9286	8.08088	21.02305	1.78618	33.15651	55.80000	10.45723	70.308
Std. Deviation		17.74920	207.28909	17.027974	20.545683	4.974905	44.784861	52.581712	10.154816	80.7449
Minimum		2.00	1.20	.039	.094	.025	.070	3.280	.035	5.0
Maximum		72.00	870.00	75.000	103.200	27.000	190.000	223.180	43.000	330.0
Percentiles	5	2.0000	2.0000	.05520	2.20250	.02500	.39000	7.04000	.08120	5.000
	25	60.0000	7.4500	.41000	6.77000	.12250	2.80000	23.00000	5.00000	10.500
	50	60.0000	30.5000	1.90000	16.50000	.26500	11.74000	39.00000	7.70000	43.000
	75	60.0000	157.5000	3.90000	29.19500	1.21000	46.29000	62.00000	14.00000	94.500
	95	68.2500	652.5000	65.40000	74.99250	16.37500	128.00000	199.44200	37.20000	298.500

c) samples taken in aerobic treatment unit tanks

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
N	Valid	40	40	41	42	42	41	41	41	30
Mean		102.0750	947.9700	12.89637	19.45652	1.30769	68.02659	88.73659	24.64512	132.133
Std. Deviation		153.35285	2506.16595	28.106202	21.312062	3.171708	134.313092	133.244583	41.098396	217.3971
Minimum		2.00	2.00	.039	.094	.025	.070	3.280	.290	5.0
Maximum		940.00	14000.00	150.000	103.200	20.000	763.450	763.450	240.000	990.0
Percentiles	5	8.7000	2.1000	.05880	.91200	.02500	.74100	6.27000	2.12000	5.000
	25	60.0000	24.0000	.53000	4.34000	.13000	4.56500	23.66000	6.55000	18.000
	50	60.0000	93.0000	2.30000	14.17000	.33000	19.67000	41.03000	11.73000	57.500
	75	63.0000	602.5000	9.40000	29.44500	1.36750	78.40000	92.91500	26.61500	160.000
	95	384.5000	6520.0000	74.50000	77.75550	5.14450	368.32800	370.34300	122.50000	852.500

d) sample taken at the beginning of a phosphorus reduction filter tank

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
N	Valid	9	9	9	9	9	9	9	9	2
Mean		44.2222	21.8000	1.35989	19.11111	3.34656	51.15222	71.88889	1.57900	74.500
Std. Deviation		25.98931	27.07231	1.247920	11.975333	8.886115	74.178640	66.560958	2.450320	92.6310
Minimum		2.00	1.20	.039	2.300	.025	.350	14.000	.035	9.0
Maximum		64.00	76.00	3.900	40.000	27.000	190.000	200.000	6.400	140.0
Percentiles	5	2.0000	1.2000	.03900	2.30000	.02500	.35000	14.00000	.03500	9.000
	25	16.0000	4.5000	.26500	7.85000	.03200	.61000	20.50000	.08300	9.000
	50	60.0000	7.0000	1.10000	22.00000	.20000	4.00000	43.00000	.17000	74.500
	75	60.0000	42.5000	2.05000	26.50000	1.17500	125.00000	132.50000	3.55000	140.000
	95	64.0000	76.0000	3.90000	40.00000	27.00000	190.00000	200.00000	6.40000	140.000

3.3.3 Effluent Composite Samples

Effluent concentrations are present from two sources: grab samples and composite samples. Time composite samples are more comparable to the influent and intermediate composite samples obtained, and so these are discussed here first and Table 6 shows their summary statistics. Grab samples will be discussed in the following section.

Among the effluent composite samples there were no samples with TSS-concentrations >1000 mg/L. While cBOD5, nitrite, TN, TP, and alkalinity have comparatively narrow distributions (75th percentile is not more than five times the 25-percentile), TSS and the other nitrogen species vary much more. 75% of cBOD5 results and about 60% of TSS-concentrations meet a concentration limit of 10 mg/L.

One key distinction in the group of effluent samples is whether or not there was a design phosphorus reduction step present before the location of the effluent sample. This, rather than the design classification, is used here as an initial distinction. Table 6b summarizes the results of composite samples following a phosphorus reduction step, and Table 6c shows the effluent composite results following only the aerobic treatment step. The median test function of Statistical Package for the Social Sciences (SPSS) served to assess the significance of differences between the two sets of effluent results (Table 7). For cBOD5 and TSS, the additional treatment step resulted in significantly lower concentrations. Because the populations of manufacturers of aerobic treatment systems differ between the two groups, it is not conclusive but likely that the additional residence time and treatment provided by the phosphorus reduction step is at least partly a reason for the better effluent results.

For ammonia, nitrate, TKN and TN, no significant differences between the two groups of effluent samples could be detected. Nitrite-N is somewhat lower (P=0.07) following a phosphorus reduction step. Overall, total nitrogen in the effluent varies widely but is typically between 20 and 40 mg/L (interquartile 15-43 mg/L), which is considerably lower than the influent concentrations (interquartile 47-94 mg/L)and intermediate sample results (interquartile 24-106 mg/L). While the lowering of concentrations shows that the treatment is effective, an effluent concentration standard of 10 mg/L that applies to systems with phosphorus reduction is only met slightly more than 10% of the time by those samples. Additional analysis is needed to assess reasons for this deviation.

Total phosphorus showed a significant effect of a phosphorus reduction treatment step. Because the differences in aerobic treatment units are not expected to influent P-treatment, this difference can likely be attributed to the P-treatment. Still, the effluent concentration standard of 1 mg/L is met by less than 10% of samples. Additional analysis is needed to assess reasons for this deviation.

Total alkalinity does show no significant differences as measured by the median test, even though there appears to be a tendency toward a slight increase with the phosphorus reduction step.

Table 6. Statistics of effluent composite sample concentrations: a) all samples; b) effluent samples following phosphorus reduction treatment step; c) effluent samples not following phosphorus reduction treatment step

a) all samples

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
N	Valid	111	111	110	111	111	110	110	109	76
Mean		8.1612	32.2955	10.73959	14.94288	.85684	20.94282	36.51609	6.42327	125.000
Std. Deviation		11.89332	75.37617	17.030477	17.654600	2.207711	30.023846	34.432948	5.010278	105.2158
Minimum		2.00	1.00	.039	.047	.025	.070	3.790	.036	5.0
Maximum		95.10	510.00	70.960	116.720	19.000	185.380	185.660	34.000	540.0
Percentiles	5	2.0000	1.0000	.03900	.05000	.02500	.37750	6.48250	.38500	5.000
	25	2.0000	2.4000	.36500	2.10000	.12000	2.44750	15.49500	3.45000	49.000
	50	3.1000	9.0000	2.65000	11.00000	.34000	9.71000	23.51500	5.70000	100.000
	75	9.2000	23.0000	11.00000	20.00000	.58000	26.20250	42.75250	7.75000	185.250
	95	30.8000	168.0000	59.00000	41.74200	3.27600	86.28700	117.12450	16.00000	331.500

b) effluent samples following phosphorus reduction treatment step

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
N	Valid	82	82	82	82	82	82	82	81	58
Mean		7.5182	30.3902	11.55263	15.11946	.74417	21.46012	36.95878	5.90136	133.586
Std. Deviation		9.06605	83.43561	16.762218	19.088660	2.266753	30.504994	36.846665	4.539155	100.1320
Minimum		2.00	1.00	.039	.047	.025	.070	3.790	.080	5.0
Maximum		34.00	510.00	64.000	116.720	19.000	185.380	185.660	27.000	540.0
Percentiles	5	2.0000	1.0000	.03900	.05000	.02500	.33200	6.31500	.55100	9.750
	25	2.0000	2.0000	.23750	1.70000	.09300	2.06750	15.49500	3.15000	66.500
	50	2.5500	7.0000	3.00000	11.00000	.21500	10.09000	22.25500	5.20000	115.000
	75	9.1250	16.2500	15.50000	20.00000	.55500	29.77750	40.90750	7.60500	190.000
	95	30.0000	178.0000	57.35000	44.09450	2.35800	83.05000	134.13000	15.60000	330.500

c) effluent samples not following phosphorus reduction treatment step

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
N	Valid	29	29	28	29	29	28	28	28	18
Mean		9.9793	37.6828	8.35854	14.44359	1.17541	19.42786	35.21964	7.93307	97.333
Std. Deviation		17.70007	46.27225	17.890998	13.039805	2.035076	29.056063	26.665620	6.015130	118.9953
Minimum		2.00	1.00	.039	.050	.025	.350	10.000	.036	5.0
Maximum		95.10	180.00	70.960	42.000	9.590	120.000	130.000	34.000	415.0
Percentiles	5	2.0000	1.5000	.07095	.07200	.02550	.45350	10.90000	.09630	5.000
	25	2.7500	7.4000	.41250	3.25000	.19000	3.67000	16.00000	5.40000	13.750
	50	4.7000	18.0000	1.85000	9.39000	.47000	8.61500	26.34000	7.10000	45.000
	75	10.5000	46.5000	7.00000	23.66500	.87500	17.57000	43.68750	9.19250	155.000
	95	65.0500	170.0000	67.82800	40.17000	7.54000	105.53700	111.03700	25.90000	415.000

Table 7. Median test results for differences between effluent composite samples taken after phosphorus reduction and effluent samples not taken after phosphorus reduction treatment steps.

Test Statistics[a]

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
N		111	111	110	111	111	110	110	109	76
Median		3.1000	9.0000	2.65000	11.00000	.34000	9.71000	23.51500	5.70000	100.000
Chi-Square		5.920	8.875	.767	.002	4.004	.192	1.725	6.133	3.171
Df		1	1	1	1	1	1	1	1	1
Asymp. Sig.		.015	.003	.381	.963	.045	.662	.189	.013	.075
Yates' Continuity Correction	Chi-Square	4.915	7.634	.431	.029	3.186	.048	1.198	5.094	2.280
	df	1	1	1	1	1	1	1	1	1
	Asymp. Sig.	.027	.006	.511	.865	.074	.827	.274	.024	.131

a. Grouping Variable: P_reduction_sampled

3.3.4 Effluent Grab Samples

This section discusses effluent grab sample results. As was the case for composite samples, the samples are distinguished by whether or not a phosphorus reduction step was present upstream of the sampling location. Table 8 summarizes the results. A median test shows significant differences between systems with and without phosphorus reduction step not only for total phosphorus but also for cBOD5, TSS, ammonia, nitrite, total nitrogen, and total alkalinity. .

The number of analytes for which significant differences occur is much larger for grab samples than composite samples, for which only cBOD5, TSS, and total phosphorus were significantly different. One reason for this could be that the higher number of samples allows detection of smaller differences as significant. Another reason could be that grab and composite samples are different. A median test for samples after a phosphorus reduction step showed that only cBOD5 was different between grab and composite samples, with the composite samples tending higher. The same test for effluent samples without a phosphorus reduction step showed no significant differences between grab and composite samples. This indicates that grab and composite samples were overall not different from each other as measured by the median test. The detection of significant differences for more analytes in grab effluent sample concentrations is then likely due to the larger sample size of grab samples. But, the assumption of the statistical test that samples are independent of each other is not strictly met because grab samples were taken in short intervals over the course of a single day and grab samples vary much less over the course of a day than between sampling events. For these reasons the finding of additional significant effects of the phosphorus reduction treatment step appears to be an artifact.

A comparison of these results of the grab sampling with the distribution of grab sample results from a broader survey in the Florida Keys is of interest: The median concentration results for about 900 samples in that study were 5 mg/L, 32 mg/L, 26 mg/L, and 7.8 mg/L respectively, for cBOD5, TSS, TN, and TP. Most of those samples were from aerobic treatment units without phosphorus reduction step, and may therefore be comparable to the results in Table 8c. The medians reported there are 4.2 mg/L, 20 mg/L, 27 mg/L, and 7.1 mg/L, respectively. This suggests that the typical effluent for ATUs has remained very similar, which is supported by the observations that median concentrations from intermediate composite results (Table 5a) are similar in magnitude to the treatment unit samples reported by Roeder and Brookman (2006). In contrast to these areas of agreements, this study found far fewer very high concentration results, so that the relative standard deviations and the 95-percentiles of this study are generally lower than the 90-percentile reported by Roeder and Brookman (2006). The lack of influent concentration measurements in the previous study makes it difficult to assess what combination of reduced water use, differences in employed technology, and differences in operation and maintenance in the two sample populations combined to yield these results.

Table 8. Statistics of effluent grab sample concentrations: a) all samples; b) effluent samples following phosphorus reduction treatment step; c) effluent samples not following phosphorus reduction treatment step

a) all samples

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
N	Valid	445	448	449	449	449	449	449	445	308
Mean		9.1968	25.9670	11.38101	14.83197	.70231	20.79302	36.09156	6.23426	125.484
Std. Deviation		17.08720	67.56809	17.523687	17.340984	1.486672	30.971103	34.401153	4.306848	108.1260
Minimum		2.00	1.00	.010	.047	.025	.038	2.700	.035	5.0
Maximum		170.00	910.00	90.000	121.030	11.550	198.920	199.050	30.000	590.0
Percentiles	5	2.0000	1.0000	.03900	.05000	.02500	.21500	6.50000	.25900	9.000
	25	2.0000	2.0000	.32500	2.44000	.12000	1.97500	15.00000	3.40000	52.500
	50	2.1000	6.3000	3.46000	11.30000	.24000	8.92000	24.00000	6.00000	98.500
	75	9.0000	22.0000	12.00000	21.00000	.58500	25.38000	44.08000	8.36000	180.000
	95	31.0000	110.0000	55.00000	42.93500	2.95000	78.18500	110.84500	13.00000	325.500

b) effluent samples following phosphorus reduction treatment step

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
N	Valid	328	331	332	332	332	332	332	328	236
Mean		7.3490	13.9807	12.36192	14.74019	.52129	21.21756	36.21759	5.65994	135.542
Std. Deviation		9.38602	28.73034	17.293897	18.587893	1.084422	31.877712	36.992441	4.050515	105.2342
Minimum		2.00	1.00	.010	.047	.025	.038	2.700	.080	5.0
Maximum		60.00	300.00	69.000	121.030	9.540	198.920	199.050	30.000	590.0
Percentiles	5	2.0000	1.0000	.03900	.04700	.02500	.07000	5.64300	.31150	11.700
	25	2.0000	2.0000	.21500	1.40000	.09000	1.54000	13.63750	2.70000	66.250
	50	2.0000	4.6000	4.00000	11.41000	.20000	9.05500	23.00000	4.90000	110.000
	75	8.3750	13.0000	17.50000	20.00000	.51000	26.99500	43.96000	7.80000	190.000
	95	28.5500	50.8000	52.05000	43.41900	1.60000	75.14200	122.56100	12.00000	321.500

c) effluent samples not following phosphorus reduction treatment step

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
N	Valid	117	117	117	117	117	117	117	117	72
Mean		14.3768	59.8769	8.59757	15.09241	1.21597	19.58832	35.73393	7.84432	92.514
Std. Deviation		28.85286	116.93906	17.944036	13.242922	2.195551	28.335685	25.798742	4.604402	111.6220
Minimum		2.00	1.00	.039	.050	.025	.074	5.800	.035	5.0
Maximum		170.00	910.00	90.000	44.000	11.550	143.260	143.260	27.000	406.0
Percentiles	5	2.0000	1.0000	.06060	.09400	.02600	.80300	7.33000	.03500	5.000
	25	2.0000	6.0000	.60500	3.51500	.18000	3.25000	18.53500	5.40000	11.000
	50	4.2000	20.0000	1.90000	11.23000	.47000	7.69000	27.00000	7.10000	32.000
	75	9.4000	50.0000	7.05000	24.89500	1.20000	17.63000	45.00000	9.60000	140.000
	95	99.5700	269.0000	69.37900	39.22900	5.28700	90.38200	90.38200	16.20000	397.000

Table 9. Median test results of differences between effluent grab samples with and without phosphorus reduction step.

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
N		445	448	449	449	449	449	449	445	308
Median		2.1000	6.3000	3.46000	11.30000	.24000	8.92000	24.00000	6.00000	98.500
Chi-Square		22.235	37.585	4.725	.087	15.678	.525	5.750	16.101	16.314
Df		1	1	1	1	1	1	1	1	1
Asymp. Sig.		.000	.000	.030	.768	.000	.469	.016	.000	.000
Yates' Continuity Correction	Chi-Square	21.231	36.278	4.269	.035	14.838	.381	5.246	15.249	15.244
	df	1	1	1	1	1	1	1	1	1
	Asymp. Sig.	.000	.000	.039	.852	.000	.537	.022	.000	.000

3.3.5 Bacteriological Samples

Late in Phase 2 and early in Phase 3, samplers obtained some effluent samples that they delivered to a local laboratory for bacteriological analysis. The small number of samples, together with the occurrences of some "too numerous to count" results and varying reporting limits, limit the precision of the results. Table 10 provides the summary of numerical values of effluent samples. Five of the twenty fecal coliform samples exceeded both the 200 cfu/100 mL annual average standard and the 400 cfu/100 mL grab sample standard for secondary treatment standards. Two of these high samples stemmed from systems discharging to drainfields, for which disinfection requirements do not apply. One of these systems also did not include a phosphorus reduction treatment step. Two of the 13 enterococci samples resulted in concentrations of 80 cfu/100 mL or larger.

Table 10. Bacteriological sample results

		Fecal_coliform(cfu/100mL)	Enterococcus(cfu/100mL)
N	Valid	20	13
Mean		326.45	104.62
Std. Deviation		636.769	329.821
Minimum		2	2
Maximum		2250	1200
Percentiles	5	2.00	2.00
	25	2.00	2.00
	50	20.00	4.00
	75	394.00	20.00
	95	2221.00	1200.00

3.4 Water Use

During most sampling events, samplers obtained an event 24-hour water use measurement based on water meter recordings. For residences overall, this resulted in 73 daily water use measurements with a mean of 190 gpd, standard deviation of 170 gpd, a median of 150 gpd, and a interquartile range from 70 to 235 gpd. As mentioned before, for the very first sampling event, samplers added water to the treatment system to trigger a dosing event. After eliminating this data point, mean, standard deviation and median remained approximately the same, and the interquartile range changed from 65 to 230 gpd. Figure 2 shows the distribution of (daily) event water uses. The distribution appears bimodal: one mode (0-67 gpd) is located at very low water uses, which may represent that no users were present on that day. The second mode (133-200 gpd) includes the median and mean water use and in this way represents a "typical water use". A determination of the Spearman correlation between water use and influent concentration (29 data pairs) did not detect any significant correlation.

The individual measurements of water use were averaged by system or house. This resulted in a mean water use of the 32 houses of 190 gpd with a standard deviation of 120 gpd, a median of 170 gpd, and an interquartile range from 110 to 240 gpd. The upward shift of the lower quartile and the reduction in standard deviations suggests that some houses that had no water use on one sampling event day, had high to very high water use on another sampling event day.

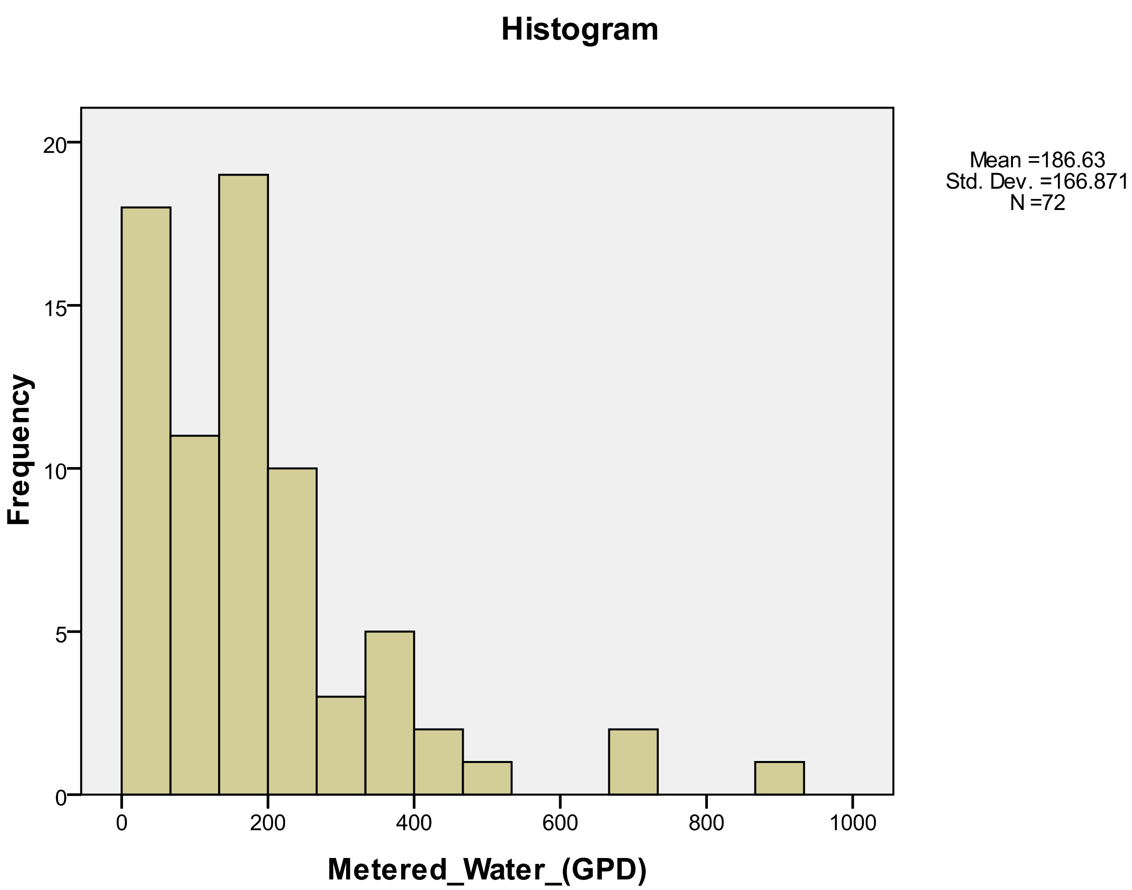


Figure 2. Histogram for residential event water use (except first sampling event)

3.5 Variations Between Grab Samples During a Composite Sampling Period

3.5.1 Variability Between Pairs of Grab Samples

One way to assess how representative one grab sample is for a sampling period is to compare it to other grab samples taken during the same sample sampling period. For the sampling periods of this study, this resulted in nearly 700 pairs. For the purposes of this analysis, a difference of zero was assigned to two samples that were below the laboratory detection limit (qualified as “U”), even though the reported detection limit may have varied. Table 11 summarizes the relative standard deviations observed. For cBOD5 and nitrite a substantial fraction of sample pairs did not show a difference, as many samples had concentrations below the detection limit. TSS showed the highest variability with an average RSTD of 35%. The various nitrogen species varied on average more than total nitrogen. TP and total alkalinity tended to vary the least.

Table 11. Relative standard deviations for pairs of grab samples taken during the same event.

relative standard deviation	cBOD5	TSS	Ammonia -N	TKN	Nitrate-N	Nitrite-N	TN	TP	Total Alkalinity
number of pairs	688	692	694	694	694	694	694	688	476
fraction with rstdev=0	0.47	0.18	0.19	0.10	0.23	0.49	0.14	0.17	0.30
5-percentile	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25-percentile	0.000	0.070	0.018	0.036	0.002	0.000	0.013	0.013	0.000
50-percentile	0.034	0.286	0.085	0.109	0.034	0.015	0.046	0.045	0.030
75-percentile	0.227	0.535	0.303	0.262	0.118	0.241	0.103	0.123	0.073
95-percentile	0.794	0.979	0.936	0.850	0.718	1.020	0.383	0.330	0.356
Average	0.166	0.351	0.230	0.206	0.131	0.199	0.100	0.098	0.070
Stdev	0.261	0.322	0.320	0.267	0.267	0.324	0.176	0.167	0.122

3.5.2 Influence of Time Lag

Several grab samples collected over time allowed an assessment of how quickly concentrations change over the course of a day. This analysis compared the time differences between the times when two grab samples were taken to the relative standard deviations of their concentration results.

Table 12 summarizes the relative differences between a sample and subsequent samples. Initial inspection suggested that the differences between the first grab sample and all subsequent samples might be different from the relationships between all subsequent samples. An explanation for such behavior could be, for example, that the first sample is more influenced by the deployment of the sampling apparatus. Therefore, Table 12 distinguishes three groupings: all data, comparisons to the first grab sample of all other grab samples, and comparisons between grab samples other than the first. For cBOD5 and TSS there is a distinct difference between the two latter sub-groupings, that is highly significant as measured by a two-tailed t-test with unequal variances; for total alkalinity the difference is less significant with a significance level of 0.057. For TSS, the first grab sample appears to show noticeably higher concentrations (relative differences median 15%, average 24%) than subsequent samples. For subsequent samples there is still some average decrease in concentrations but to a lesser extent (average 7%, median 0%). For cBOD5, the average relative difference between the first and subsequent samples is about 10%, but the median is 0 %, and for subsequent sample there appears to be no strong downward pattern. For all other analytes, there did not appear to be a significant difference between the differences to the first sample and differences between all subsequent samples.

Table 13 shows the median of the resulting relative standard deviations grouped by time difference between sampling events. Results are based on at least 30 samples in each group. In contrast to the plausible expectation that later samples should generally be more different from an initial sample compared to earlier samples, there is no consistent pattern showing such behavior. Given the anomaly of the first grab sample results for TSS and cBOD5 discussed before, the same sub-grouping was used in this analysis. TSS, which in all groupings showed the highest variability, showed a median relative standard deviation between 30 and 40% compared to the first grab sample, but only 20-30% for differences between subsequent grab samples. For nitrate and cBOD5 the typical variability is diminished to about half, from levels less than 10% to levels below 5%. Total alkalinity, ammonia, nitrate-, and nitrite nitrogen do appear to have a tendency towards increased variability with time in both sub-groupings, but the overall effect is small, with increases in relative nitrate and total alkalinity standard deviations of less than 5% in all cases, and increases of ammonia and nitrite relative standard deviations of 11% or less.

Table 12. Median relative difference between two grab samples, the first grab sample and subsequent grab samples, and relative differences between grab samples other than the first grab sample.

Relative differences		cBOD5	TSS	Ammonia-N	TKN	Nitrate-N	Nitrite-N	TN	TP	Total Alk.
overall	Median	0.000	-0.064	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Average	-0.044	-0.153	-0.022	0.009	-0.006	0.041	0.010	-0.009	-0.021
first sample	Median	0.000	-0.154	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Average	-0.099	-0.240	-0.028	-0.005	-0.003	0.040	0.011	-0.017	-0.039
all other samples	Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Average	0.009	-0.070	-0.016	0.023	-0.010	0.042	0.009	-0.002	-0.004
Significance level of two-tailed t-test w/ unequal variance between first and all other samples		0.001	0.001	0.786	0.437	0.832	0.961	0.927	0.473	0.057

Table 13. Median relative standard deviation between different grab samples.

	Time Difference (d)		Parameter								
	between	and	cBOD5	TSS	TKN	Ammonia -N	Nitrate-N	Nitrite -N	TN	TP	Total Alk.
first grab sample	0.04	0.10	0.06	0.30	0.10	0.08	0.04	0.02	0.03	0.03	0.02
	0.10	0.21	0.05	0.40	0.12	0.08	0.03	0.06	0.05	0.05	0.05
	0.22	0.39	0.07	0.37	0.11	0.07	0.04	0.05	0.06	0.09	0.04
	0.71	1.17	0.06	0.34	0.15	0.15	0.06	0.13	0.05	0.05	0.05
all other grab samples	0.04	0.10	0.03	0.22	0.09	0.06	0.02	0.00	0.04	0.04	0.02
	0.10	0.21	0.03	0.30	0.12	0.09	0.02	0.00	0.05	0.03	0.02
	0.22	0.39	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d
	0.71	1.17	0.00	0.22	0.12	0.11	0.04	0.06	0.03	0.05	0.03

3.6 Variability of Grab Samples During Diurnal Sampling

Relative standard deviations for the grab samples for each sampling period were determined. Table 14 summarizes the distribution of grab sample relative standard deviations. As could be expected, there is considerable variability in this measure between no changes at all during the course of a day, and relative standard deviations that exceed 100%. Generally, total alkalinity, TN, and TP show the lowest variability, with 95% of sampling events resulting in a relative standard deviation of 40% or less. The individual nitrogen species have usually higher variability than the total nitrogen measurements. Nitrate, cBOD5, TKN, ammonia and nitrite show increasing variability. The highest variability by far is shown by TSS, for which only 25% or sampling events show a relative standard deviation of 40% or less.

A Pearson correlation of the ranks of relative standard deviations indicated very limited associations. The highest correlation was 0.56 between nitrate and nitrite nitrogen variability, and 0.53 between TSS and total alkalinity variability. The next highest correlations were between TKN and total nitrogen (0.4), nitrate and total nitrogen (0.39), total nitrogen and total phosphorus (0.38), and ammonia and TKN (0.37). The correlation of variability between nitrogen species is plausible. More interesting is the result that some association exists between analytes that are not as obviously related, such as TSS and total alkalinity, and TN and TP.

Linear correlations between the mean concentration during a day and the relative standard deviations resulted in correlation coefficients of less than 0.1 for all analytes except for TSS, for which the correlation coefficient was only 0.17. This indicates that the normalization of standard deviations to relative standard deviations was successful in removing the influence of the absolute magnitude of concentrations from the variability assessment.

This and the previous section developed two measures of the variability of grab samples: the distribution of relative standard deviations between any two individual grab samples taken during an event (previous section), and the relative standard deviations of all grab samples taken during an event. A comparison between the two indicates that the relative standard deviations of all grab samples taken during a sampling event tend to be larger, in particular for nitrite, TSS, and cBOD5. The exception is nitrate. While no further analysis of this was attempted, one possible reason for this could be that the analysis of this section utilized the numerical value for any sample, while the analysis for inter-grab sample variability assigned a difference of zero to two grab samples that were both below the detection limit, even though the detection limit may have been different due to different dilutions.

Table 14. Distribution of relative standard deviations for grab samples collected over a day

	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
number of events	110	111	111	111	111	111	111	110	76
fraction with rstdev=0	0.35	0.07	0.11	0.12	0.39	0.04	0.05	0.05	0.17
5-percentile	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00
25-percentile	0.00	0.24	0.04	0.02	0.00	0.08	0.03	0.03	0.02
50-percentile	0.13	0.40	0.14	0.06	0.14	0.15	0.06	0.08	0.05
75-percentile	0.36	0.66	0.42	0.19	0.44	0.36	0.13	0.14	0.10
95-percentile	0.95	1.03	0.95	0.71	1.22	0.68	0.40	0.36	0.38
Average	0.24	0.47	0.28	0.18	0.29	0.25	0.12	0.13	0.09
Stdev	0.31	0.32	0.35	0.30	0.40	0.24	0.15	0.19	0.12

3.7 Differences Between Grab and Composite Samples

Table 15 shows the relative differences between the average of grab samples and the time composite samples taken during the same sampling event. Negative numbers indicate that the composite sample had higher concentrations than the average of the grab samples. The median and average of the relative differences are very close to zero, indicating that there is no systematic bias between the two measures of daily effluent concentrations.

The standard deviation of the relative differences provides a measure of how frequently the differences are large. The most varying analyte is TSS, while total alkalinity, TP, TN and nitrate are the least variable. This order of variability is the same as the one for average relative standard deviations of grab samples over the course of a day (see Table 14).

A different approach to comparing grab samples and composite samples consists in performing a median test between all composite effluent samples and all individual grab samples. Table 16 shows the results of this test. This analysis indicates that cBOD5 (p=0.012) and to a lesser extent (p=0.065), TSS, are somewhat but significantly higher in composite samples than in grab samples. It may require further analysis to discern what causes this result to be different from the results shown in Table 15.

Table 15. Distribution of relative differences between average of grab samples and time-composite samples during the same sampling event, generally a 24-hour period.

	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
Number of events	110	111	110	111	111	110	110	109	76
5-percentile	-0.76	-1.54	-0.89	-0.37	-0.72	-1.05	-0.36	-0.45	-0.37
25-percentile	-0.23	-0.47	-0.10	-0.06	0.00	-0.17	-0.06	-0.06	-0.08
50-percentile	0.00	0.00	0.01	0.00	0.00	0.02	0.01	0.01	-0.01
75-percentile	0.10	0.47	0.22	0.07	0.14	0.19	0.10	0.09	0.05
95-percentile	0.80	1.27	1.09	0.42	1.11	0.62	0.34	0.21	0.31
Average	-0.01	-0.01	0.07	0.01	0.05	-0.05	0.02	-0.02	-0.01
Stdev	0.51	0.78	0.55	0.33	0.57	0.53	0.28	0.26	0.22

Table 16. Median test results between all effluent composite and effluent grab samples.

Test Statistics[a]

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
N		556	559	559	560	560	559	559	554	384
Median		2.400	6.800	3.000	11.11500	.24500	8.980	24.00	5.880	99.500
Chi-Square		6.812	3.802	.621	.101	.551	.199	.004	.560	.066
Df		1	1	1	1	1	1	1	1	1
Asymp. Sig.		.009	.051	.431	.750	.458	.655	.947	.454	.798
Yates' Continuity Correction	Chi-Square	6.269	3.400	.465	.045	.405	.116	.002	.411	.016
	df	1	1	1	1	1	1	1	1	1
	Asymp. Sig.	.012	.065	.495	.832	.525	.734	.968	.521	.898

a. Grouping Variable: sample_type

3.8 Observations Relating to High Variability

Notes taken by the samplers on the sampling events suggest a few possible sources for variability between grab samples and differences between grab and time-composite samples.

In the very first sampling event, substantial amounts of water were added to the influent, in order to trigger a dosing event, which in turn would refill the sampling port. This resulted in a total water use for the day of 630 gallons. The series of grab samples from this event show a pronounced step increase in concentrations from the first grab sample to subsequent grab samples for all parameters. Relative to other sampling events, this event had among the highest relative standard deviations for TN, nitrite, and nitrate (top ten), and fairly high for TKN and cBOD5 (top twenty). The differences between the average of grab samples and the time-composite samples were among the ten largest positive for cBOD5, nitrite, TKN, and TN; and negative for nitrate.

For the 53rd and 54th events, notes indicated that the sampler requested the owner to use additional water because not enough was left in the sampling port to sample, resulting in a total water use of 150 and 50 gallons. In both cases, the total suspended solids show a marked elevation during the grab samples preceding the request, and a drop in the samples after the request. The other parameters do not change clearly. The relative standard deviations for event 53 were not particularly high for any parameter, while cBOD5 for the event 54 showed the 5th highest relative standard deviation. In contrast, the relative differences between grab samples and composite samples were among the ten highest positive for cBOD5, TSS, TN, and TP in the first case and the ten highest for cBOD5 and TSS in the second case.

For the 76th event, a sampling note indicated that after the first grab sample, water was added for about 15 minutes to the building sewer cleanout, which increased the total usage to 150 gallons on that day. The influence on effluent concentration is less clear, as suspended solids in the next grab sample increased and then decreased markedly over the next two samples. For this day the TP concentrations show the fifth highest relative standard deviation and cBOD5 concentrations the 17th highest. Among the relative differences between grab and time-composite samples, only ammonia showed a relatively high negative difference.

Event 106 included addition of 15 minutes of water after the first grab sample, after having advised the owner to use some water before the sampling event. This resulted in a water use of 340 gallons. While some decrease in the concentrations of several parameters in subsequent grab samples during the same afternoon appears to be present, the composite sample results are consistent with the initial grab samples. Ammonia and total nitrogen relative standard deviations were in the top 20 of sampling events.

A note for event 59 indicated that the owner returned home overnight after being absent while the grab samples were taken. Even though the return occurred after the grab samples were taken, the grab samples show comparatively high relative standard deviations for nitrate and nitrite (in top 10) and TSS (in top 20). The composite effluent sample shows a marked change from the grab effluent samples for all parameters, with ammonia and nitrate showing among the largest negative relative differences, and TKN and TN the highest positive differences. This occurred, even though the water use for the day was only 30 gallons.

A sampling note for event 60 indicated that it rained after the last grab sample was taken, and that surface runoff flowed into to the effluent sampling port. Given that the disturbance occurred after the grab samples were taken, it is not surprising that the relative standard deviations were not very high compared to other events. A comparison of grab and composite effluent samples shows that the composite samples contained about twice as high suspended solids, and about a third lower TKN, nitrate, nitrite, TN, and TP concentrations than the fairly steady grab samples. In terms of relative differences between grab sample average and composite sample for this event, nitrate, TN, TP and total alkalinity are among the ten highest events, but TSS was not.

Overall, these anecdotes suggested that water use patterns over the course of the day can influence grab samples, which in turn can influence the variability of the grab samples obtained and the differences between composite and grab sample averages. Perhaps because timing of water use and grab samples was variable in this study, there was no general pattern in these differences discernable.

3.9 Differences Between Repeat Sampling Events

3.9.1 Effluent Samples

Over the course of the study, systems were sampled repeatedly, with one exception of a single sample event system. For some systems that were included in all phases of the study, up to 7 sampling events occurred, for systems that were only included in the last phase, only two sampling events occurred. These sampling events provide an opportunity to assess the variability between samples at the same system on different days. The intervals between two sampling events at the same site ranged from the next day to 799 days, with 90% between 49 and 730 days.

The results for relative differences for all possible combinations of sampling event results are shown in Table 17. Both TSS and ammonia appear to show a bias that later sampling events are higher in concentration than earlier events, while total alkalinity shows an element of the reverse. Given the large standard deviations, these biases are not significant when assuming a normal distribution.

Tables 18 and 19 illustrate the distribution of relative standard deviations between samples of the same system based on averages of grab samples (Table 18) and composite samples (Table 19). To exclude the effect of some systems having been sampled more frequently than others, Table 20 summarizes average relative standard deviations and their variability after first averaging the observations for each system and then averaging across the 38 systems with more than one sampling event. In all cases, TN and TP show the lowest variability, while nitrite and ammonia show the highest variability.

Table 17. Summary of relative differences between event samples at the same system.

Parameter	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
Average of relative differences between composite	0.08	0.33	0.38	-0.09	-0.01	-0.03	0.00	-0.09	-0.18
stdev comp	0.84	1.02	1.18	0.87	1.29	1.11	0.65	0.62	0.74
Average of relative differences between average of event grab samples	0.05	0.23	0.35	-0.12	0.01	-0.02	0.08	-0.08	-0.17
stdev grab	0.90	0.92	1.15	0.91	1.23	1.13	0.68	0.63	0.75

Table 18. Distribution of relative standard deviations between event averages of multiple grab samples taken from the same system

Parameter	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
Number	132	138	138	138	138	138	138	136	47
5-percentile	0.00	0.02	0.03	0.03	0.05	0.07	0.01	0.02	0.04
25-percentile	0.02	0.22	0.28	0.11	0.37	0.23	0.10	0.10	0.17
50-percentile	0.36	0.44	0.73	0.40	0.79	0.58	0.31	0.21	0.33
75-percentile	0.80	0.89	1.12	0.80	1.14	1.07	0.58	0.46	0.56
95-percentile	1.21	1.24	1.37	1.30	1.31	1.33	1.03	0.93	1.10
Average	0.46	0.54	0.72	0.49	0.76	0.66	0.37	0.32	0.42
Stdev	0.44	0.40	0.45	0.42	0.41	0.44	0.31	0.31	0.34

Table 19. Distribution of relative standard deviations between composite effluent samples taken from the same system.

Parameter	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
Number	138	138	133	138	138	133	133	131	47
5-percentile	0.00	0.00	0.04	0.03	0.07	0.06	0.02	0.01	0.03
25-percentile	0.14	0.35	0.32	0.13	0.55	0.22	0.11	0.11	0.17
50-percentile	0.39	0.62	0.86	0.32	0.85	0.62	0.27	0.23	0.30
75-percentile	0.80	0.97	1.14	0.71	1.18	1.03	0.50	0.46	0.50
95-percentile	1.08	1.28	1.38	1.30	1.34	1.33	0.99	0.97	1.05
Average	0.47	0.64	0.75	0.46	0.81	0.65	0.35	0.32	0.41
Stdev	0.36	0.39	0.45	0.41	0.41	0.44	0.30	0.31	0.35

Table 20. Average relative standard deviations based on averaging relative standard deviations for each system (n=38).

Parameter	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
Average grab system averages	0.45	0.54	0.60	0.57	0.77	0.54	0.34	0.31	0.43
Stdev	0.38	0.34	0.41	0.41	0.33	0.38	0.28	0.28	0.36
Average comp sample systems	0.38	0.61	0.63	0.58	0.80	0.55	0.35	0.31	0.43
Stdev	0.33	0.35	0.39	0.41	0.37	0.39	0.29	0.25	0.37

The Pearson correlation coefficient between length of time between sampling events and relative standard deviations was less than 0.2 for all analytes. This indicates that there is no common pattern of samples becoming more different as more time elapses between sampling events. For grab samples, the following pairs showed Pearson correlation coefficients between 0.5 and 0.7: TKN and TN, TKN and cBOD5, total alkalinity and cBOD5, and ammonia and total alkalinity. These pairs appear to indicate a common pattern of completeness of biochemical stabilization and nitrification. Composite effluent samples have similar correlations, except lower for ammonia and total alkalinity, and cBOD5 and total alkalinity, and higher between total alkalinity and TKN.

One-way ANOVAs allowed an assessment of the importance of differences between systems relative to the variability of grab samples or composite samples. Differences between systems were significant ($P<0.05$) relative to variability between events (composite samples) and variability between grab samples (grab samples), with the exception of nitrite for composite samples, while nitrate showed the largest F-value of all composite sample parameters. For grab samples, TN and TP were the largest F-values. This indicates that there are differences in the consistency of treatment between systems.

3.9.2 Influent Samples

Table 21 shows the distribution of the resulting relative differences between influent samples from the same system. While the averages suggest some bias, the highest for total phosphorus, ammonia and nitrate, compared to the standard deviation, they are not significantly different from zero (based on a normal distribution). A negative bias would indicate that influent concentrations decrease over time for the same system, for example due to changing patterns of household behavior.

A Pearson correlation between the relative standard deviations of influent samples and the time difference between influent samples showed no correlation coefficient larger than 0.3. Pearson correlations between the relative differences of analytes showed many correlation coefficients larger than 0.5, indicating that for influents, changes occur for several analytes together. The highest correlations were between TKN and TN (0.98) and ammonia and total alkalinity (0.82). TKN and ammonia, TN and ammonia, TKN and total alkalinity, and TN and total alkalinity all showed correlation coefficients between 0.7 and 0.8. With correlation coefficients between 0.5 and 0.7, total phosphorus and total alkalinity, total phosphorus and TKN, total phosphorus and TN, cBOD5 and TSS, TN and cBOD5, TKN and cBOD5, TN and cBOD5, and TN and TSS show much stronger correlations than they did for effluent samples.

Table 22 shows the distribution of relative standard deviations between influent samples from the same system. This table is comparable to Table 11 for effluent samples. Table 23 averages the relative standard deviations over the number of systems that were repeatedly sampled. The two tables show similar results, but nitrate appears more variable between systems and total phosphorus less variable between systems. Ammonia and total alkalinity show somewhat lower variability between systems Average relative standard deviations are generally of similar magnitude for influent and effluent samples. An analyte that appears to be more variable in influent samples is nitrate, which in influents is generally a small fraction of the total nitrogen, while ammonia is less variable.

A one-way ANOVA allowed an assessment of the importance of differences between systems relative to the variability of composite samples. Differences between systems were not significant relative to variability between events (composite samples) for cBOD5, TSS, and nitrate, and significant ($p<.05$) for total phosphorus, total alkalinity, ammonia, nitrite, TKN and total nitrogen. This indicates that the influent variability is large enough for each system that differences between systems are not identifiable for cBOD5 and TSS, but that differences by system are identifiable for TN and TP.

Table 21. Distribution of relative differences between influent composite samples taken from the same system.

Parameter	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
Number	44	48	48	48	48	48	48	46	21
5-percentile	-1.19	-1.44	-1.36	-1.62	-1.79	-1.05	-0.85	-1.40	-0.45
25-percentile	-0.53	-0.78	-0.16	-0.15	-0.71	-0.53	-0.53	-0.77	-0.19
50-percentile	-0.03	-0.19	0.09	0.00	0.25	-0.10	-0.11	-0.33	-0.04
75-percentile	0.33	0.50	0.62	0.94	0.50	0.47	0.47	0.19	0.12
95-percentile	1.12	1.96	1.33	1.64	1.69	1.35	1.31	1.44	0.50
Average	-0.10	-0.05	0.18	0.12	0.08	0.02	0.05	-0.23	-0.07
Stdev	0.73	1.00	0.83	1.07	1.07	0.83	0.76	0.88	0.38

Table 22. Distribution of relative standard deviations between influent composite samples taken from the same system.

Parameter	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
Number	44	48	48	48	48	48	48	46	21
5-percentile	0.01	0.10	0.00	0.00	0.01	0.01	0.01	0.06	0.03
25-percentile	0.12	0.25	0.10	0.00	0.24	0.09	0.09	0.19	0.05
50-percentile	0.29	0.48	0.26	0.65	0.42	0.38	0.38	0.40	0.14
75-percentile	0.73	0.86	0.74	0.96	1.10	0.65	0.58	0.83	0.27
95-percentile	0.95	1.39	1.17	1.24	1.27	1.27	1.00	1.16	0.40
Average	0.40	0.57	0.43	0.56	0.60	0.43	0.40	0.51	0.19
Stdev	0.32	0.40	0.41	0.50	0.45	0.39	0.35	0.38	0.20

Table 23. Average relative standard deviations based on averaging relative standard deviations for each system (n=18).

Parameter	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	TOTAL ALK.
Average	0.36	0.57	0.46	0.74	0.68	0.42	0.36	0.38	0.22
Stdev	0.32	0.33	0.44	0.40	0.42	0.44	0.35	0.31	0.22

3.10 Summary of Variability of Samples

The preceding sections described the variability observed between samples that could be thought of a representing the same observation points. Repeated analyses of the same sample, multiple grab samples during the same sampling events, and multiple sampling events at the same systems provide measures of variability at different time scales. Within the event time-scale, there was some indication that the variability of total alkalinity, ammonia, nitrate-, and nitrite nitrogen increased with longer time intervals between samples, but the effect was small. There was no such effect identified for the between event variability, because the variability was too high.

Figure 3 summarizes the variability as average relative standard deviation and its standard deviation, and as 75^{th} percentile of relative standard deviations. Figure 3 a and 3 b show this for grab sample variability, including the variability of replicate samples as a baseline variability. Figure 3 c and 3 d compare influent and effluent time composite samples. In most cases, the between-event variability is at least twice as large as the within-event variability. The only exception to this is TSS, which has the highest replicate and within-event variability of all analytes and for which the within-event variability is only about a third lower than the between-event variability.

Time composite effluent samples result in very similar variability characteristics as the grab samples. Influent and effluent time composite samples vary similarly with the possible exception that influent TP is more variable than effluent TP and influent total alkalinity is less variable than effluent total alkalinity.

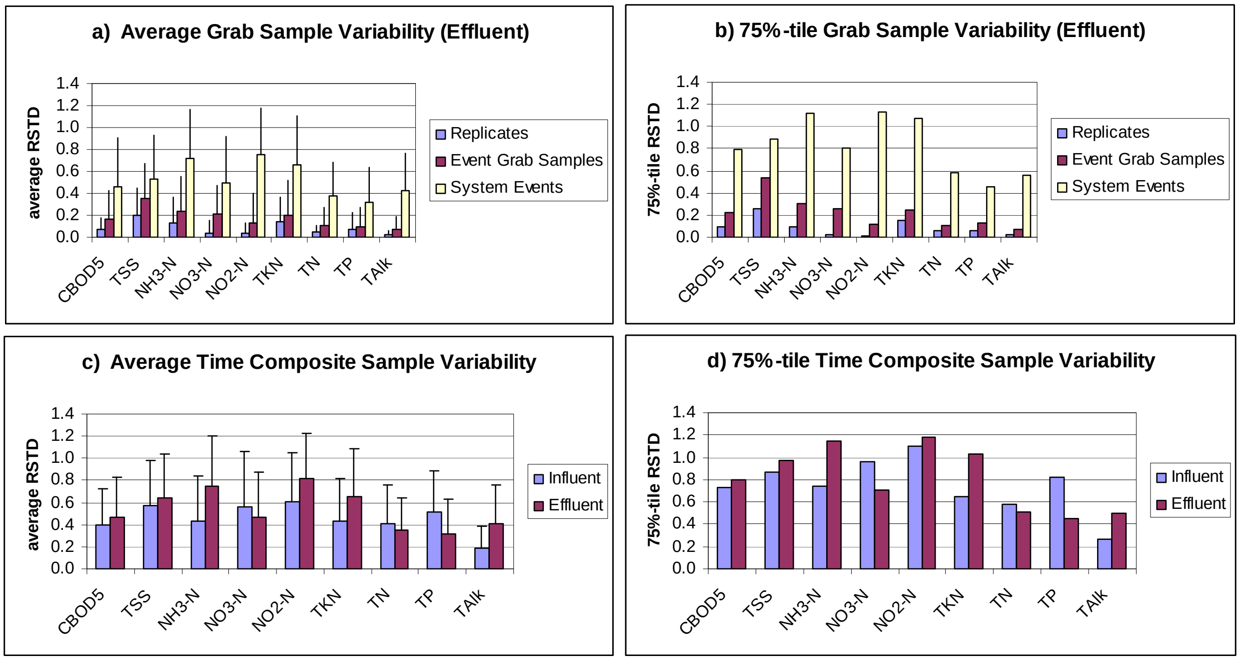


Figure 3. Comparisons of variability between samples. a) average relative standard deviations (+ one standard deviation) of replicates, grab samples during an event, and events for a system; b) 75%-tile of the relative standard deviations of replicates, grab samples during and event, and events for a system; c) average relative standard deviations (+one standard deviation) for influent and effluent time composite samples between events for a system; d) 75%-tile for influent and effluent relative standard deviations between events for a system

3.11 Differences between Days, Months and Seasons

3.11.1 Differences Between Days

Each sampling event spanned parts of two days, usually from the morning of one day to the morning of the next day. Sampling equipment was usually deployed on Monday, Tuesday, or Wednesday and composite samples taken on the following day, to allow for shipments to the laboratory to arrive by Friday. Only in three cases did sampling start on a Sunday.

Differences in results between days could result from patterns in user behavior over the course of a week. Only the individual home residential treatment systems were included in the analysis. To assess this effect, a median test for differences between water use measurements and composite sample concentration results by day was performed. In this assessment of composite samples, “Monday” represents the results from an event that began on a Sunday and ended on a Monday, while for grab samples, the day is the day when the sample was collected.

For effluent composite samples, water use is the only measurement that varies significantly between days. In follows a pattern of decreasing use from Monday through Thursday. Even after excluding the three Monday measurements, which all exceeded the median, the differences were still significant. For influent composite samples the differences between any concentration results, including water use, were not significant even at the 30%-level. The conflicting results on differences in patterns of water use indicates that for the smaller (n=30) number of measurements from systems that did allow for influent sampling, water use was fairly even, while the larger (n=73) number of measurements from all systems included enough differences in water use to become significant. This indicates that generalizations of user behavior need to proceed with caution.

Interestingly, for effluent grab sample concentrations, there appeared to be significant differences for TSS and ammonia-nitrogen ($P<0.05$), and to a lesser extent for total nitrogen ($P=0.088$). Using a different test (Kruskal-Wallis), the differences for total nitrogen were not significant. The TSS-concentrations followed a decreasing pattern from Sunday through Thursday. This could be, in part, related to the finding that the first grab samples tended to have higher TSS concentrations than later ones. On Sundays and Mondays, the proportion of first samples was much higher than Thursdays when sampling wrapped up.

This study showed a consistent lack of significant concentration differences by day in either influent or effluent composite samples, and only limited differences between effluent grab samples. This contrasts with results from a wider survey of systems with individual grab samples a few years earlier in the same area (Roeder and Brookman, 2006). Their analysis found generally higher concentrations on Wednesdays than on other days. Overall, this suggests that differences by day are not consistent.

3.11.2 Differences Between Months

As a first step towards assessing seasonal differences, data were analyzed for significant differences by the month of sample taken. Only the individual home residential treatment systems were included in the analysis. Effluent composite samples showed significant ($P<0.05$) differences for TKN and total nitrogen in the median test, but only significant differences for TKN in the Kruskal-Wallis test. The validity of this finding appeared impacted by the highest and lowest months being represented by very few samples (highest month n=1; two lowest months, n=2,3). No significant differences were found in event water use measurements between months. This indicates that the overall system population was not impacted by seasonal use patterns. This may be related to the initial system selection, which looked for homesteaded residences. Roeder and Brookman (2006) discuss similarly a lack of consistent differences between sample months for grab samples taken in February through November.

3.11.3 Differences Between Seasons

The initial experimental plan envisioned to classify samples according to visitor season, from the beginning of sampling through May as the peak season, and subsequent samples through December as off-season. The extension of sampling over several years and the finding of no significant differences in water use by month in the previous section suggest a modification of this approach. Instead of usage pattern, season is conceptualized as climatic season. The soil survey of the Keys area contains climatic data that closely align with, but are slightly different from the initial divisions (Hurt et al., 1995). For the purposes of analysis, the warm, wet season includes those months with average daily temperatures in exceeding 80^{o}F and monthly precipitation exceeding 3.2 in. These are the months from May through October. The cold, dry season includes the other months with average daily temperatures below 78^{o}F and monthly precipitation below 2.7 in. About two thirds of sampling events occurred during the cold, dry season.

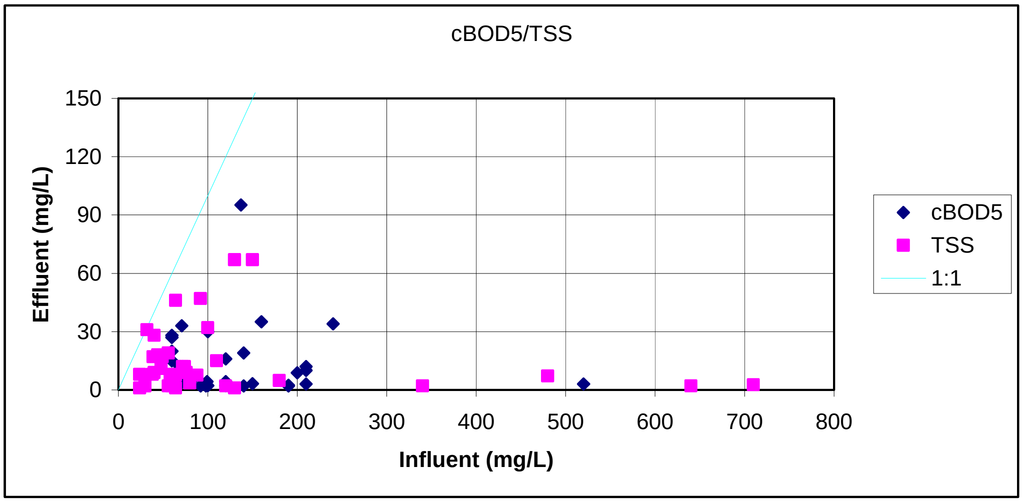
Assessments of differences by season for individual home system composite effluent and influent samples showed no significant differences for concentrations and water use. This indicates that for the individual home treatment systems considered the steady use and possibly the confinement to a treatment system are more important than seasonal differences temperature and precipitation. This finding may be specific to the Florida Keys, where the average daily temperature for January, the month with the lowest average daily temperature, is 69.3^{o}F.

4 INFLUENCES ON EFFLUENT CONCENTRATION

4.1 Influent Strength

The first level of analysis consists of a comparison of influent and effluent concentrations, in this case composite samples on the same sampling event. Figure 4 shows the results for up to 38 samples for laboratory analyses (excluding high solids, tap water, and recirculation samples). For comparison purposes, a 1:1 line, representing no treatment is also included. A result above the line indicates higher concentrations leaving the treatment system than entering it. One cause for such behavior is variability of the influent, combined with ineffective treatment, as in a situation where the influent concentration is lower for the sampling event period but the effluent concentration reflects prior, higher concentrations for a time influenced by the hydraulic residence time in the treatment system. Few sampling events yielded results that were above this line, and in agreement with the scenario outlined, they occur at relatively low influent concentrations. The most occurrences were for TP. Relative to TN, it appears unlikely that the influent variability is larger, so this is more likely a reflection of treatment effectiveness.

The overall results shows no correlations between influent and effluent concentrations (maximum R^2=0.14 between influent TN and effluent NO3-N). For cBOD5 and TSS, Figure 4 a illustrates that most effluent samples contain less than 10 mg/L of either. While TN effluent concentrations overall did not correlate with influent concentrations, there appears to be one group of results that remains close to the 1:1 line, indicating little treatment effectiveness, and another group with effluent concentrations remaining below 40 mg/L regardless of influent concentrations. Only about a quarter of influent samples contain less than 50 mg/L TN. TP shows most points just below the 1:1 line, with a few points indicating higher treatment effectiveness, mainly at high influent concentrations. Total alkalinity shows a pattern somewhat similar to TN, with a group of results close to the 1:1 line, indicating little removal, and a group that has seen higher alkalinity reductions. This corresponding pattern is consistent with the concept that nitrification, one of the treatment steps in nitrogen reduction, reduces alkalinity.



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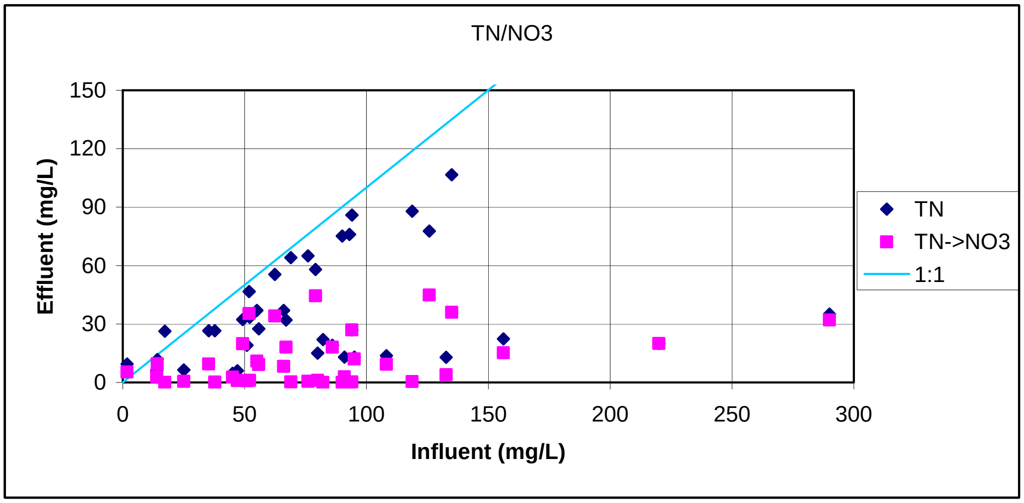

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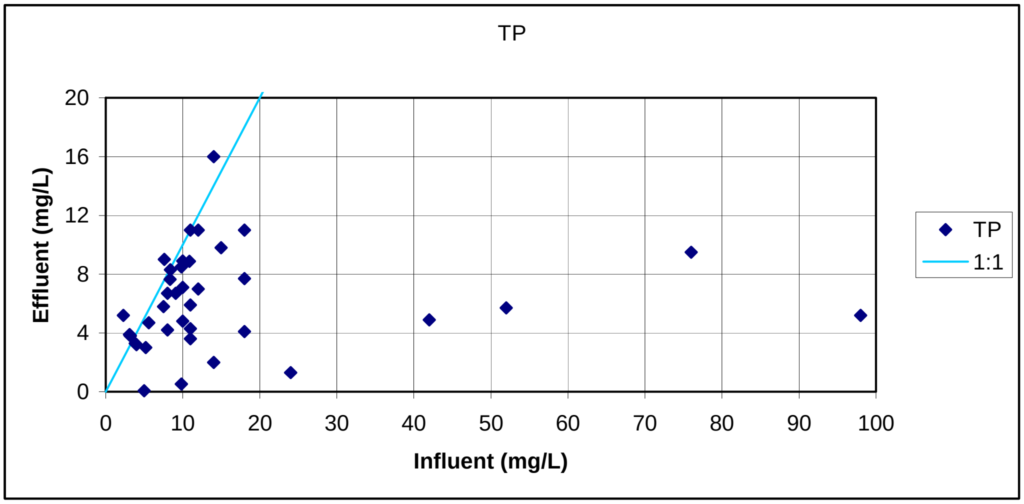

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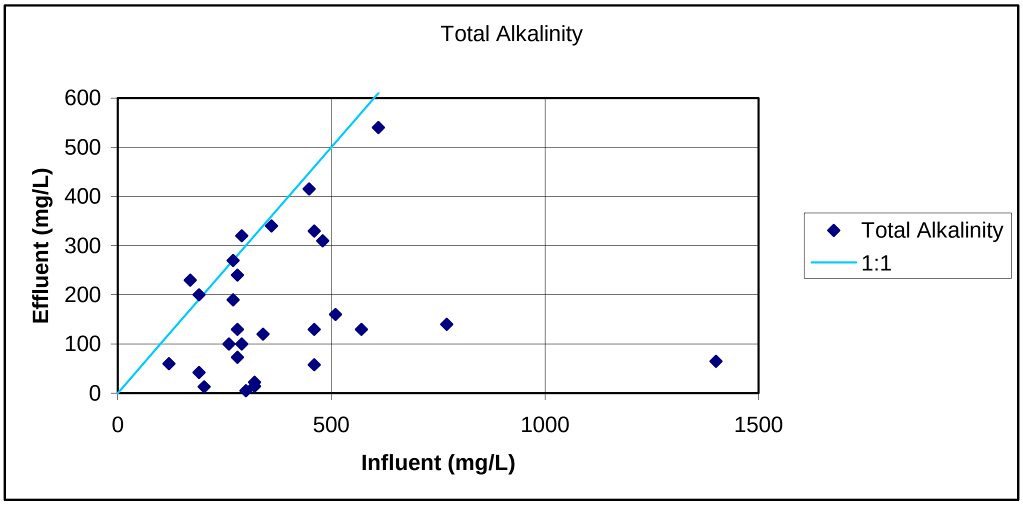


d)

Figure 4. Influent and effluent concentrations for composite samples, where both were sampled during the same sampling event. Influent excludes samples with high solids, tap water and recirculation systems. a) cBOD5 and TSS; b) TN; c) TP; d) total alkalinity.

Based on a median test, the influent did not differ significantly among the permitting categories (residential PBTS, ATU, commercial PBTS) for cBOD5, TSS, TKN, TN, TP and total alkalinity. On the other hand, effluent concentrations differed significantly between the different groups (<0.05) for cBOD5, TSS, ammonia-N, and total phosphorus. TKN had a lower level of significance (0.062). A comparison between just single family residences PBTS and ATU had similar results. One difference between many of the PBTSs and the ATUs is the presence of a phosphorus reduction treatment step, which was previously shown to have a significant effect on many of the same analytes.

4.2 Phosphorus Reduction Treatment Approaches

Six phosphorus treatment approaches were included as part of this study. The classification was based on field observations and permit review. The treatment approaches were: AOS, a type of light expanded clay aggregate (LECA) material; brickchips either unsaturated or undetermined; LECA filtralite either saturated or unknown; and mid-floc, a chemical additive. Of these, LECA and brick chips had been tested in unsaturated conditions in a treatment feasibility demonstration study in the Florida Keys (Ayres Associates 1998, 2000). This study included the side-by-side comparison of a variety of treatment technologies on Big Pine Key. The results were available when the treatment system standards were set and have informed subsequent designs. Since then, engineers have specified LECA-filtralite also in saturated conditions in part based on information by the manufacturer; and occasionally, engineers have specified mid-floc, likely based on experiences with larger wastewater treatment plants. A median test indicated significant differences in effluent quality for most of the analytes.

Table 24 shows the statistics of total phosphorus concentrations after each of these treatment steps. These statistics indicate that the mid-floc and AOS treatments result in the highest median TP-concentrations, while the Leca filtralite treatment systems provide the lowest concentrations. The mid-floc treatment relies on the addition of chemicals to a treatment tank. The apparent lack of effectiveness could be due to either lack of maintenance, as in keeping chemicals supplied and the dosing mechanism operating, or a lack of technological treatment effectiveness. All the other treatment approaches are designed to rely on absorption, and the design usually contain a note that there is a limited lifetime for the absorption capacity. The lack of treatment effectiveness for at least two of the treatment approaches sampled, AOS and unsaturated brick chip, indicates that the performed monitoring and maintenance is not sufficient to determine that replacement was needed or that design or installation shortcomings had occurred.

	AOS	mid-floc	brick chip unsaturated	brick chip unknown	LECA saturated	LECA unknown
Mean	6.79	10.39	5.64	6.83	3.99	1.48
Std. Deviation	4.47	6.36	4.63	2.13	2.65	1.03
Median	8.90	8.75	4.60	6.15	3.95	1.20
N	9	8	36	12	10	6

Table 24. Statistics of total phosphorus concentration after different phosphorus reduction treatment steps.

4.3 Nitrogen Reduction: Nitrification

A pairwise comparison of influent and effluent composite samples was used to assess limitations on treatment effectiveness for nitrogen. The details are contained in Roeder and Brookman (2010). The general results of that effort were the following:

The most nitrified samples (TKN/TN <0.2) show the lowest total nitrogen concentrations along with consistently very low levels of cBOD5. This is consistent with the result of an influent-effluent comparison that TN-reduction between influent and effluent was very strongly correlated with the TKN-reduction, or nitrification. For these highly nitrified samples with low cBOD5 concentrations, a carbon limitation for further denitrification appears likely.

The least nitrified (TKN/TN >0.9) effluent samples also tended to have a substantial amount of cBOD5 left. Both lack of nitrification and remaining cBOD5 are consistent with a lack of aeration or aerobic activity. There are no data available at this point to assess if this lack stems from toxicity, technological limitations, or operational upsets, including shutting off the system. Intermediately nitrified effluents also showed some, albeit lower, levels of cBOD5. Some of these effluent samples contained very low alkalinity, which could suggest an alkalinity limitation to further nitrification.

Nitrogen reduction effectiveness was estimated for the three groups of nitrification completeness based on influent/effluent composite sample pairs in each group and found noticeable differences between the groups: for highly nitrified effluent samples (14 effluent samples), the median removal was 75%; for intermediately nitrified effluent samples (34 samples) the median removal was 44%; for the 15 least nitrified effluent samples, the median removal was 28%. This indicates that there are differences in well as compared to poorly operating treatment systems. The analyses so far have not concluded what causes the differences in operational quality have. Anecdotes exist that homeowners occasionally switch off the aeration of the treatment system, or an electrical malfunctions stops aeration until the malfunction is remedied, but the extent of this problem was not quantified in this study. It appears likely that operation and maintenance play a role in ensuring proper and optimal functioning of a treatment system.

5 SCREENING TESTS

The study included several screening tests to assess whether the results agreed with the results of laboratory analytical methods. This agreement could be useful in two ways: a quantitative agreement to allow prediction of laboratory results from field screening tests, or the determination that a sample exceeds a given concentration value.

5.1 Visual Classification

The visual classification consisted of three values: clear, grey, and black. Grey included a combination of “slight”, “intermediate”, and “grey”observations,. The samplers deemed none of the samples assessed “black”. A median test between “grey” and “clear” samples indicated significant differences for TSS, TKN, and ammonia. Complicating the diagnostic value is the overlap between concentrations in samples that appeared clear (n=96) and grey (n=19), respectively. Further analysis indicated that the visual analysis can serve as a good indicator if a sample exceeds 10 mg/L TSS. Grey samples had high odds of exceeding 10 mg/L TSS (18:1), while clear samples had comparatively low odds (28:68). The resulting odds ratio of 44 was the highest found for the three analytes for which visual classification appeared to be significant.

5.2 Olfactory Classification

The olfactory classification consisted of the categories "no odor", "earthy", "musty", and "septic" or "pungent". The classification relied on the understanding by the sampler of these terms. The samplers classified most (n=96) of the assessed samples as containing no odor, only three as smelling earthy, eleven as smelling musty, and nine as smelling septic. A median test indicated significant differences between these classes in regards to the visual classification, TSS, ammonia, and TKN. As in the case of visual classifications, the overlap of concentrations for each olfactory class complicates the use of smell as indicator of exceeding certain concentrations. For example, all samples classified as musty or septic contained at least 3 mg/L TSS and TKN, but about two thirds of the non-odorous samples contained also at least 3 mg/L, allowing little distinction. Overall, the presence of smell appeared to be an indicator for TSS, ammonia or TKN exceeding 10 mg/L with odd ratios between 17 and 19.

5.3 Hach Test Kits

The study utilized a Hach DR/890 to analyze samples for nitrate, ammonia, and reactive-phosphorus. The sample volume analyzed by the Hach kit stemmed from the same intermediate sampling container that the laboratory samples were taken from. Based on this origin, variability similar to the replicate variability is expected. An additional way to assess the ease and reliability of using the screening test consisted in keeping separate the data from Phase 1 and 2 and from Phase 3, which coincided with differences in the staff performing the measurements. For the first two phases, half a dozen staff had worked on this project, while in the third phase, only a couple of people performed the sampling. This splitting provides a repetition of the experiment and allows an assessment of the importance of the analyst. Figure 5 compares the laboratory results to the results of the Hach analyses. In each of the three analytes, there are noticeable differences between the phases.

For ammonia (Figure 5 a), the slope of the correlation is slightly less than one for both phase categories, indicating a slight underestimate when using the Hach-kit. While the slope is very similar, the correlation coefficient was higher for Phase 1 and 2 than in Phase 3 (0.9 vs. 0.7). This appears to be due largely to a few outliers during Phase 3. For nitrate, the data shown in Figure 5 b were truncated at a laboratory concentration of 25 mg/L. This removed the influence of exceeding the upper end of the undiluted measurement range with the screening test, which was 33 mg/L, and resulted in a flattening of the Hach data points. The slope of the correlation between laboratory and screening methods was close to one in both data sets, indicating a good correspondence. The correlation coefficients were higher than for ammonia, and again higher for the first two phases than the third phase (0.97vs 0.68).
For phosphorus, the correlation coefficients were the lowest of this set (0.56 and 0.46, respectively). One possible reason for higher variability is that in contrast to the other two measurements, the screening test does not measure the same chemical species as the laboratory test (reactive vs. total phosphorus) but only a subset. But there are also indications, that the procedure of the screening test gave rise to misunderstandings: During Phase 1 and 2, several screening measurements cluster along a 3:1 line; such points are likely the result of analysts forgetting to convert from phosphate (PO4) to phosphorus (PO4-P) by multiplying with 0.326. The upper limit of the measurement range is less than two mg/L phosphorus. This necessitated sample dilutions, usually at a ratio of 1:10 to obtain a result in the measurement range, and this dilution step could lower measurement precision and introduce recording errors.

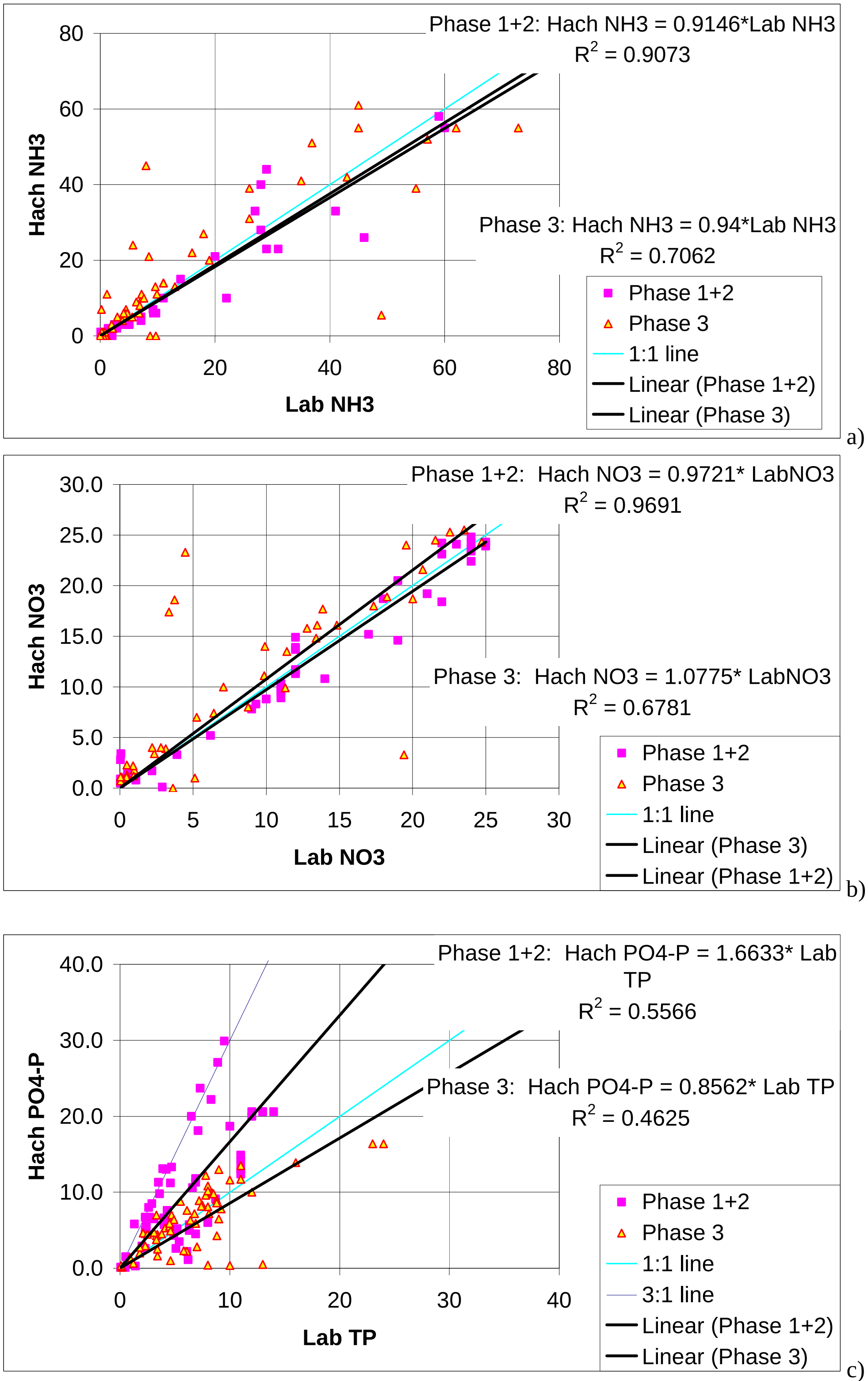


Figure 5. Comparison of laboratory analysis results and results of analysis by samplers using Hach DR/890 test kits. a) NH3-N; b) NO3-N; c) reactive-P vs. total P

5.4 Taylor Kit

A Taylor swimming pool kit provided an alternative means of assessing pH, total alkalinity and free chlorine. For 37 samples, results from both the laboratory and a Taylor titration of alkalinity were available. Figure 6 illustrates the relationship between laboratory and Taylor measurements of total alkalinity. Except for two visible outliers during Phase 1 and 2, the correlations are high in all phases (0.74 and 0.92) and indicate a one-to-one correspondence between the two measurements. One of the outliers was associated with the highest measured total alkalinity sample in the group (540 mg/L), and exceeded 1000 mg/L during Taylor titration. Only one of the three lowest Taylor alkalinity results was associated with below detectable levels of alkalinity in the laboratory analysis. The reasons for the other deviations remain speculative, one possibility, at least for two low Taylor measurements of less than ten, is that the recorder of the measurement omitted the conversion calculation from drops to mg/L, which usually would result in a multiple of ten. Overall, total alkalinity appears a measurement that has potential for reliable determination in the field.

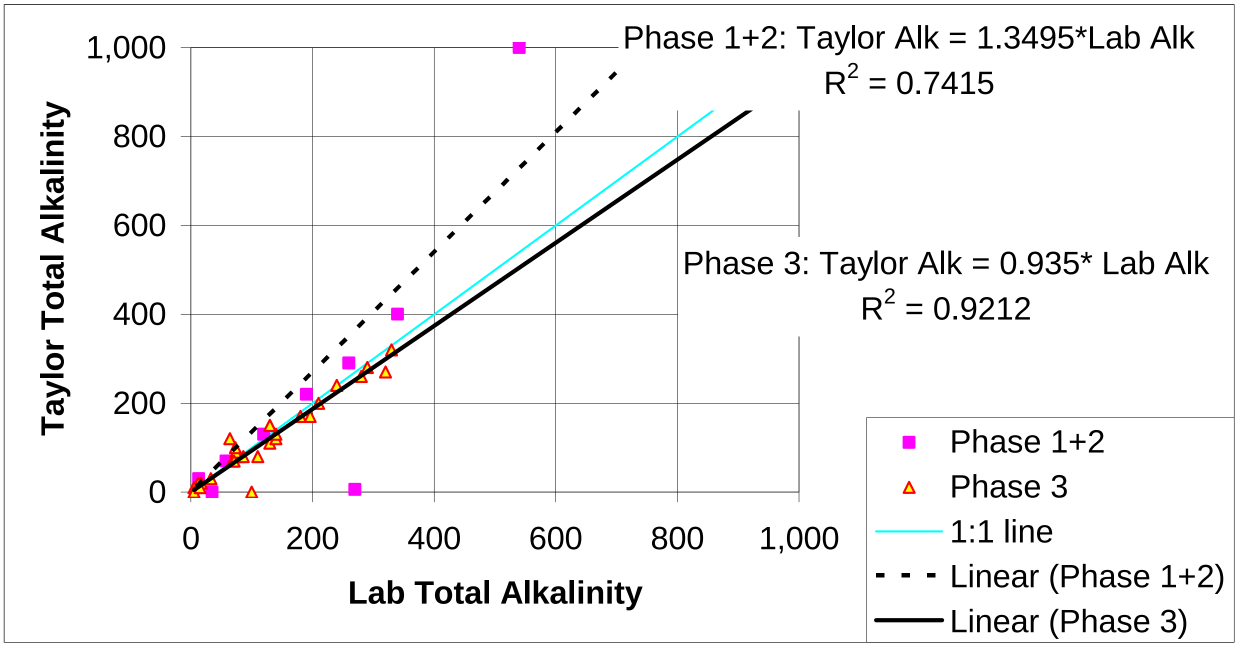


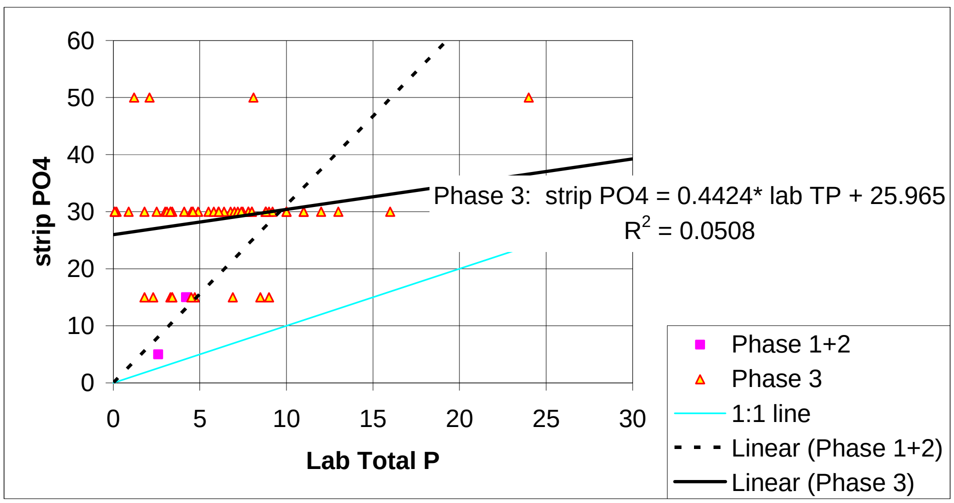
Figure 6. Illustration of the relationship between total alkalinity measurements in the laboratory and measurements using a Taylor kit.

Of the 27 chlorine measurements during Phase 3, fourteen, or about half showed no or less than 0.5 mg/L free chlorine, which is below the standard of 64E-6 for free chlorine prior to an injection well. No laboratory measurement of chlorine occurred, so an assessment of the accuracy is not feasible. The chlorine measurements did not coincide with bacteriological samples, so no assessment of the effectiveness of chlorination is feasible.

Although four of these measurements occurred apparently before the point of chlorination, these results indicate that the supply of a steady sufficient chlorine level is frequently not achieved. No data are available to assess how much of this problem is lack of maintenance, e.g. in the form of supplying chlorination tablets, and how much is due to design issues, e.g. the chlorinators, frequently based on erosion of a stack of tablets, not being suitable to provide the chlorine.

5.5 Test Strip Measurements

For up to 58 samples, test strips results are available for reactive phosphorus, nitrate, nitrite, alkalinity and chlorine. Of these, only alkalinity showed any promise as a somewhat quantitative measure of measurements obtained by other methods. Too few data were collected during Phase 1 and 2 to perform a meaningful correlation assessment. For reactive phosphorus, the results from Phase 3 show no meaningful correlation (0.05) with laboratory concentrations. For nitrate, the results are similar, for Phase 3, a very low correlation (0.25) was present. For nitrite, there was no correlation. For total alkalinity, a correlation can be seen, but appears to be leveling off, resulting overall only in a correlation coefficient of 0.5. The correlation coefficient increases to 0.68 if the y-intercept is allowed to vary. For chlorine, the few samples for which both measurements by test strip and by Taylor kit had been obtained showed no apparent correlation between the two.



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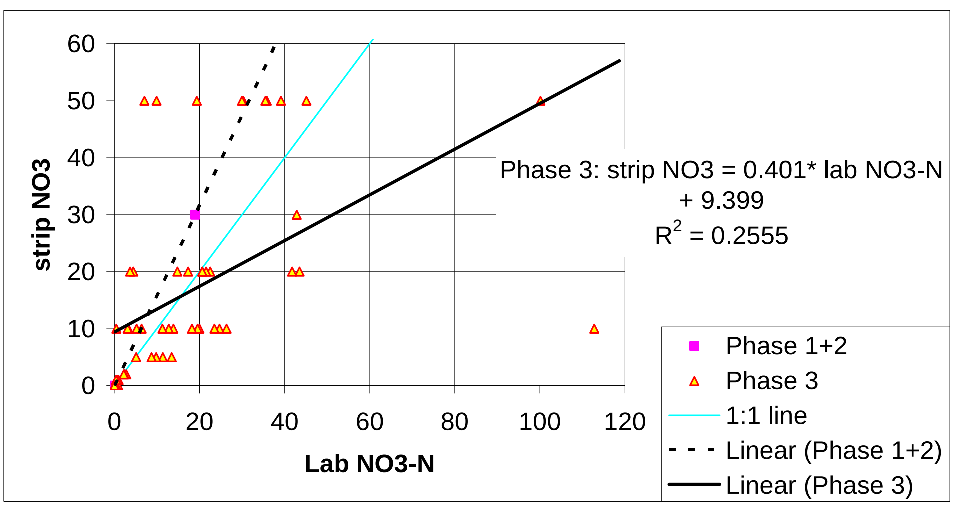

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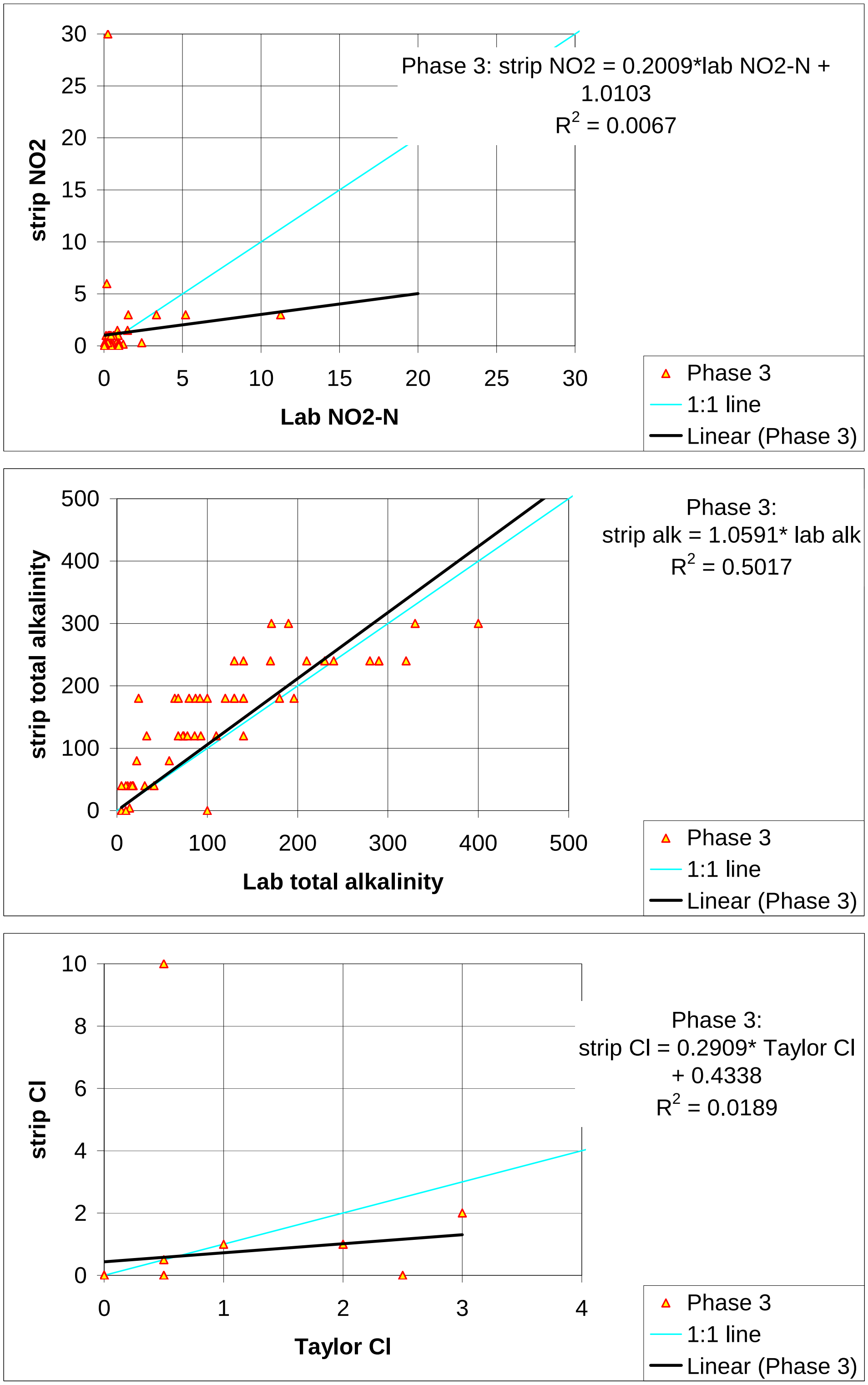

c) d) e)

Figure 7. Relationships between other measures of concentrations and results of test strip measurements: a) ortho-phosphorus vs. lab TP b) nitrate vs lab nitrate-N c) nitrite vs lab nitrite d) alkalinity vs. lab total alkalinity e) chlorine vs Taylor chlorine

6 CONCLUSIONS AND RECOMMENDATIONS

This study reports on samples from aerated onsite sewage treatment systems in Florida Keys. Over the course of the study between February 2007 and June 2009 we obtained grab and composite samples from 40 treatment systems in Monroe County at different frequencies. Experiences and conclusions can be categorized into two groups: (1) Validation of a sampling protocol and (2) Preliminary assessments on the treatment effectiveness of treatment systems based on the sampling protocol.

6.1 Validation of a Sampling Protocol

Occasional spurious high concentrations were reported, in many cases for one analyte but not for others in the same sample. While this may influence means, median concentration results are less impacted by this and appear generally reliable. Rapid review of sample results on the background of typical results and communication with the laboratory appear to be a way to resolve some of these. The conditions for such interaction were much improved for Task 4.

Relative to target concentrations, results from analysis of blanks indicated that the approach to sampling using peristaltic pumps was successful. For the sampling project of Task 4 of this grant agreement, flushing volumes were increased in an attempt to further reduce TKN and TN in equipment blanks, which had been detected most frequently.

TSS appeared to be the most variable parameter in replicate samples from an intermediate container with a median relative standard deviation of 12%, but for cBOD5, TN, and TP this measure was 3% and less. Concerns about samples obtained from intermediate containers are thus less warranted for nutrient analyses than for TSS analyses.

Detailed characterization of the treatment systems and sampling locations are very important. Particularly in treatment systems with multiple treatment steps, “influent” and “effluent” need further qualification, and may be ambiguous to a sampler encountering the treatment system or to a data analyst. In the present study this required some reclassification during data analysis from “influent” to “intermediate”. For Task 4, data fields for sample location description were more extensive, and a screen for the validity of “influent” samples was developed.

Effluent concentrations varied widely overall, but less so than in a previous survey of ATUs in the Keys. The operational and maintenance conditions of a treatment system need to be better characterized if one wants to distinguish between technical limitations of treatment and shortcomings due to operator error or lack of maintenance. The assessment protocol for Task 4 included a more detailed assessment, including characterization if the power was on, observation of problems and the dissolved oxygen concentration as a measure of aeration.

Assessments of variability between grab samples showed that TSS had the highest variability, while TP and total alkalinity had the least, followed by TN. The first grab sample of a sampling event tended to be about 20% higher in TSS and 10% in cBOD5 than subsequent grab samples. This difference did not exist for nutrient species. Given that the emphasis of the project is on nutrient treatment effectiveness, grab sampling appeared appropriate for Task 4.

There was no overall bias found between the effluent composite and average of grab samples during the same event, even though for any event there could be differences. These differences were the least for total alkalinity, TP, TN, and nitrate, with more than 50% of events showing a relative difference of less that 10%.

The between event variability as expressed by relative standard deviations, is at least twice as large as the within event variability for all parameters, except for TSS.

Analysis for differences by weekday showed no consistent results. Flow measurements for a subset of systems, but not for all measurements, appeared to decrease from Monday through Thursday. Grab, but not composite, effluent sample results for TSS and cBOD5 indicated a decrease from Sunday through Thursday, but this is at least partly due to differences in the occurrence of first grab samples on each day. Differences in concentrations between the wet/hot and dry/cold seasons were not significant.
Some screening tests held some promise, and should be further investigated.

Visual/olfactory assessments appeared to be able to discriminate a threshold-value of TSS (visual) and possibly TSS, ammonia, and TKN (olfactory). During Task 4, the assessment protocol was refined to use more standardized terminology.

The Hach DR/890 colorimeter showed good agreement with laboratory nitrate and ammonia measurements and less so for ortho-phosphorus compared to total phosphorus. In all cases there was an indication of between study-phase variability. To address these issues the recording forms for Task 4 were revised to better capture dilution and conversion factors.

Taylor kits provided good agreement with laboratory measurements for total alkalinity. Task 4 relied largely on Taylor kits for this measurement, with some additional laboratory measurements for confirmation. Chlorine measurements by Taylor kit could not be independently assessed. They were utilized occasionally during the implementation of Task 4 to assess the effectiveness of chlorination devices.

6.2 Preliminary Assessment of Treatment Systems

Maintenance and operation of treatment systems appear to be important variables that were not systematically characterized in this study. Both the sampling results of processes that require replenishment of materials and anecdotes by the samplers indicated that this is an important, but not quantified, element of performance variability.

Typical influent concentrations of cBOD5 and TSS were consistent with domestic sewage, and total phosphorus slightly elevated. TN concentrations were about twice as high as concentrations during a study that established the feasibility of current treatment standards and as the septic tank effluent concentrations provided in Florida performance-based treatment system regulations as point of comparison. Overall, 50% of influent composite samples showed a TN concentration between 47 and 94 mg/L, compared to 15 and 43 mg/L for the effluent.

While overall, increased TN influent concentrations may be related to the use of water-saving devices, within the study there was no correlation between influent concentrations and the event water use measurements. Average water use for the individual homes treatment systems during sampling events was 190 gpd, both as average of individual measurements and as average of the site averages.

Intermediate composite samples indicated some influence of aerobic treatment systems but incomplete nitrification.

Overall, the addition of a phosphorus reduction treatment step, usually a media filter, improved treatment for TSS, cBOD5, nitrite-nitrogen, and total phosphorus. Systems without that treatment step had median concentration results similar to an earlier survey of ATUs in the Keys.
Among the phosphorus treatment approaches sampled there were significant differences in effluent concentrations. While overall, total phosphorus was significantly reduced, the Keys treatment standard was not met in most cases, even for the better performing approaches.

Within the treatment systems sampled, nitrification appeared to be a limiting step to nitrogen reduction. The sampling events with the most nitrified effluent achieved typically about a 75% reduction compared to their influents, while the events with the least nitrified effluent only achieved a typical TN-reduction of about 28% and did not eliminate cBOD5. Events with intermediate nitrification showed intermediate TN-reduction and some indications of occasional alkalinity limitation.

25% of the obtained fecal coliform samples exceeded the secondary grab sample standard of 400 cfu/100 mL. Nearly half of the obtained chlorine measurements did not meet the system-required chlorine residual. Such observations confirm that aerobic treatment alone is not sufficient to meet secondary fecal coliform standards. The chlorine measurements also point to the need for monitoring the effectiveness of chlorination units.

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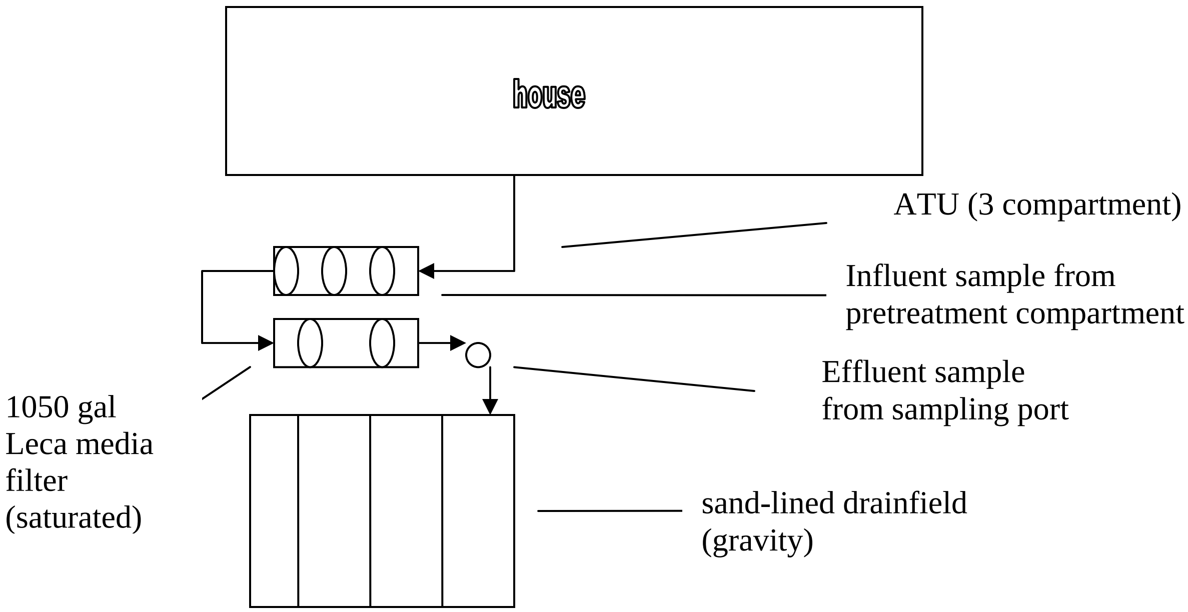
APPENDIX A: SCHEMATICS OF SAMPLED SYSTEMS

Note: These are not-to-scale flow schematics of treatment systems, based on observations by the samplers and reviews of permit records.

001: RP-001



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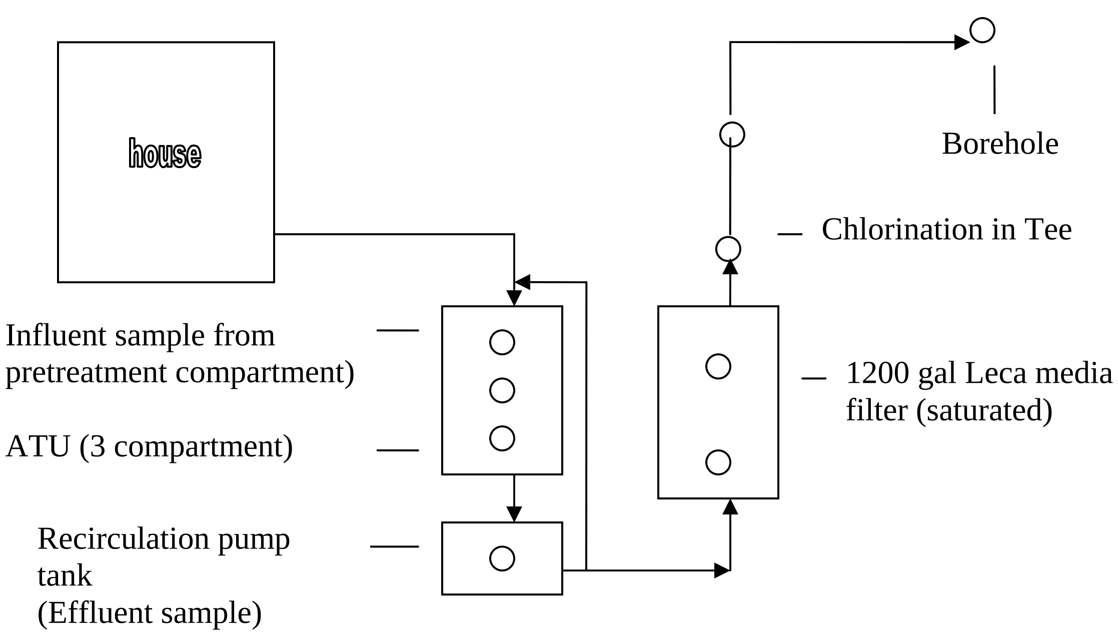

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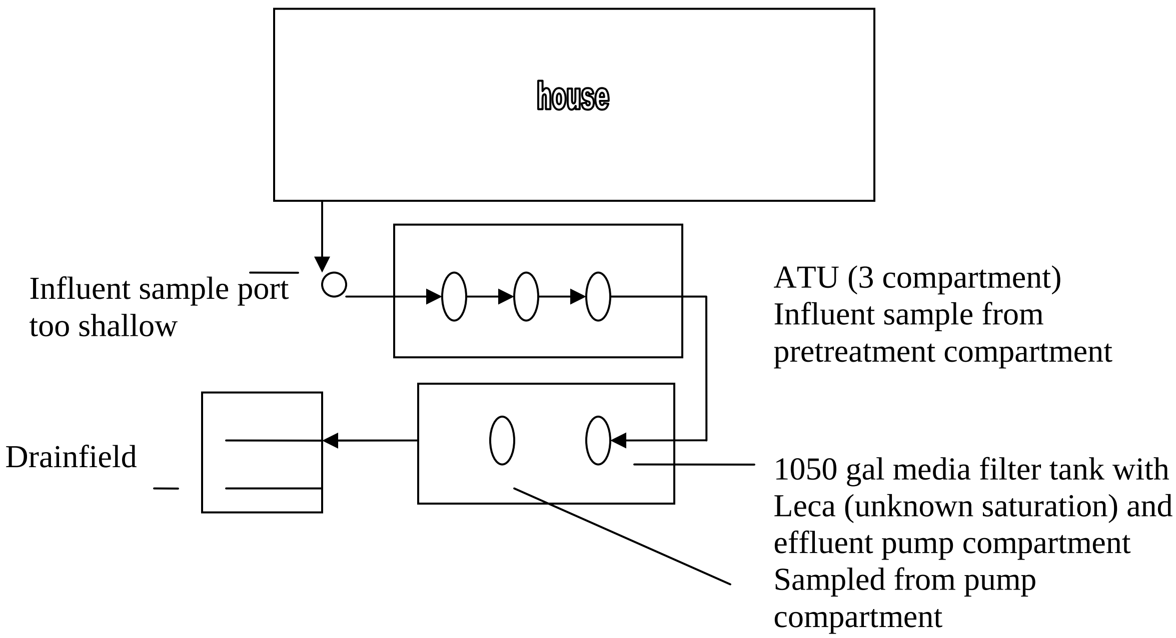

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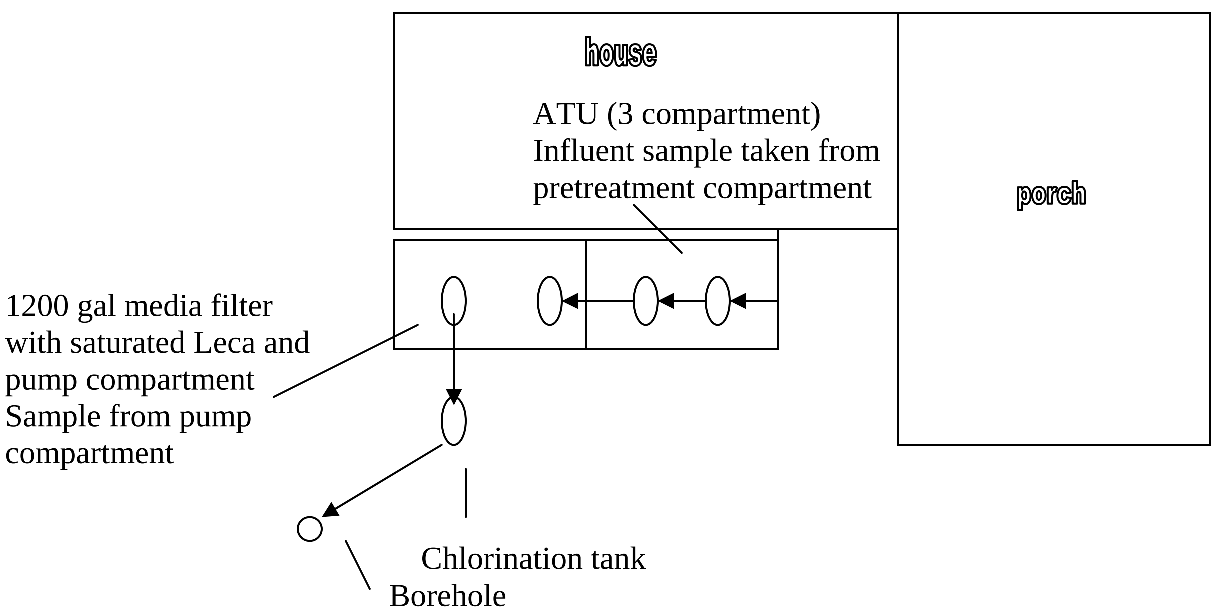

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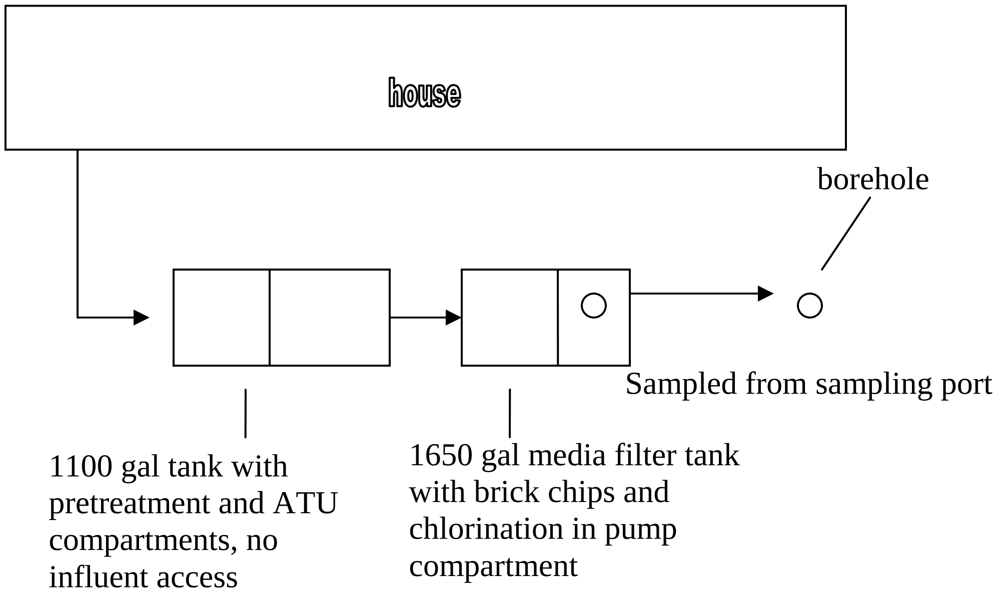

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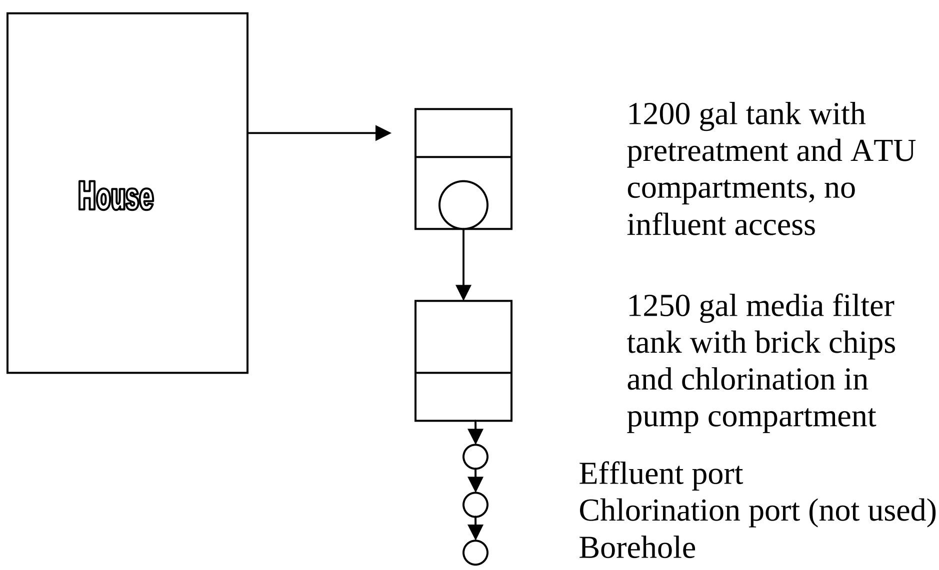

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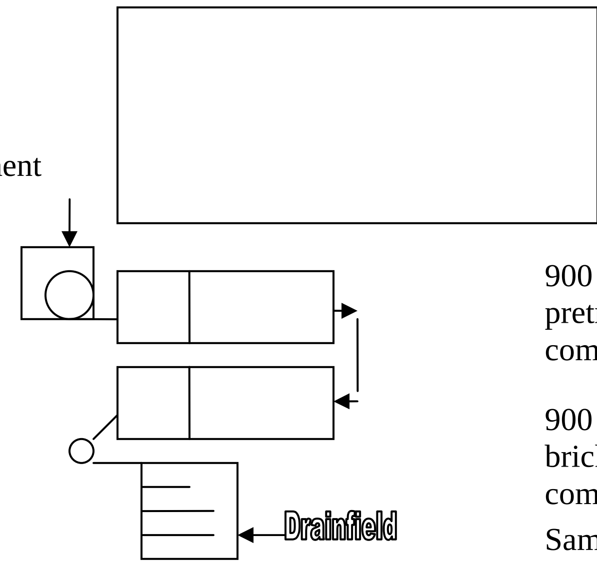


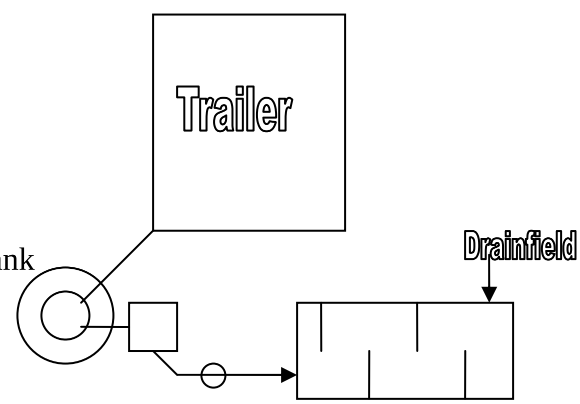
300 gal pretreatment tank

900 gal tank with pretreatment and ATU compartment

900 gal media filter with brick chips and pump compartment

Samples from effluent port and pump compartment

008: RP-008

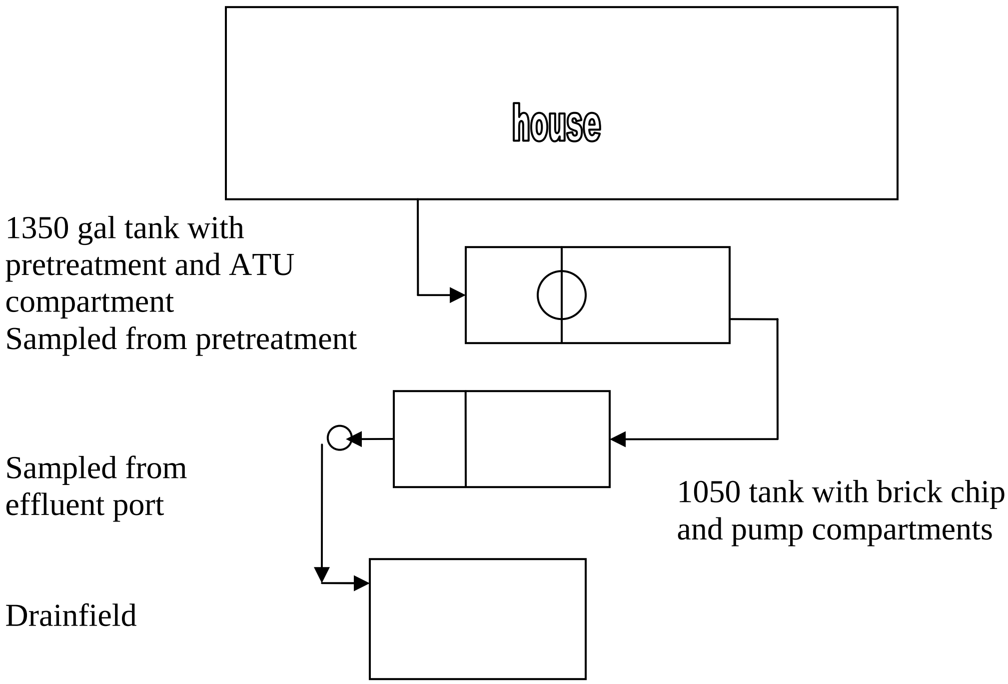


760 gal ATU tank
400 gpd

300 P-reduction tank w/ mid-floc

Effluent Sampling Port

009: RP-009



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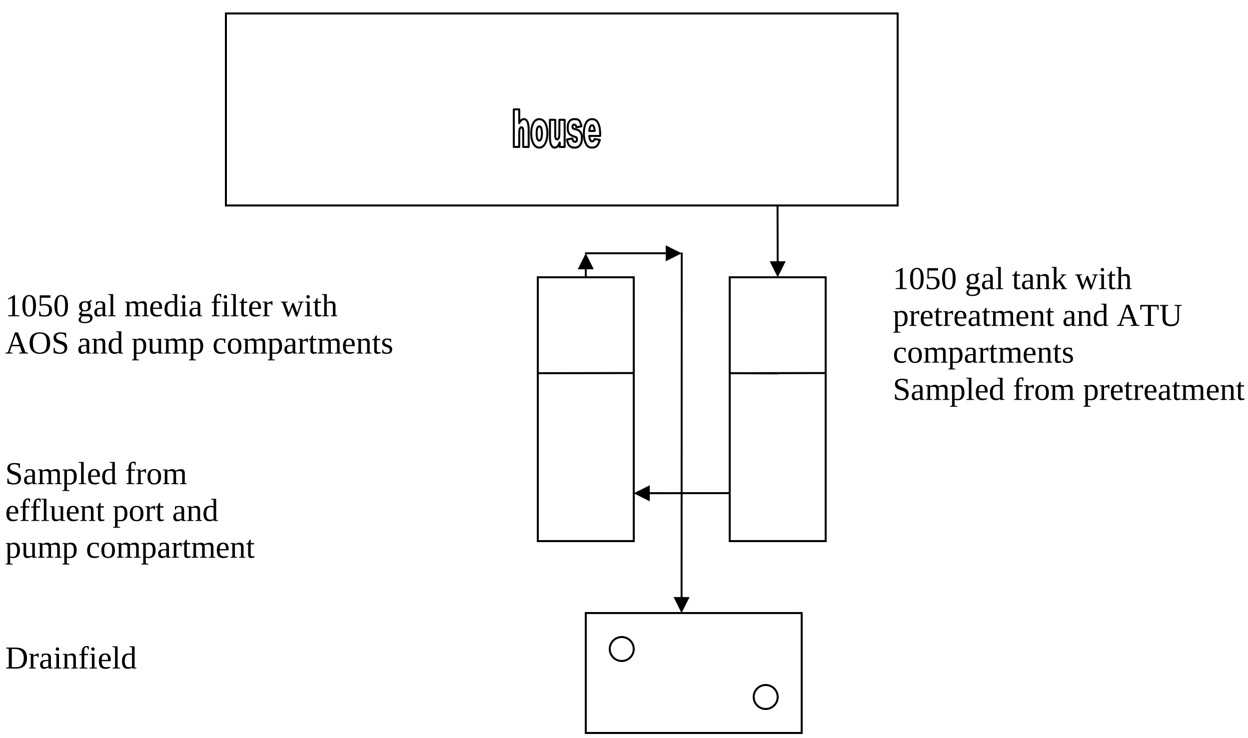

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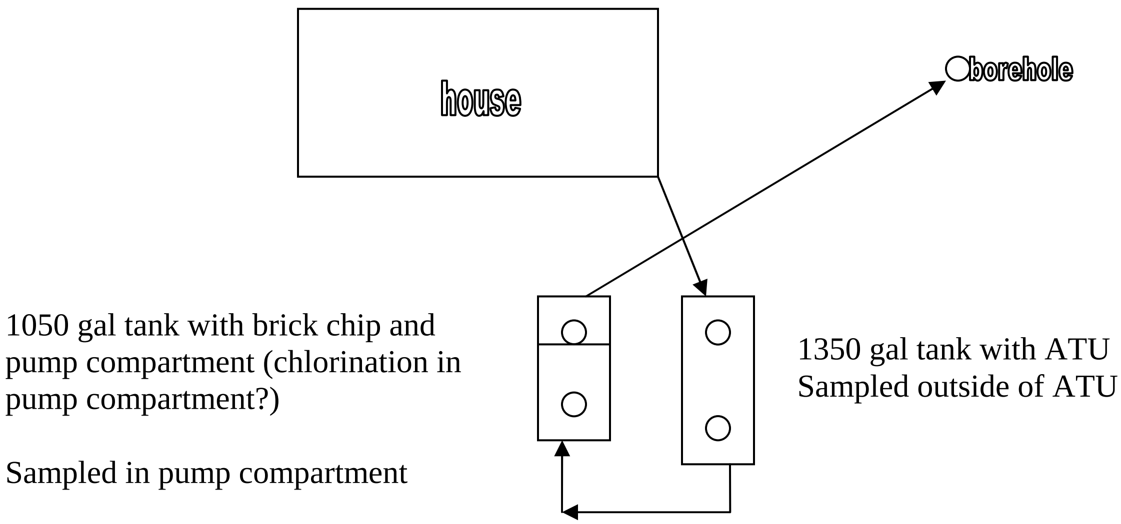

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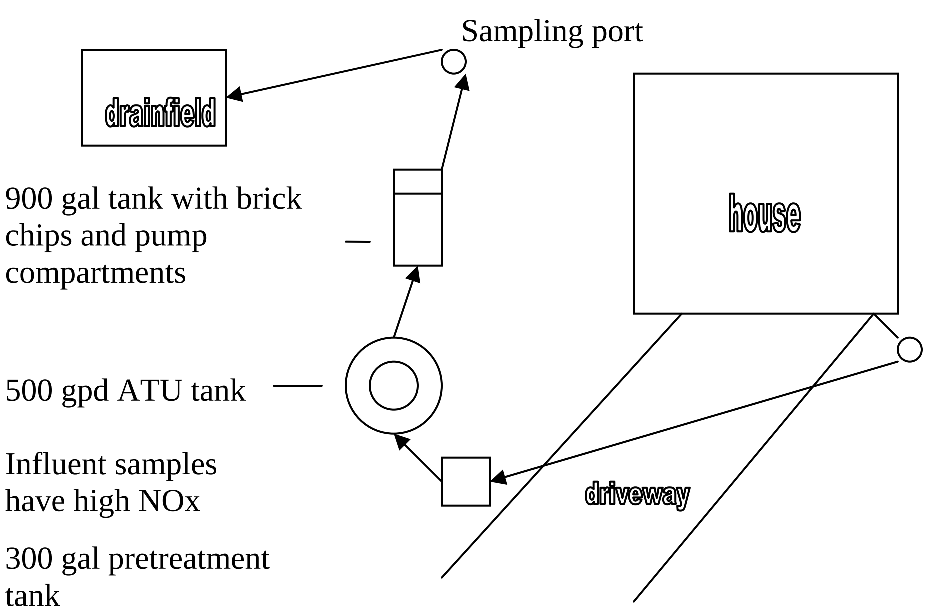

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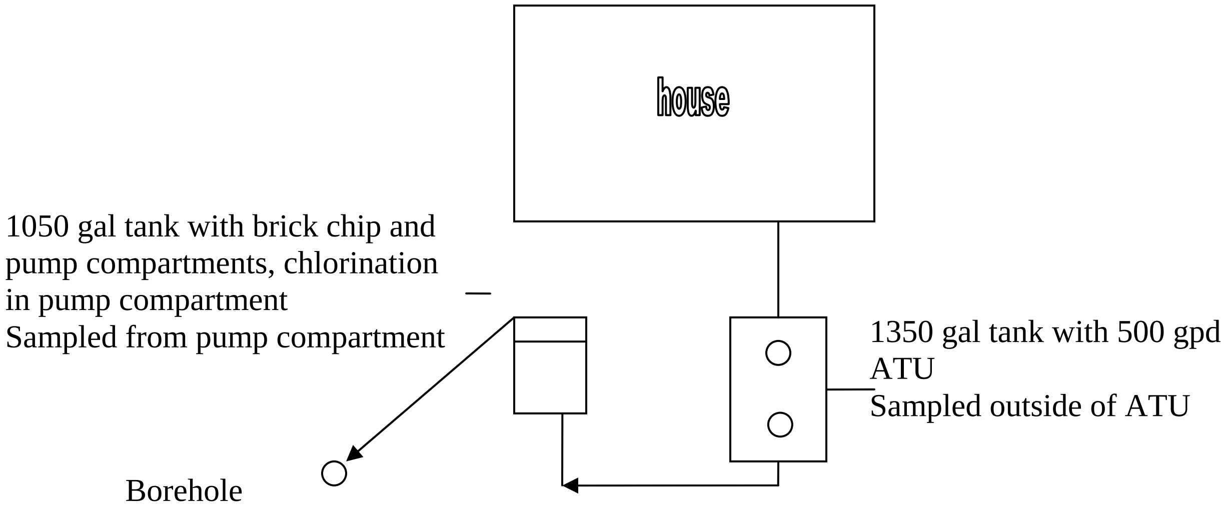

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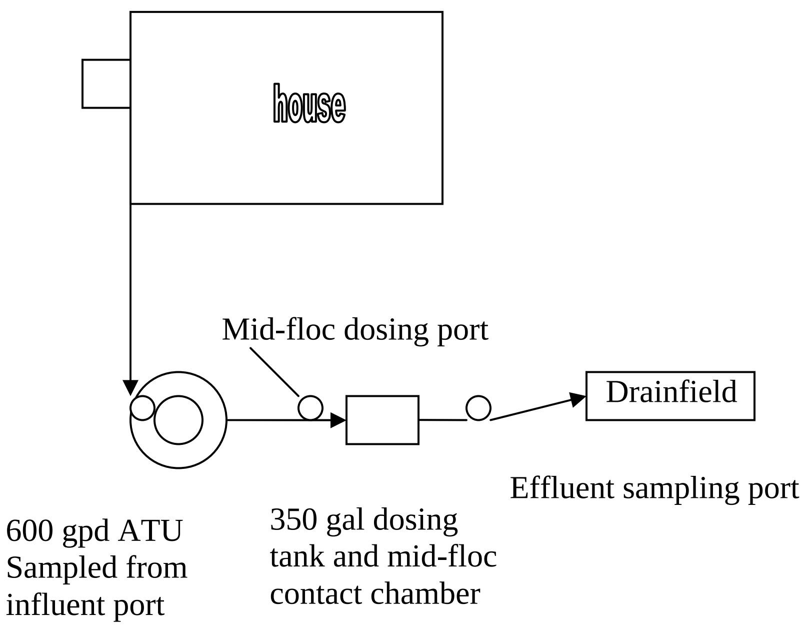

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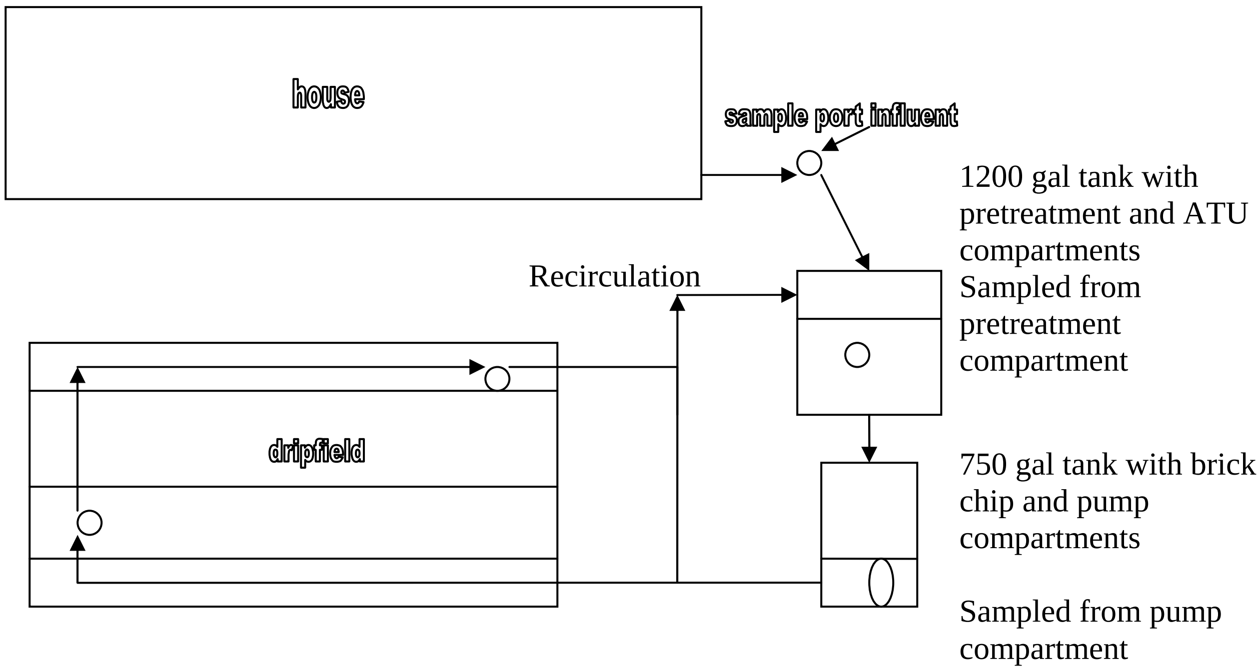

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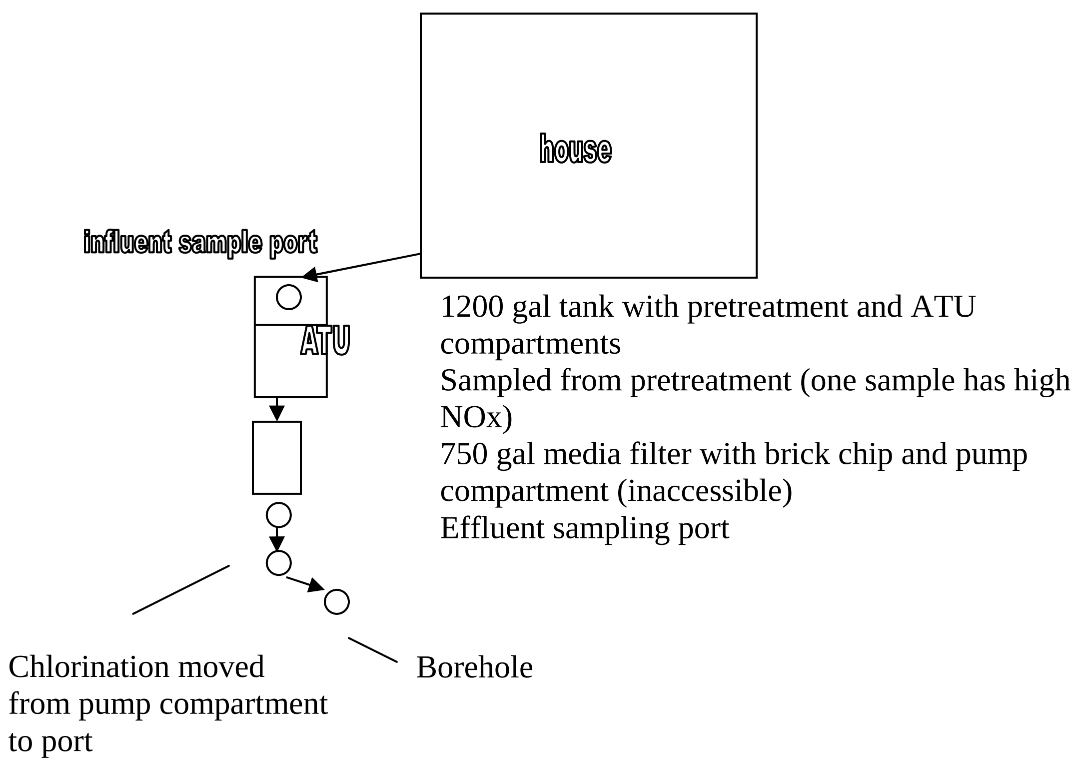

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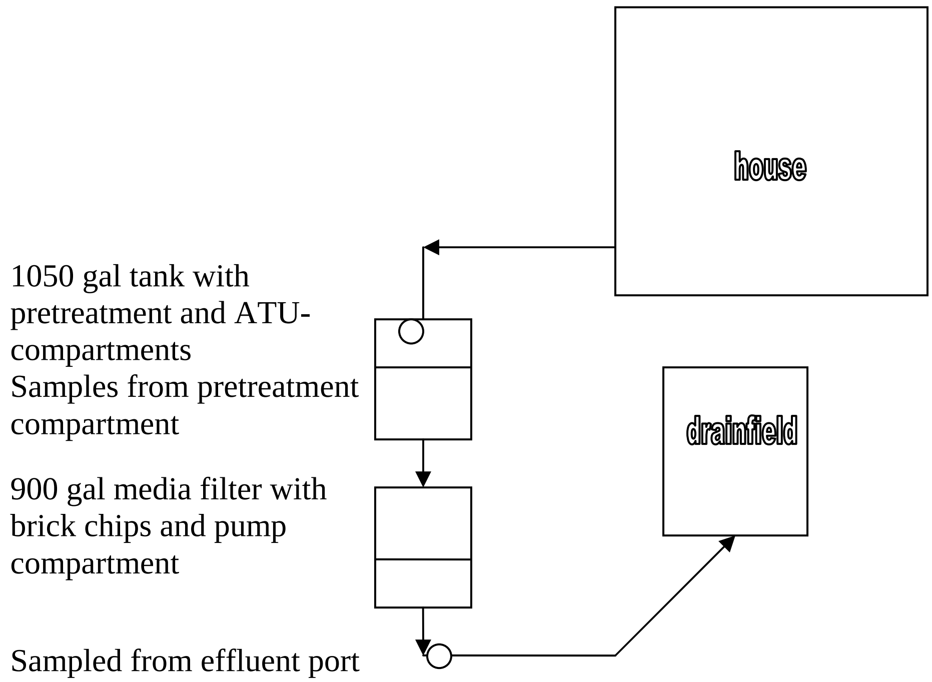

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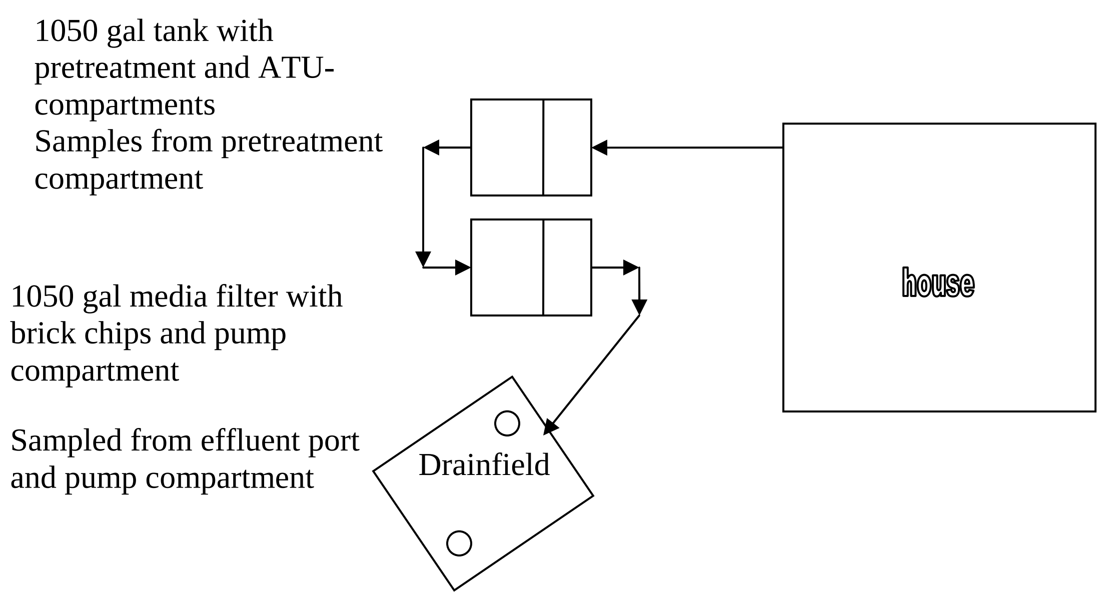

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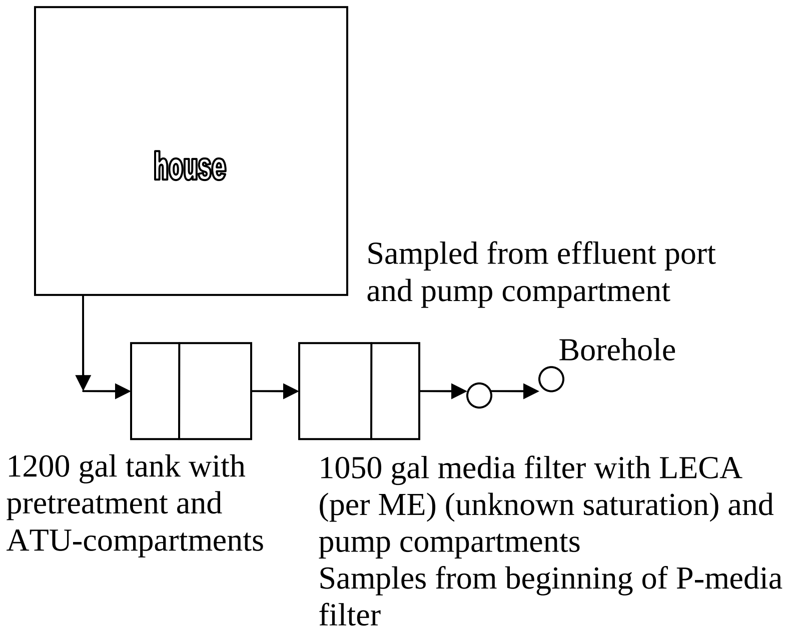

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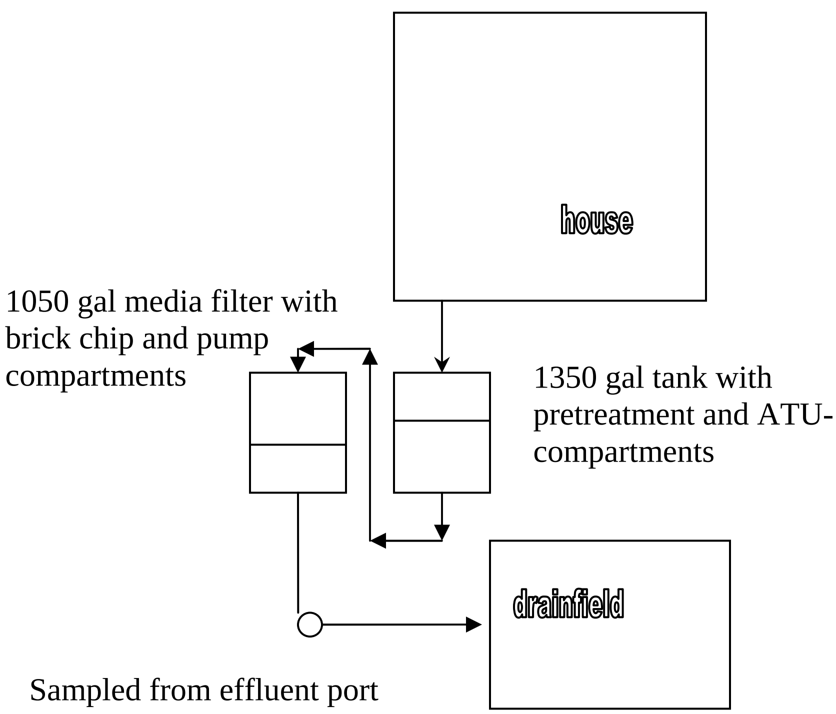

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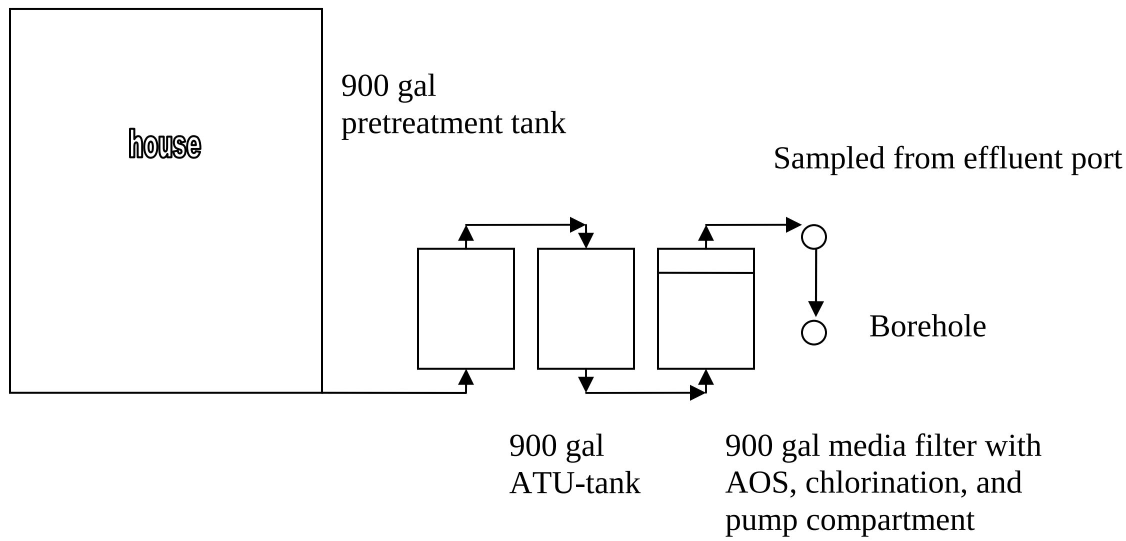

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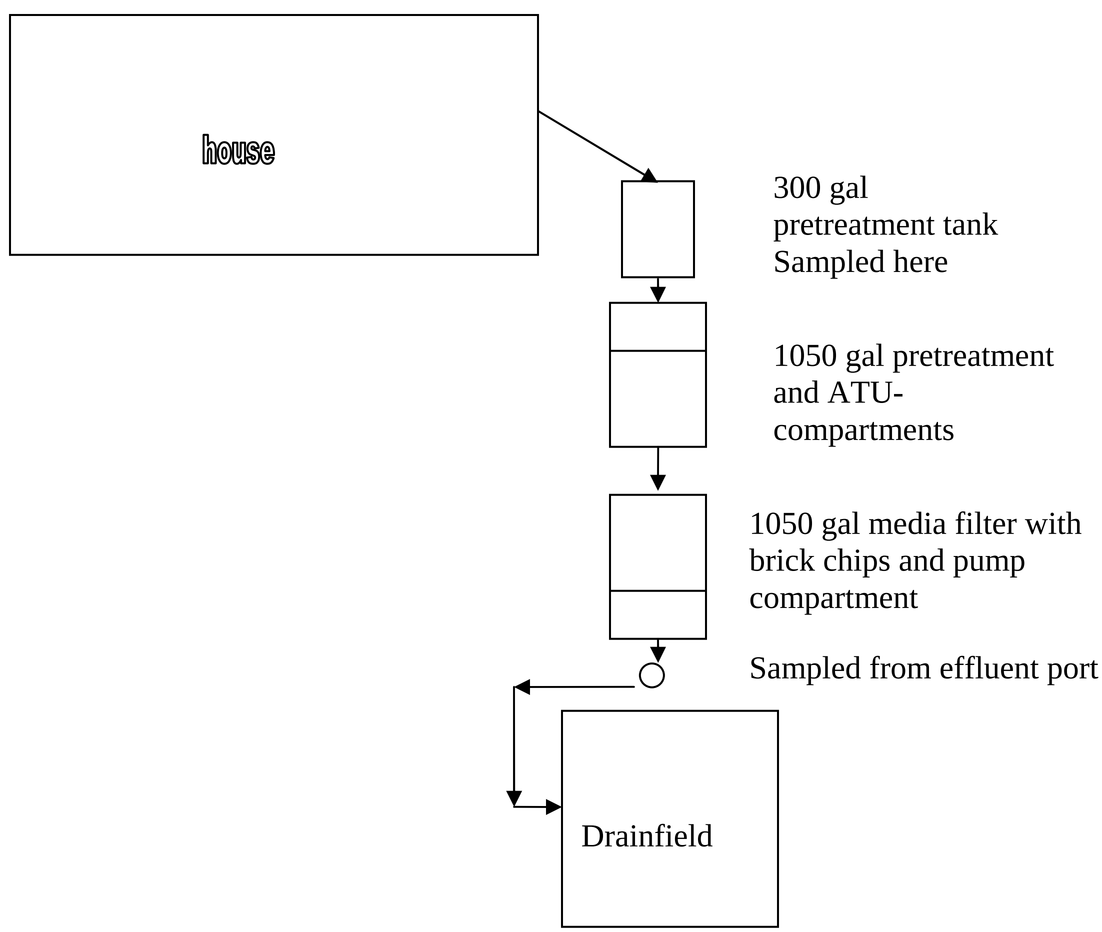

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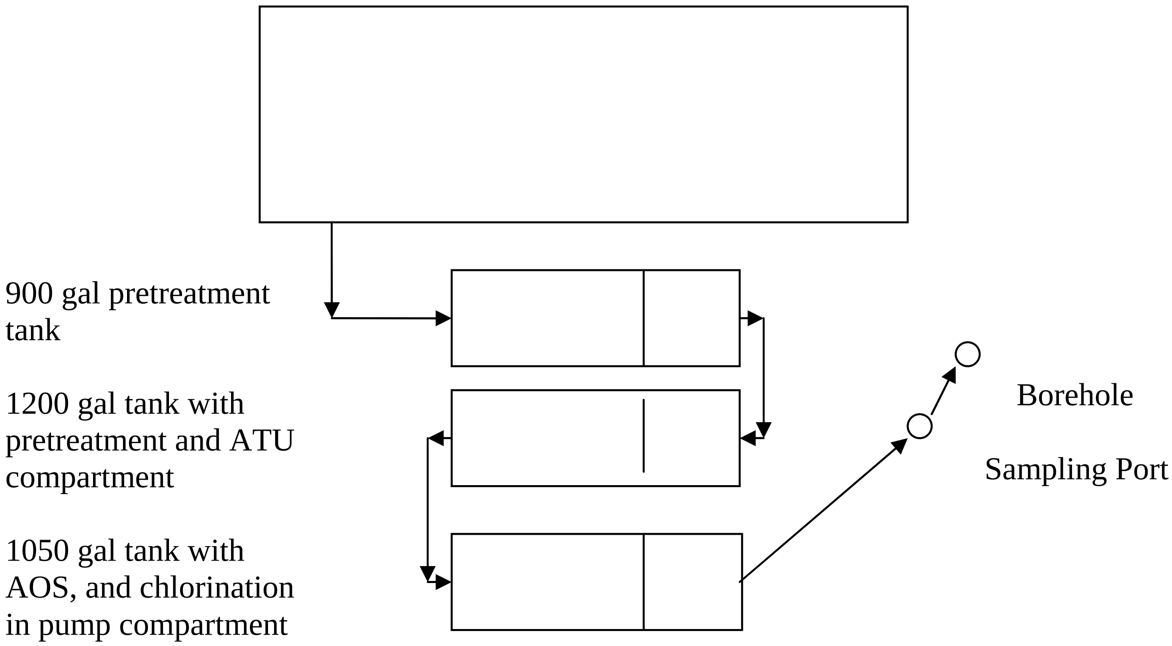

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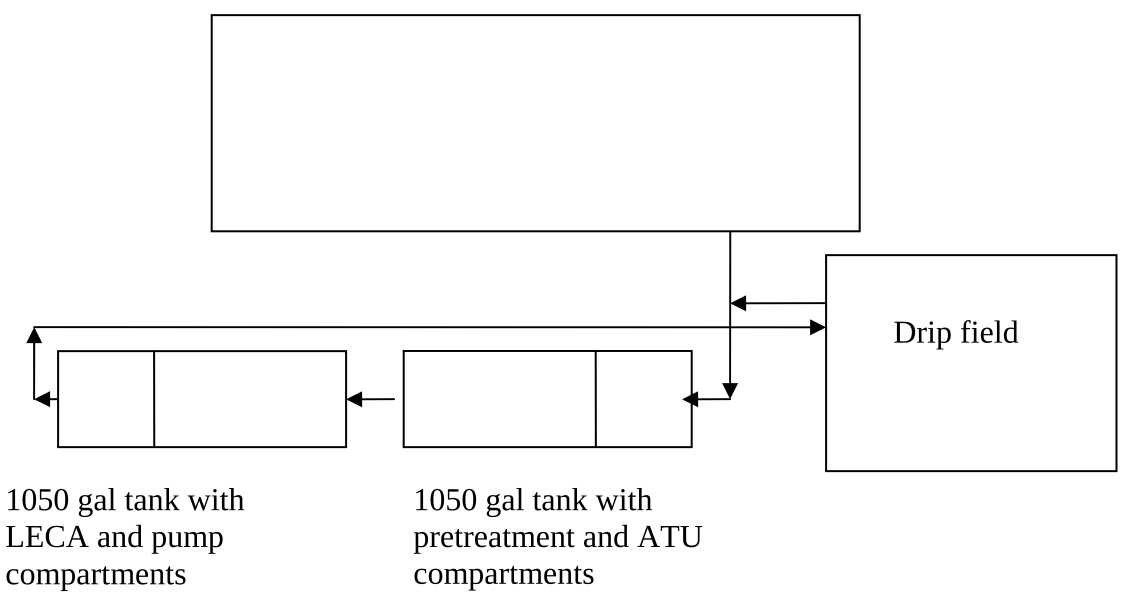

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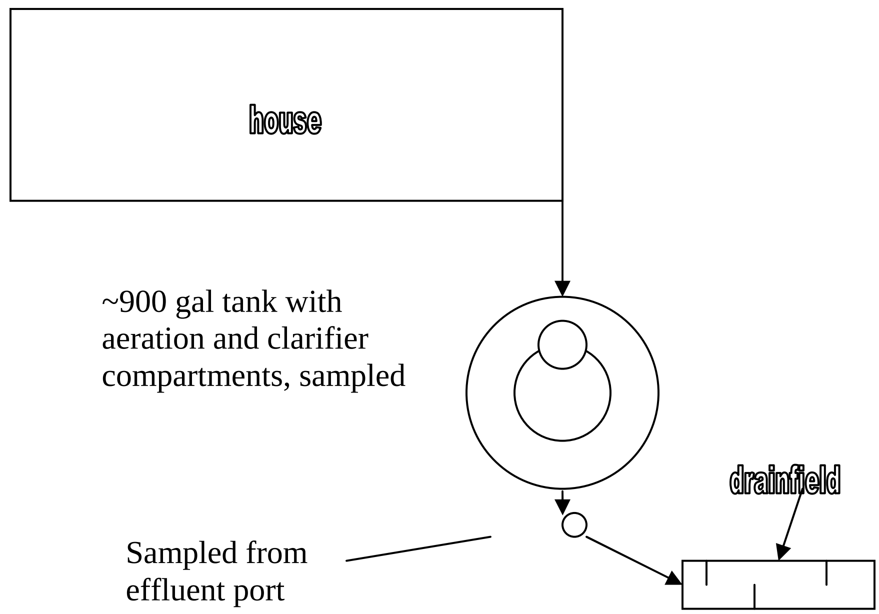

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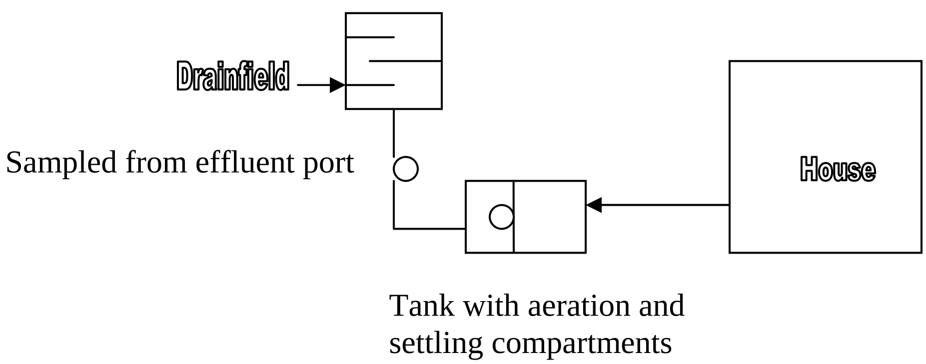

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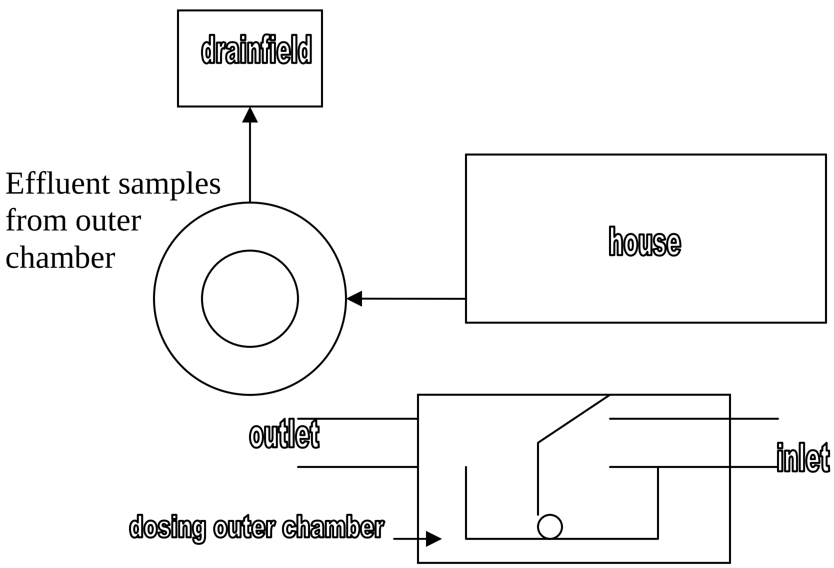

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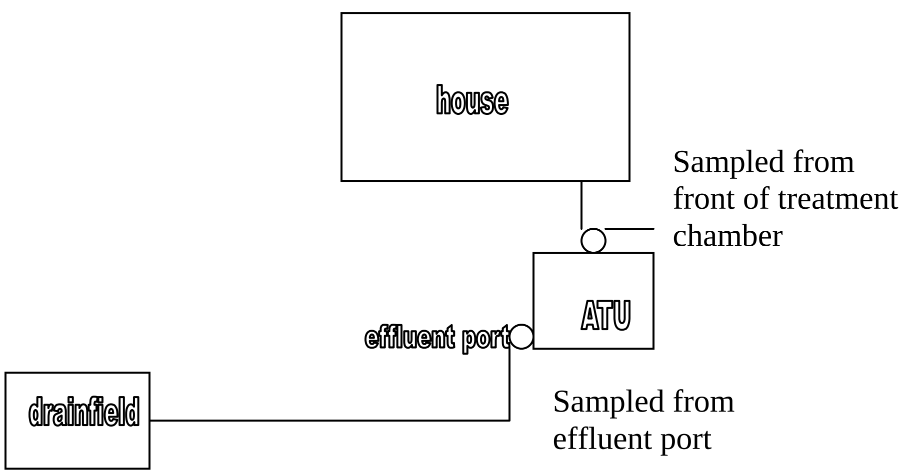

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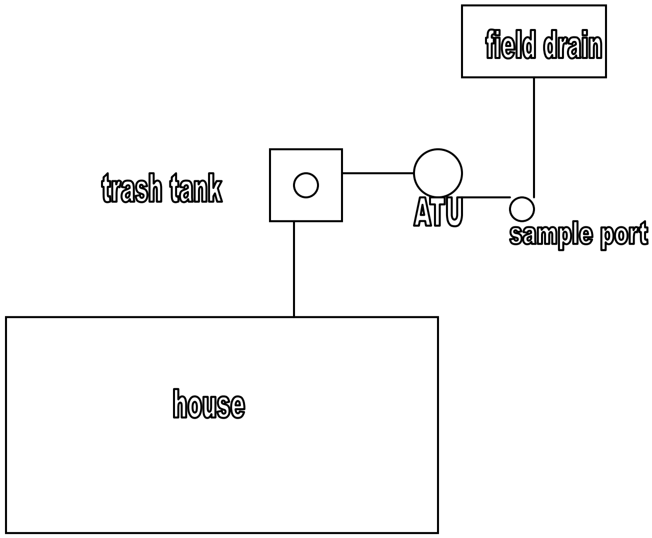

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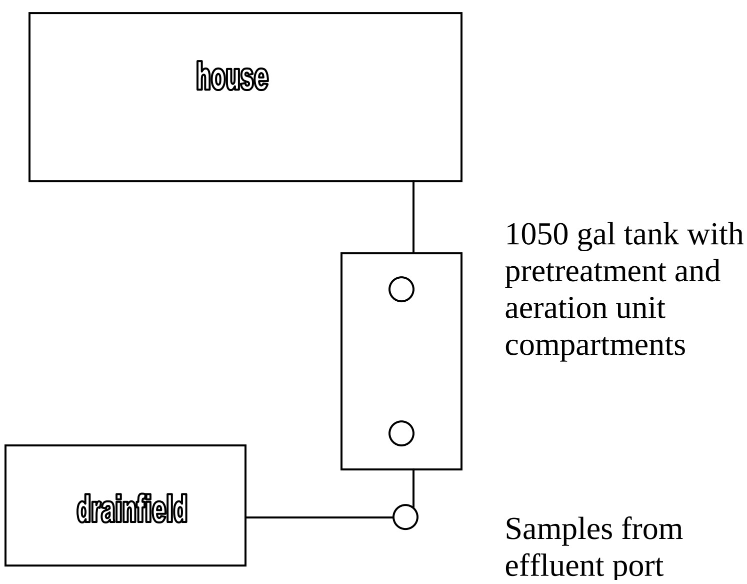

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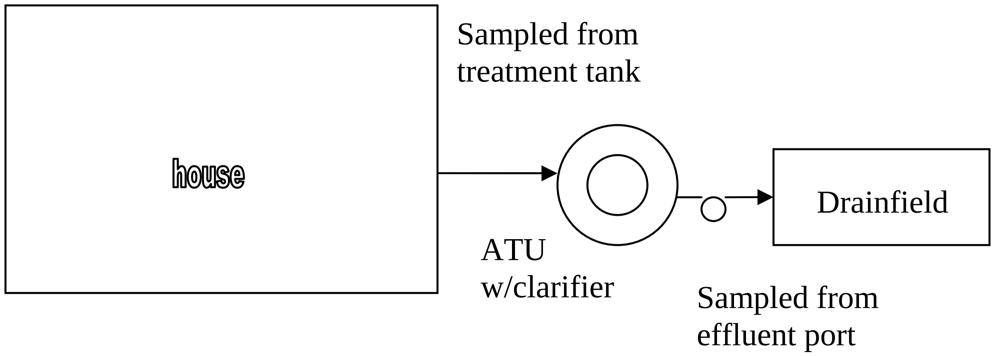

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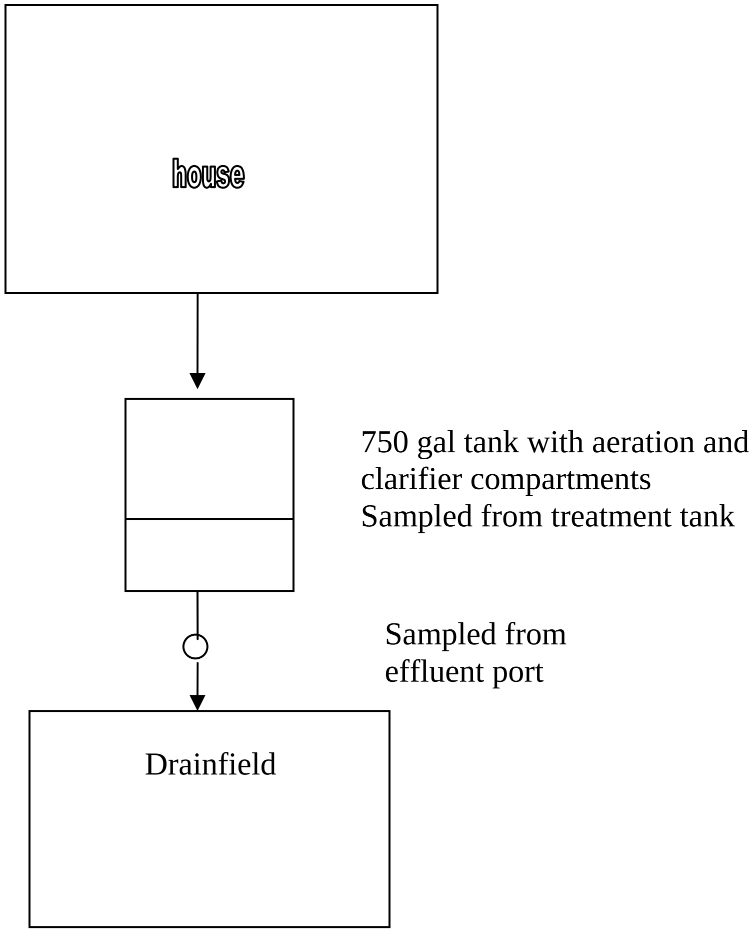

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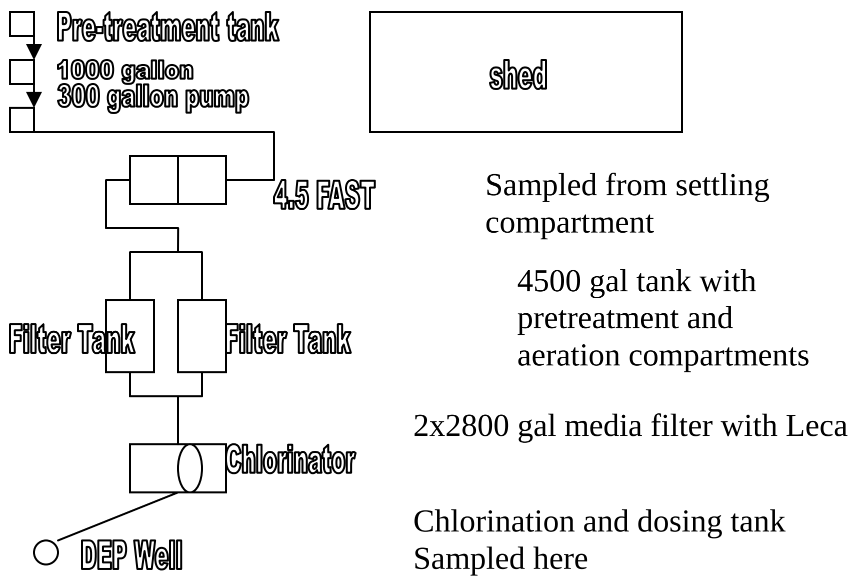

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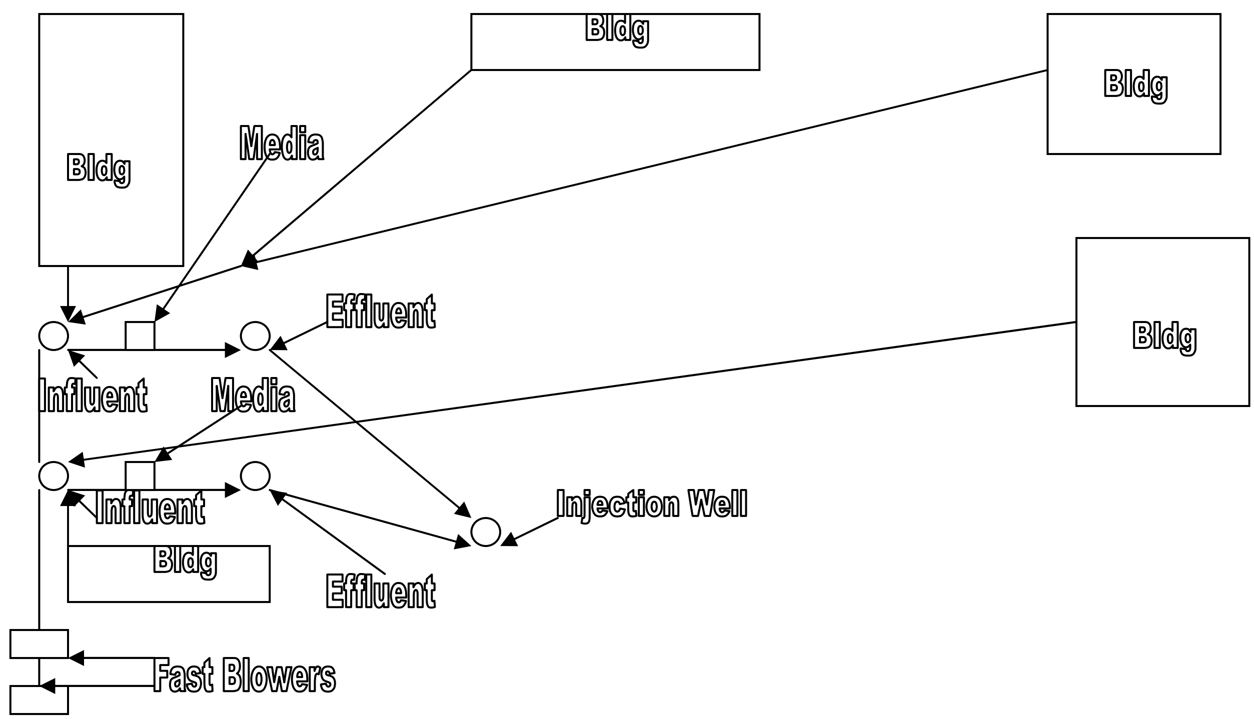

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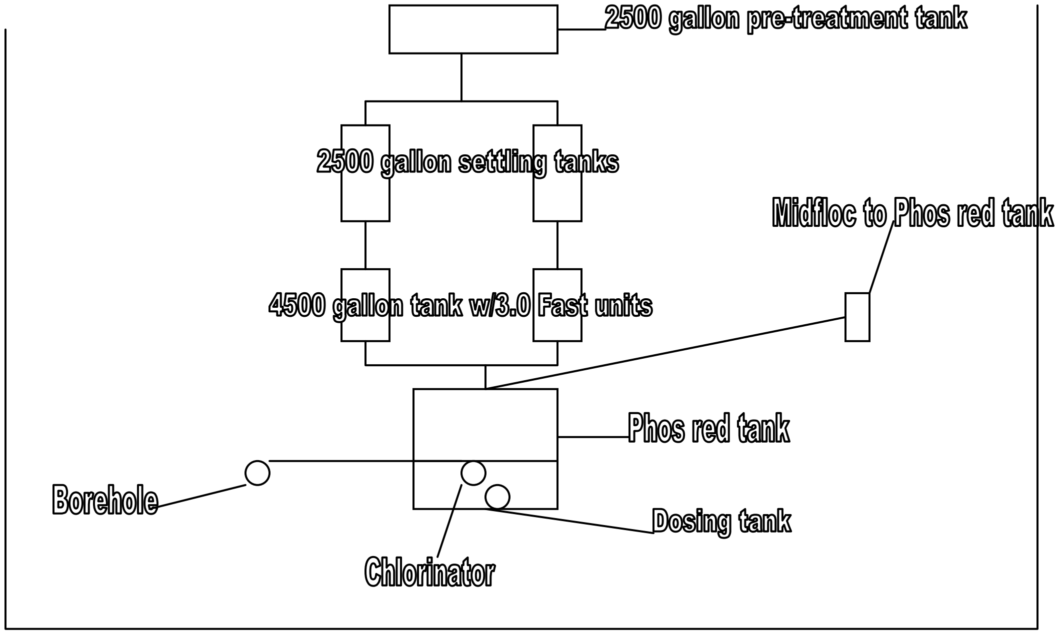

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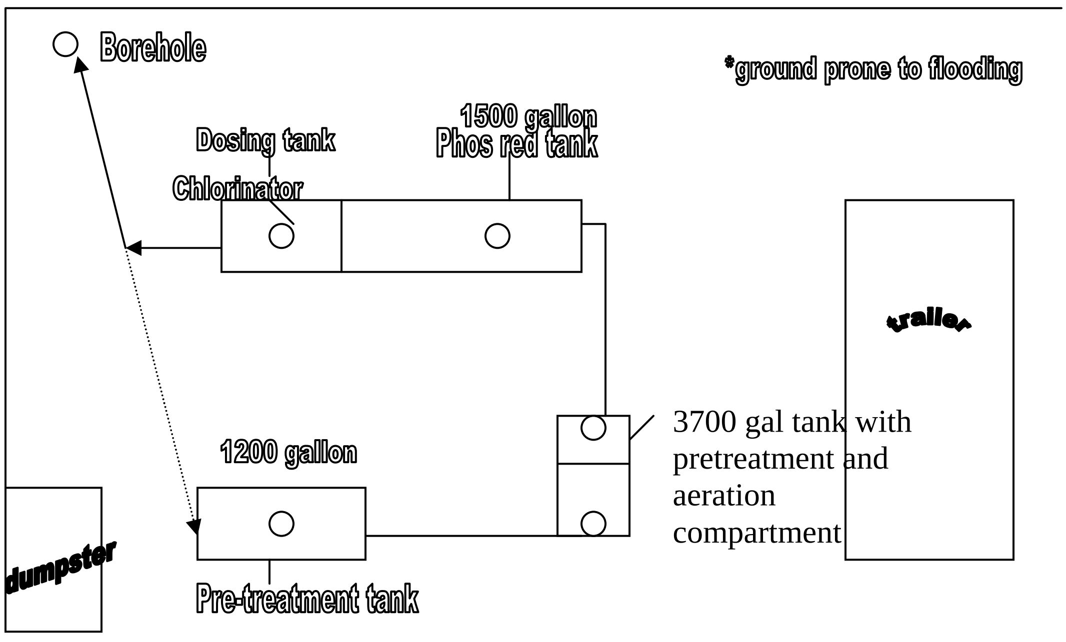

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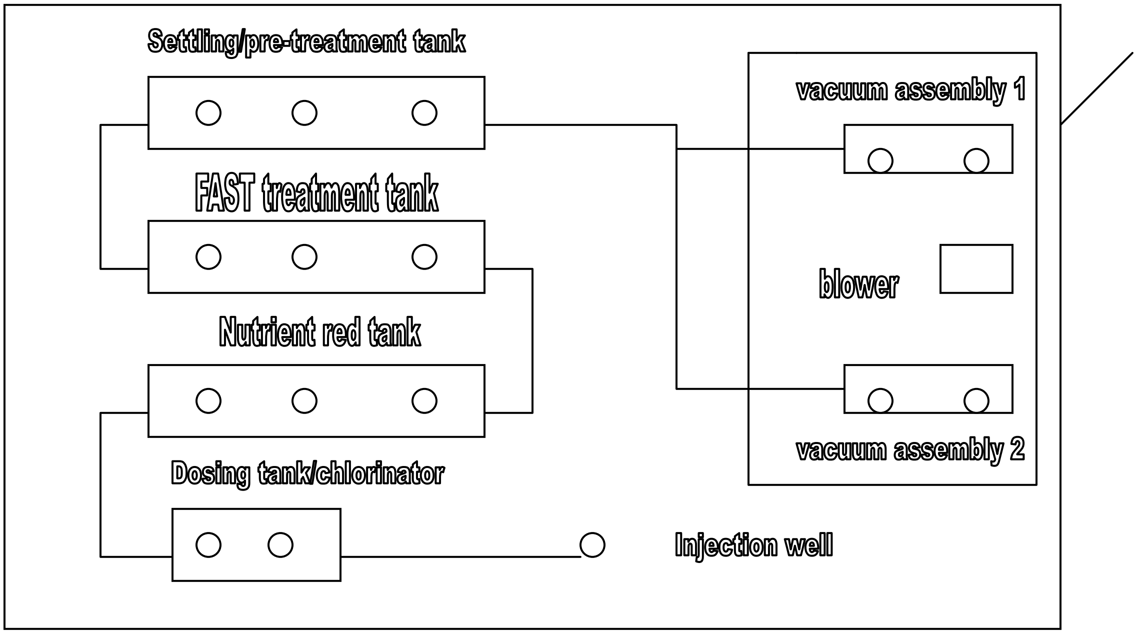
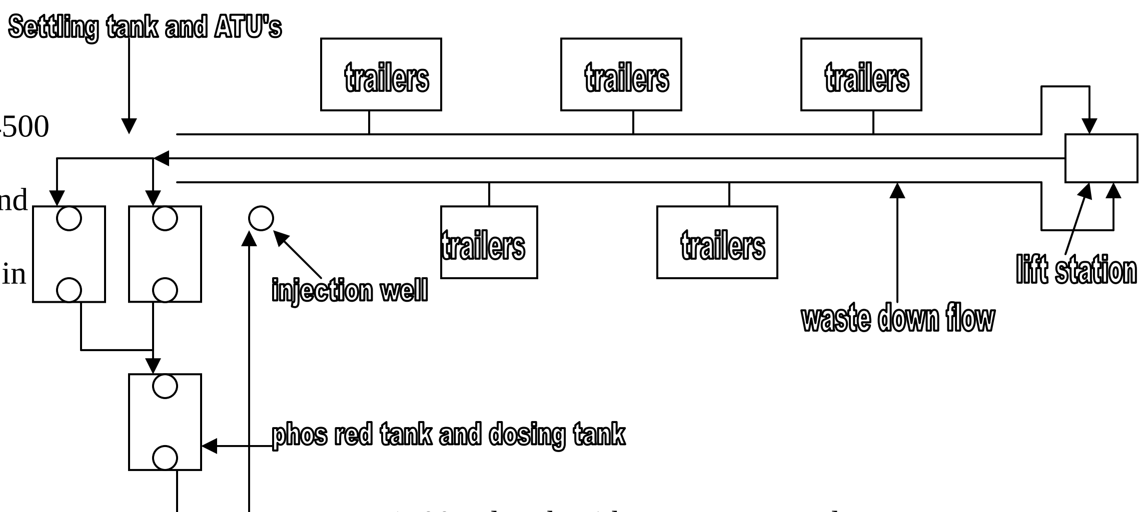


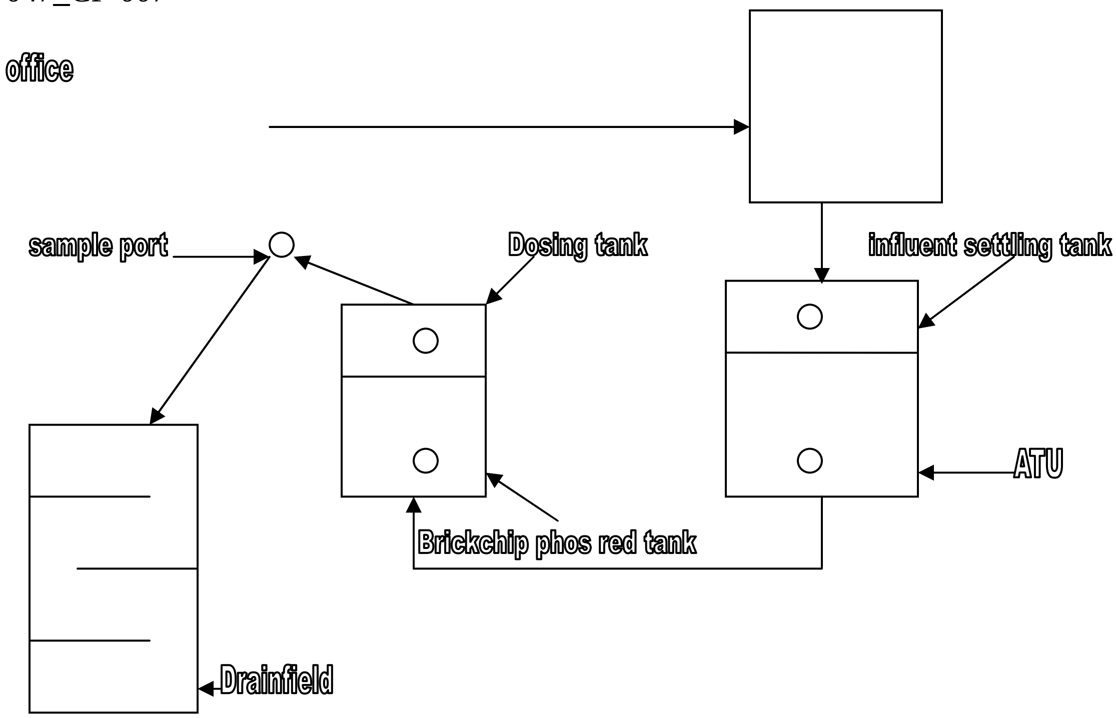
046_CP-006

4400 gal and 4500 gal tanks with pretreatment and aeration compartments in parallel
Sampled from pretreatment



1500 gal tank with P-treatment and chlorination/pump compartments
Sampled from pump compartment

047_CP-007



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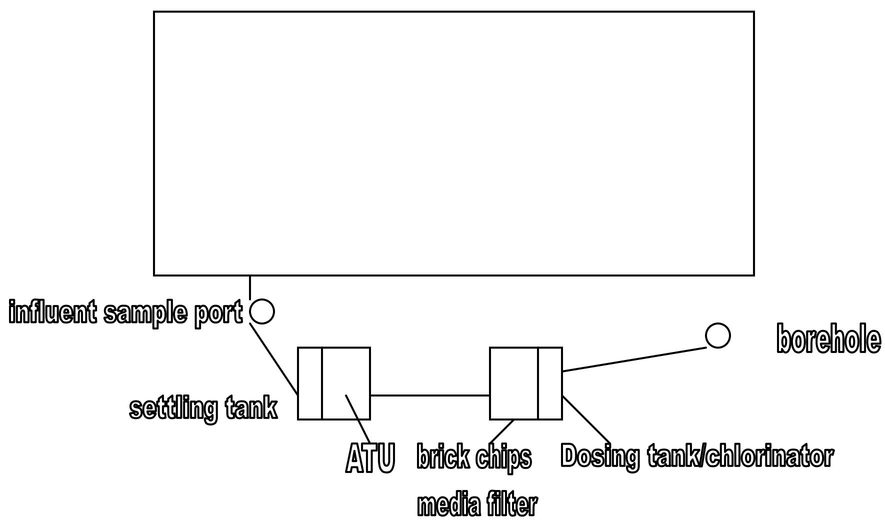

APPENDIX B: ELECTRONIC TASK 1 DATABASE

Department of Health
Bureau of Onsite Sewage Programs

Nitrogen Reduction Strategies Study
Progress Update
November 2011

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Purpose:

- Develop passive strategies for nitrogen reduction that complement the use of conventional onsite sewage treatment and disposal systems
- Further develop and test the most cost-effective nitrogen reduction strategies

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Project Tasks:

A. Technology Selection & Prioritization

B. Field Testing of Technologies

C. Evaluation of Nitrogen Reduction by Soils & Shallow Groundwater

D. Nitrogen Fate and Transport Modeling

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Task A: Technology Selection & Prioritization

- Selected different technologies for field testing after conducting a literature review, technology evaluation, and technology prioritization process
- Built pilot scale units with various media combinations at a newly constructed test facility at the University of Florida's Gulf Coast Research and Education Center in Wimauma, Florida
- Results from two-stage passive biofilter are encouraging after 12 months of testing, showing a TN reduction of over 95% (2.6 mg/L)
- Also testing reactive media in a more in-situ/in-ground system approach

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Nitrogen Study Test Facility

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Task B: Field Testing of Technologies

- Installation of top ranked nitrogen reduction technologies at actual home sites and document performance and cost
- Total of seven sites to be installed and monitored
- One system (Nitrex) installed to date in Wakulla County, sampling is underway
- Other homeowner agreements have been reached for potential sites in Hillsborough, Marion, Lee, Seminole, and Wakulla counties

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Task C: Evaluation of Nitrogen Reduction by Soils & Shallow Groundwater

- Field evaluations of nitrogen reduction in Florida soils
- Will provide data for the development of a simple planning model
- Test Facility to be constructed to conduct controlled tests in multiple drainfield configurations
- Up to four home sites will be evaluated
- Two home sites (Wakulla and Seminole counties) and the existing mounded system at the test facility have been instrumented and tested to date
- Other homeowner agreements have been reached in Hillsborough, Marion, Seminole, and Wakulla counties

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Task D: Nitrogen Fate and Transport Modeling

- Development of a simple fate and transport model of nitrogen from onsite sewage treatment and disposal systems that can be used for assessment, planning, and siting
- Quality Assurance Project Plan has been completed
- Development of a soil model is underway and will be utilized to generate a simple tool for prediction of nitrogen removal in Florida soils

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Funding Recommendations

- Project is funded through June 30, 2012. Funding (cash) required in the amount of $2.2 million for continuation and completion of all tasks in the original project scope.
- The results of this project will assist with producing more cost-effective nitrogen reducing systems that protect groundwater with lower life-cycle costs and lower energy demands.

FLORIDA DEPARTMENT OF HEALTH

2012 PROGRESS REPORT ON PHASE II AND PHASE III OF THE FLORIDA ONSITE SEWAGE NITROGEN REDUCTION STRATEGIES STUDY

Bureau of Onsite Sewage Programs

February 1, 2012

H. Frank Farmer, Jr., M.D., Ph.D., F.A.C.P.
State Surgeon General

Rick Scott
Governor

Table of Contents

List of Figures

List of Tables

PROGRESS REPORT ON PHASE II AND PHASE III OF THE FLORIDA ONSITE SEWAGE NITROGEN REDUCTION STRATEGIES STUDY

EXECUTIVE SUMMARY

This report is submitted in compliance with Line Item 465 Section 3, Conference Report on Senate Bill 2000, General Appropriations Act for Fiscal Year 2011-2012. The Florida Legislature has provided a total of $2.9 million (cash) for Phases I and II of a three phase project with a total estimated cost of $5.1 million. This project is to develop cost-effective, passive strategies for nitrogen reduction for onsite sewage treatment and disposal systems (OSTDS). This project will require additional cash and budget authority in the amount of $2.2 million to complete the study.

This project is in its third of five years and is on schedule and within budget. Funds appropriated and expended to date have established necessary viable protocols and have been appropriately used to test, calibrate, and refine technologies and strategies to be tested in the field. Without further funding for the final Phase III of the project, necessary and extensive field testing will not occur. If field testing does not occur, the project will not yield results that can be used to develop viable, cost-effective alternative passive technologies for use by homeowners for nitrogen issues associated with onsite systems.

Regardless of the source, excessive nitrogen has negative effects on public health and the environment. This project has been endorsed by Florida TaxWatch as a good use of public funds (Wenner 2008). RRAC supports concluding this study as originally scoped. The tasks associated with the final phase include: continuation and completion of field monitoring of the performance and cost of technologies at home sites and of nitrogen fate and transport in the shallow groundwater; development of nitrogen fate and transport models that will be calibrated with the field sampling results; and final reporting on all tasks with recommendations on onsite sewage nitrogen reduction strategies. In previous years, this project has been funded through one-year non-recurring appropriations. The uncertainly of ongoing funding has caused inefficiencies in the project.

The Research Review and Advisory Committee recommends that the Legislature:

1. Provide additional cash in the amount of $2.2 million for continuation and completion of the tasks associated with this legislatively mandated study.
2. Provide budget authority to DOH in the amount of $1.5 million for the fiscal year 2012-2013 for continuation of the tasks associated with this legislatively mandated study. In fiscal year 2013-2014 budget authorization to DOH will be required in the amount of $700,000 for completion of the tasks associated with this legislatively mandated study.

Continued support for this project will ultimately benefit Florida’s approximately 2.7 million onsite system owners by finding cost-effective nitrogen reduction strategies that will improve environmental and public health protection. When fully funded, the results of this project will assist with producing nitrogen reducing systems that protect groundwater through reduced life-cycle costs and lower energy demands.

INTRODUCTION

The Florida Legislature has provided a total of $2.9 million (cash) for Phases I and II of a three phase project with a total estimated cost of $5.1 million. This project is to develop passive strategies for nitrogen reduction for onsite sewage treatment and disposal systems (OSTDS). This includes an initial appropriation of $900,000 by the 2008 Legislature for the first phase of this study and an appropriation of $2,000,000 by the 2010 Legislatures for the second phase of this study. This project will require additional cash and budget authority in the amount of $2.2 million to complete the study. This report is submitted in compliance with Line Item 465 Section 3, Conference Report on Senate Bill 2000, General Appropriations Act for Fiscal Year 2011-2012, which appropriated the funding for the study.

This study was based on budget language in 2008 (Line Item 1682, House Bill 5001, General Appropriations Act for Fiscal Year 2008-2009) that instructed:

> …the Department of Health to further develop cost-effective nitrogen reduction strategies. The Department of Health shall contract, by request for proposal, for Phase I of an anticipated 3-year project to develop passive strategies for nitrogen reduction that complement use of conventional onsite wastewater treatment systems. The project shall be controlled by the Department of Health's Research Review and Advisory Committee and shall include the following components: 1) comprehensive review of existing or ongoing studies on passive technologies; 2) field testing of nitrogen reducing technologies at actual home sites for comparison of conventional, passive technologies and performance-based treatment systems to determine nitrogen reduction performance; 3) documentation of all capital, energy and life-cycle costs of various technologies for nitrogen reduction; 4) evaluation of nitrogen reduction provided by soils and the shallow groundwater below and down gradient of various systems; and 5) development of a simple model for predicting nitrogen fate and transport from onsite wastewater systems. A progress report shall be presented to the Executive Office of the Governor, the President of the Senate and the Speaker of the House of Representatives on February 1, 2009, including recommendations for funding additional phases of the study.

The 2010 legislative direction (included in Appendix A) specified that the existing contract for this project will remain in full force; that the Department, the Department's Research Review and Advisory Committee (RRAC), and the Florida Department of Environmental Protection (DEP) shall work together to provide technical oversight; that DEP will have maximum technical input; that the main focus and priority for work in Phase II shall be in developing, testing, and recommending cost-effective passive technologies for nitrogen reduction; that field installations for this project will be subject to significant testing and monitoring; and that no state agency shall implement any rule or policy that requires nitrogen reducing systems or increases their costs until the study is complete.

The 2011 legislative direction (included in Appendix B) specified that the existing contract for this project will remain in full force; that the Department, the Department's Research Review and Advisory Committee (RRAC), and the Florida Department of Environmental Protection (DEP) shall work together to provide technical oversight; that completion of Phase II and Phase III must be consistent with the terms of the existing contract; that the main focus and priority for Phase III be developing, testing, and recommending cost-effective passive technology design criteria for nitrogen reduction; the installed systems are experimental in nature and shall be installed with significant field testing and monitoring; and that no state agency shall implement any rule or policy that requires nitrogen reducing systems or increases their costs until the study is complete.

Regardless of the source, excessive nitrogen has negative effects on public health and the environment. The primary motivations for this study are the environmental impacts that the increased levels of nitrogen in water bodies can cause. Programs within DEP identify water bodies impaired by excessive nitrogen, establish targets for maximum nutrient loads, and develop management action plans to restore the water bodies. The relative impact of OSTDS on total nitrogen levels varies from watershed to watershed with estimates ranging from below five to more than 20 percent. There is widespread interest in the management of OSTDS and their nitrogen impacts. This project has been endorsed by Florida TaxWatch as a study that is a good use of public funds and that provides homeowners with cost-effective options for nitrogen reduction (email communication from Kurt Wenner to Jerry McDaniel June 2, 2008). The significance of this innovative project is that it evaluates and develops strategies to reduce nitrogen impacts from OSTDS regulated by the Florida Department of Health (DOH). The goal is to develop systems that complement the use of conventional OSTDS and are also affordable and ecologically protective with reduced engineering and installation costs that assist in sustainable development.

The study contract was awarded in January 2009 to a Project Team led by Hazen and Sawyer, P.C., and was based upon an anticipated budget of $5 million over a 3 – 5 year project timeframe, with an additional $100,000 budget to DOH for project management. As a result of the time required for contracting, unspent monies in fiscal year 2008-2009 were budgeted in 2009 to complete the initial tasks of the project. The contract identifies the following tasks:

Task A – Technology Evaluation for Field Testing: Review, Prioritization, and Development: This task includes literature review, technology evaluation, prioritization of technologies to be examined during field testing, and further experimentation with approaches tested in a previous DOH passive nitrogen removal study. Objectives of this task are to prioritize technologies for testing at actual home sites and to perform controlled tests at a test facility to develop design criteria for new passive nitrogen reduction systems.

Task B – Field Testing of Technologies and Cost Documentation: This task includes installation of top-ranked nitrogen reduction technologies at actual homes, with documentation of their performance and cost. Cost documentation for the systems will be broken down by permitting, design, materials and construction, and operation and maintenance.

Task C – Evaluation of Nitrogen Reduction Provided by Soils and Shallow Groundwater: This task includes several field evaluations of nitrogen reduction in Florida soils and shallow groundwater and also will provide data for the development of a simple planning model in Task D.

Task D – Nitrogen Fate and Transport Modeling: The objective of this task is to develop a simple fate and transport model of nitrogen from OSTDS that can be used for assessment, planning and siting of OSTDS.

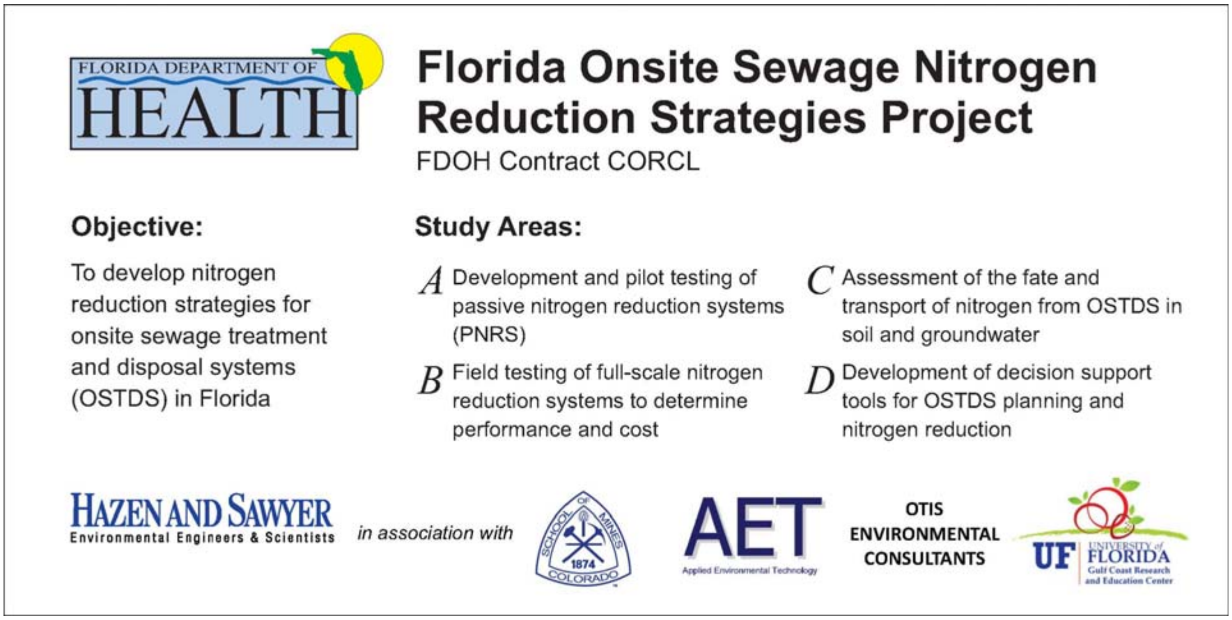

Figure 1. Sign posted at the University of Florida's Gulf Coast Research & Education Center's test facility.

1 PROJECT STATUS

Funding for the first and second phases of this project has been appropriated. A summary of the major project elements and their timing with funding phases is shown in Table 1. The contractor, in coordination with the RRAC and DOH, has successfully completed parts of Tasks A, B, C, and D, including literature reviews; ranking of nitrogen reduction technologies for field testing; design and construction of a test facility for further development of passive technologies; development of quality assurance documents for the test facility work, groundwater monitoring, field testing, and nitrogen fate and transport modeling; installation of a nitrogen reducing system at a home site; completion of several sampling events of passive systems at the test facility and field sites; and field sampling of the soil and groundwater under OSTDS at residential homes throughout Florida and at the test facility.


Figure 2. Test facility constructed at the University of Florida's Gulf Coast Research & Education Center.

Current efforts and work remaining for the 2011-2012 fiscal year includes: installation and field sampling of field sites at residential homes throughout Florida and at the test facility for the testing of passive systems and to test the soil and groundwater under OSTDS; design and construction of a soil and groundwater test facility; sampling at the soil and groundwater test facility; and initiating development of a nitrogen fate and transport model. RRAC supports concluding this study as originally scoped. In particular, the following work by task will proceed with the current funding level:

1. The technology evaluation (Task A) included a total of 7 sample events at the passive nitrogen test facility, measuring 14 different analytes at 23 sampling points in 11 systems, as well as a final report on the pilot passive nitrogen removal study at the Gulf Coast Research and Education Center (GCREC).
   Current Status as of November 2011: All sample events at the test facility have been completed. Test results are encouraging after 12 months of testing, showing a reduction in total nitrogen of over 95%, with a final effluent concentration of 2.6 mg/L for several of the systems.
2. For field testing of technologies (Task B), the quality assurance project plan has been finalized. Approximately four onsite systems, utilizing various nitrogen removal technologies, will be installed at home locations throughout the State of Florida. It is anticipated that four field system performance monitoring events will be conducted on these systems with the current funding level, measuring 16 different analytes at 2-8 different sampling points. A life cycle cost assessment template will also be completed.
   Current Status as of November 2011: Eleven homeowners residing at locations across Florida have agreed to participate in the study to date for Task B, and a final determination of which sites to use will be finalized in the near future. Home sites have been identified in Wakulla County, the Wekiva area, and several other areas throughout the State. At least one of the home sites will have a gravity-fed system installed. Construction has been completed for one system and sampling has begun.
3. To evaluate nitrogen reduction provided by soils and shallow groundwater (Task C), it is anticipated that a soil and groundwater test facility will be constructed to show how groundwater fate and transport of nitrogen occurs in multiple soil treatment unit regimes. Three sampling events will be completed with the current funding level, sampling six different locations at each site, and measuring multiple parameters in the effluent, soil, and groundwater. The existing OSTDS mound system at the University of Florida’s Gulf Coast Research & Education Center (GCREC) in Wimauma, Florida will be instrumented to study how nitrogen behaves in the soil and groundwater. Four sampling events that examinine multiple parameters, will be completed at the existing OSTDS mound system at GCREC with the current funding level. At least one soil and groundwater monitoring event will occur at up to two home sites to evaluate nitrogen movement in the soil and groundwater in the field, measuring multiple parameters in the effluent, soil, and groundwater.
   Current Status as of November 2011: Testing of media components has been completed per 381.0065(4)(m) F.S., one tracer test has been completed, and construction of the soil and groundwater test facility has begun. Instrumentation of the existing OSTDS mound system at GCREC has been completed and 3 sample events have been conducted. Six homeowners have agreed to participate in the study to date for Task C and a final determination of which sites to use will be finalized in the near future. Two home sites have been selected and instrumented and one sample event has occurred at each site. At one site, the groundwater flow direction could not be delineated, and no additional sampling events will occur.

4. To address nitrogen fate and transport modeling for Task D, a final quality assurance project plan has been completed, and the first steps will include the development of a soil model to show how nitrogen is affected by treatment in Florida-specific soils. **Current Status as of November 2011:** Work has focused primarily on soil modeling under the current budget. Development of a soil model is underway and will be utilized to generate a simple tool for prediction of nitrogen removal in the unsaturated zone of Florida soils.

2 ANTICIPATED PROGRESS IN 2012-2014

During the 2012-2014 fiscal year, additional funding will be critical to complete the tasks associated with the final phase. These include: continuation and completion of field monitoring of performance and cost of technologies at home sites and of nitrogen fate and transport in the shallow groundwater; development of various nitrogen fate and transport models that will be calibrated with the field sampling results; and final reporting on all tasks with recommendations on onsite sewage nitrogen reduction strategies. In particular, the following work will occur with the final phase of funding being requested with this report:

1. For Task A, the final task report will be written. This report will include a summary of the accomplishments of the passive nitrogen removal test facility.
2. For Task B, it is anticipated that an additional three onsite systems utilizing various nitrogen removal technologies will be installed at home locations throughout the State of Florida; four field system performance monitoring events will be conducted on these systems; and final reporting on all of the field work associated with this task will be completed. Cost documentation for the systems will be broken down by permitting, design, materials and construction, and operation and maintenance.
3. For Task C, instrumentation of two sites and monitoring events at all four home sites will be conducted to evaluate nitrogen movement in the soil and groundwater in the field. Monitoring will be conducted at six groundwater test areas at the soil and groundwater test facility to show how groundwater fate and transport of nitrogen occurs. Final reporting for this task will be completed.
4. For Task D, the soil model will be completed and integrated with groundwater models which will be developed, calibrated, and validated, utilizing the results of the field work collected in previous tasks, and a final task report will be written summarizing the results of this task.

3 FUNDING NEEDS

Activities in fiscal years 2008-2011 have prepared the framework for rapid implementation of all remaining project tasks in fiscal years 2012-2014. Cash and budget authorization in the amount of $2.2 million is required to reap the benefits of all previous work and to complete the goals of this project. For the 2012-2013 budget year, $1.5 million are required to fund the continuation of scheduled tasks. For the 2013-2014 budget year, $700,000 are required to fund the completion of scheduled tasks.

This project is in its third of five years and is on schedule and within budget. Funds appropriated and expended to date have established necessary viable protocols and have been appropriately used to test, calibrate, and refine technologies and strategies to be tested in the field. Without further funding for the final Phase III of the project, necessary and extensive field testing (the major portion of Task B) will not occur and the project will essentially not yield results that can be used to develop viable, cost-effective alternative passive technologies for use by homeowners for nitrogen issues associated with onsite systems.

Project Tasks (described previously) are broken down further into funding phases as follows:

Initial Funding in 2008-2010 (Phase I): $900,000 (cash and budget authority) appropriated (in 2008 and 2009 state budgets) – Status: Complete. The initial funding was targeted to prioritize systems for testing, summarize existing knowledge, develop testing protocols, and establish a test facility for detailed soil and groundwater monitoring and for preliminary testing of pilot scale passive nitrogen reduction systems.

Funding in 2010-2011: $2 million (cash and budget authority) appropriated (in 2010 state budget) – Status: Ongoing. This funding is for field monitoring over at least a one-year monitoring period of performance and cost of technologies at home sites, and of nitrogen fate and transport. This funding will also continue the development and monitoring work at the test facility and continue the modeling work.

Funding in 2011-2012: Although $2.75 million in budget authorization was appropriated in the 2011 state budget, no additional cash accompanied the budget authorization – Status: Ongoing. The remaining cash from the 2010-2011 appropriation is being used to continue the monitoring of systems and the soil modeling work. The preliminary results of the project are encouraging.

Funding in 2012-2014: To adequately fund the final phase of the project, $2.2 million cash is needed. A budget appropriation of $1.5 million will be needed for FY 2012-13. For the 2013-2014 budget year, $700,000 are required to fund the completion of scheduled tasks. Further testing is required to confirm the results to date with field data and to provide data for development of the engineering specifications for full system designs. The funds will be used to complete monitoring and other field activities, perform additional testing as deemed appropriate by the Legislature, and for final reporting with recommendations on onsite sewage nitrogen reduction strategies for Florida's future. The one-year non-recurring approach to funding this project has caused delays in progress and is inefficient.

Further information on this project, including previous legislative reports and detailed project reports, can be found on the Department's website:

http://www.doh.state.fl.us/environment/ostds/research/Nitrogen.html

Table 1. Summary of Funding Phase Tasks and Associated Number of Deliverables.

	Task	Phase I[a] $900,000 (July 2008-November 2010, completed)	Phase II[a] $2,000,000 (Current Funding, in progress)	Phase III[a] $2,200,000 (Future Funding, yet to be funded)
A	**Task A: Technology Selection & Prioritization**	**$352,144**	**$336,514**	**$35,480**
	Literature review	1		
	Ranking of nitrogen reduction technologies for field testing	1		
	Design and construction of test facility	1		
	Quality assurance project plan	1		
	Monitoring and sample events		7	
	Final test facility report		1	
	Final task report			1
B	**Task B: Field Testing of Technologies**	**$50,202**	**$599,610**	**$529,243**
	Quality assurance project plan		1	
	Installation of ranked nitrogen reduction technologies at 8 field sites		4	4
	System performance monitoring events at 8 sites		4	4
	Life cycle cost assessment template development		1	
	Final life cycle cost assessment report (per system)			8
	Final task report			1
C	**Task C: Evaluation of Nitrogen Reduction by Soils & Shallow Groundwater**	**$216,164**	**$1,095,977**	**$598,860**
	Quality assurance project plan	1		
	Design of test facility	1		
	Construction of test facility		1	
	Monitoring and sample events (6 test areas)		3	3
	Instrumentation of existing OSTDS mound at GCREC facility		1	
	GCREC mound sample events		4	
	Field sites sample events (4 sites)		1	3
	Final task report			1
D	**Task D: Nitrogen Fate and Transport Models**	**$74,357**	**$292,021**	**$441,644**
	Quality assurance project plan	0.5 (draft)	0.5 (final)	
	Soil model		1	
	Shallow groundwater models			1
	Calibration of models to existing data sets			1
	Uncertainty analysis for models			1
	Validation and refinement of models			1
	Final task report			1
	Project Management (sum of contractor and DOH)	**$119,953**	**$126,375**	**$231,456**
	Contractor project management	$90,695	$109,003	$178,085
	DOH project management	$29,258	$17,372[b]	$53,371[b]
	Total Budget[c]	**$812,820**	**$2,450,497**	**$1,836,722**
	Total Budget Remaining as of April 15, 2011	**$0**	**$1,670,029**	**$1,836,722**

a. Numbers in each subtask represent the numbers of budgeted deliverables.
b. DOH project management costs for Phases II and III are estimated costs.
c. Budgeted totals differ from the legislative funding amounts due to scheduling.

DOH – Department of Health
GCREC – Gulf Coast Research & Education Center
OSTDS – Onsite Sewage Treatment and Disposal Systems

4 RECOMMENDATIONS

The Research Review and Advisory Committee recommends that the Legislature:

1. Provide additional cash in the amount of $2.2 million for continuation and completion of the tasks associated with this legislatively mandated study.
2. Provide budget authority to DOH in the amount of $1.5 million for the fiscal year 2012-2013 for continuation of the tasks associated with this legislatively mandated study. In fiscal year 2013-2014, budget authorization to DOH will be required in the amount of $700,000 for completion of the tasks associated with this legislatively mandated study.

This additional funding will be applied to the final phase of the project, primarily continuation and completion of field monitoring of performance and cost of technologies at home sites and of nitrogen fate and transport in the shallow groundwater, development of various nitrogen fate and transport models that will be calibrated with the field sampling results, and final reporting on all tasks with recommendations on onsite sewage nitrogen reduction strategies.

Continued support for this project will ultimately benefit Florida's approximately 2.7 million onsite system owners by finding cost-effective nitrogen reduction strategies that will improve environmental and public health protection. When fully funded, the results of this project will assist with producing nitrogen reducing systems that protect groundwater through reduced life-cycle costs and lower energy demands.

APPENDIX A. 2010 Legislative Language

SECTION 3 – HUMAN SERVICES

486	SPECIAL CATEGORIES	
	CONTRACTED SERVICES	
	FROM GENERAL REVENUE FUND	153,772
	FROM ADMINISTRATIVE TRUST FUND . . .	337,765
	FROM FEDERAL GRANTS TRUST FUND . . .	348,235
	FROM GRANTS AND DONATIONS TRUST FUND	2,648,438
	FROM RADIATION PROTECTION TRUST FUND	150,000

From the funds in Specific Appropriation 486, $2,000,000 from the Grants and Donations Trust Fund is provided to the department to continue phase II and complete the study authorized in Specific Appropriation 1682 of chapter 2008-152, Laws of Florida. The report shall include recommendations on passive strategies for nitrogen reduction that complement use of conventional onsite wastewater treatment systems. The department shall submit an interim report of phase II on February 1, 2011, a subsequent status report on May 16, 2011, and a final report upon completion of phase II to the Governor, the President of the Senate, and the Speaker of the House of Representatives prior to proceeding with any nitrogen reduction activities.

Section 14. In order to implement Specific Appropriation 486 of the 2010-2011 General Appropriations Act, and for the 2010-2011 fiscal year only, the following requirements shall govern Phase 2 of the Department of Health's Florida Onsite Sewage Nitrogen Reduction Strategies Study:

(1) The underlying contract for which the study was let shall remain in full force and effect with the Department of Health and funding the contract for Phase 2 of the study shall be through the Department of Health.

(2) The Department of Health, the Department of Health's Research Review and Advisory Committee, and the Department of Environmental Protection shall work together to provide the necessary technical oversight of Phase 2 of the project, with the Department of Environmental Protection having maximum technical input.

(3) Management and oversight of Phase 2 shall be consistent with the terms of the existing contract; however, the main focus and priority for work to be completed for Phase 2 shall be in developing, testing, and recommending cost-effective passive technology design criteria for nitrogen reduction.

(4) The systems installed at actual home sites are experimental in nature and shall be installed with significant field testing and monitoring. The Department of Health is specifically authorized to allow installation of these experimental systems. In addition, before Phase 2 of the study is complete and notwithstanding any law to the contrary, a state agency may not adopt or implement a rule or policy that:

(a) Mandates, establishes, or implements any new nitrogen-reduction standards that apply to existing or new onsite sewage treatment systems or modification of such systems;

(b) Increases the cost of treatment for nitrogen reduction from onsite sewage treatment systems; or

(c) Directly requires or has the indirect effect of requiring, for nitrogen reduction, the use of performance-based treatment systems or any similar technology; provided the Department of Environmental Protection administrative orders recognizing onsite system modifications, developed through a basin management action plan adopted pursuant to section 403.067, Florida Statutes, are not subject to the above restrictions where implementation of onsite system modifications are phased in after completion of Phase 2, except that no onsite system modification developed in a basin management action plan shall directly or indirectly require the installation of performance-based treatment systems.

APPENDIX B. 2011 Legislative Language

SECTION 3 – HUMAN SERVICES

465	SPECIAL CATEGORIES	
	CONTRACTED SERVICES	
	FROM GENERAL REVENUE FUND	97,489
	FROM ADMINISTRATIVE TRUST FUND . . .	335,165
	FROM FEDERAL GRANTS TRUST FUND . . .	643,776
	FROM GRANTS AND DONATIONS TRUST FUND	3,401,038
	FROM RADIATION PROTECTION TRUST FUND	150,000

From the funds in Specific Appropriation 465, $2,725,000 in nonrecurring funds from the Grants and Donations Trust Fund is provided to the department to complete phase II and phase III and complete the study authorized in Specific Appropriation 1682 of chapter 2008-152, Laws of Florida. The report shall include recommendations on passive strategies for nitrogen reduction that complement use of conventional onsite wastewater treatment systems. The department shall submit an interim report of the completion of phase II and progress on phase III on February 1, 2012, a subsequent status report on May 16, 2012, and a final report upon completion of phase III to the Governor, the President of the Senate, and the Speaker of the House of Representatives prior to proceeding with any nitrogen reduction activities.

Section 7. In order to implement Specific Appropriation 465 of the 2011-2012 General Appropriations Act, and for the 2011-2012 fiscal year only, the following requirements govern the completion of Phase 2 and Phase 3 of the Department of Health's Florida Onsite Sewage Nitrogen Reduction Strategies Study:

(1) The Department of Health's underlying contract for the study remains in full force and effect and funding for completion of Phase 2 and Phase 3 is through the Department of Health.

(2) The Department of Health, the Department of Health's Research Review and Advisory Committee, and the Department of Environmental Protection shall work together to provide the necessary technical oversight of the completion of Phase 2 and Phase 3 of the project.

(3) Management and oversight of the completion of Phase 2 and Phase 3 must be consistent with the terms of the existing contract. However, the main focus and priority to be completed during Phase 3 shall be developing, testing, and recommending cost-effective passive technology design criteria for nitrogen reduction.

(4) The systems installed at homesites are experimental in nature and shall be installed with significant field testing and monitoring. The Department of Health is specifically authorized to allow installation of these experimental systems. Notwithstanding any other law, before Phase 3 of the study is completed, a state agency may not adopt or implement a rule or policy that:

(a) Mandates, establishes, or implements more restrictive nitrogen-reduction standards to existing or new onsite sewage treatment systems or modification of such systems; or

(b) Directly or indirectly requires the use of performance-based treatment systems or similar technology, such as through an administrative order developed by the Department of Environmental Protection as part of a basin management action plan adopted pursuant to s. 403.067, Florida Statutes. However, the implementation of more restrictive nitrogen-reduction standards for onsite systems may be required through a basin management action plan if such plan is phased in after completion of Phase 3.

Rick Scott
Governor

H. Frank Farmer, Jr., MD, PhD, FACP
State Surgeon General

December 20, 2011

The Honorable Rick Scott
Governor of the State of Florida
The Capitol – Plaza Level 05
Tallahassee, Florida 32399

Dear Governor Scott:

I am pleased to provide you with a copy of the Florida Department of Health's (Department) Progress Report on Phase II and Phase III of the Florida Onsite Sewage Nitrogen Reduction Strategies Study. This report was prepared pursuant to Line Item 465 Section 3, Conference Report on Senate Bill 2000, General Appropriations Act for Fiscal Year 2011-2012, which provides that this Phase II and Phase III status report be submitted on February 1, 2012. This progress report follows the status report submitted to your office on May 16, 2011.

The 2011 Legislature tasked the Department to continue and complete a study on passive strategies for nitrogen reduction, initial funding for which the Legislature had authorized in 2008. The Department must also submit a status report on May 16, 2012 and a final report upon completion of Phase III.

This report recommends the Legislature provide additional cash to the Department in the amount of $2.2 million for continuation and completion of the tasks associated with this legislatively mandated study. We also ask that budget authority be provided to the Department in the amount of $1.5 million for fiscal year 2012-2013 and $700,000 for fiscal year 2013-2014 for continuation and completion of the tasks associated with this study.

If you have questions or would like additional copies, please contact Gerald R. Briggs, Bureau Chief of the Onsite Sewage Programs, by calling (850) 245-4070, or by e-mail at Gerald_Briggs@doh.state.fl.us.

Sincerely,

H. Frank Farmer, Jr., M.D., Ph.D., F.A.C.P.
State Surgeon General

HFF/grb
Enclosure

FLORIDA DEPARTMENT OF HEALTH

Rick Scott
Governor

H. Frank Farmer, Jr., MD, PhD, FACP
State Surgeon General

December 20, 2011

The Honorable Mike Haridopolos
President, Florida Senate
409 The Capitol
404 South Monroe Street
Tallahassee, Florida 32399-1100

Dear President Haridopolos:

I am pleased to provide you with a copy of the Florida Department of Health's (Department) Progress Report on Phase II and Phase III of the Florida Onsite Sewage Nitrogen Reduction Strategies Study. This report was prepared pursuant to Line Item 465 Section 3, Conference Report on Senate Bill 2000, General Appropriations Act for Fiscal Year 2011-2012, which provides that this Phase II and Phase III status report be submitted on February 1, 2012. This progress report follows the status report submitted to your office on May 16, 2011.

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If you have questions or would like additional copies, please contact Gerald R. Briggs, Bureau Chief of the Onsite Sewage Programs, by calling (850) 245-4070, or by e-mail at Gerald_Briggs@doh.state.fl.us.

Sincerely,

H. Frank Farmer, Jr., M.D., Ph.D., F.A.C.P.
State Surgeon General

HFF/grb
Enclosure

Office of the State Surgeon General
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FLORIDA DEPARTMENT OF HEALTH

Rick Scott
Governor

H. Frank Farmer, Jr., MD, PhD, FACP
State Surgeon General

December 20, 2011

The Honorable Dean Cannon
Speaker, Florida House of Representatives
420 The Capitol
402 South Monroe Street
Tallahassee, Florida 32399-1300

Dear Speaker Cannon:

I am pleased to provide you with a copy of the Florida Department of Health's (Department) Progress Report on Phase II and Phase III of the Florida Onsite Sewage Nitrogen Reduction Strategies Study. This report was prepared pursuant to Line Item 465 Section 3, Conference Report on Senate Bill 2000, General Appropriations Act for Fiscal Year 2011-2012, which provides that this Phase II and Phase III status report be submitted on February 1, 2012. This progress report follows the status report submitted to your office on May 16, 2011.

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If you have questions or would like additional copies, please contact Gerald R. Briggs, Bureau Chief of the Onsite Sewage Programs, by calling (850) 245-4070, or by e-mail at Gerald_Briggs@doh.state.fl.us.

Sincerely,

H. Frank Farmer, Jr., M.D., Ph.D., F.A.C.P.
State Surgeon General

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

Wednesday January 4, 2012

10:00 am – 1:00 pm

Agenda:

- Introductions and Housekeeping
- Review Minutes of Meeting November 15, 2011
- Nitrogen Study Update
- Update on 319 Grant
- Other Business
- Public Comment
- Closing Comments, Next Meeting, and Adjournment

Introductions & Housekeeping

- Roll call
- Identification of audience
- How to view web conference
- DO NOT PUT YOUR PHONE ON HOLD!!!!
- Download reports:

http://www.myfloridaeh.com/ostds/research/Index.html

Introductions & Housekeeping

New appointments to the committee:

- Environmental Interest Group: Craig Diamond (member)
- Septic Tank Industry: Wayne Crotty (member), Bob Himschoot (alternate)
- Florida Department of Health: Paul Davis (member), Tom Higginbotham (alternate), Taylor Brown (alternate)
- Restaurant Industry: Geoff Luebkemann (member), Susan McKinley (alternate)

Who has left the committee (thank you letters from DOH sent):

- Kim Dove (DOH, member)
- Mike McInarnay (Septic Tank Industry, alternate)

Thank you letters sent from the RRAC to Patti Sanzone and Sam Averett

Review Minutes of Meeting November 15, 2011

- See draft minutes

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

- Wekiva River Basin Commission letter drafted and sent to Lee Constantine (Chair)
- TRAP letter of support sent 1/4/11 to Senator Alexander, Speaker Cannon, Representative Grimsley, President Haridopolos, Senator Hays, Representative Hooper, Representative Hudson, Senator Negron, and Representative Williams
- RRAC letter is being drafted by Clay Tappan (Chair)
- Presentation by Damann Anderson accepted for the University of Florida Water Institute Symposium on February 16, 2012

Florida Onsite Sewage Nitrogen Reduction Strategies Study

- Legislative Progress Report was sent on 12/21/11 to the Governor, Speaker of the House, and President of the Senate

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Progress since last meeting:

- Continuation of monitoring of mound system at GCREC
- Literature review and data set specification for the simulation of bioreactor filtration treatment of onsite wastewater
- Design and construction of passive in-situ in-ground test systems

Florida Onsite Sewage Nitrogen Reduction Strategies Study: Construction of Mini Mounds

- Switch to Soil and Groundwater Test Facility Construction Progress Report

319 Project on Performance and Management of Advanced Onsite Systems

Purpose: Assess water quality protection by advanced OSTDS throughout Florida

Progress:

- Granting period is now complete
- Final invoice sent to DEP
- Final report submitted for Monroe Diurnal and Seasonal Variability of Advanced Systems
- Final report submitted for Database of Advanced Systems

319 Project on Performance and Management of Advanced Onsite Systems: Keys Study Results

Validation of a Sampling Protocol:

- Occasional spurious high concentrations were reported, in many cases for one analyte but not for others in the same sample. While this may influence means, median concentration results are less impacted by this and appear generally reliable. Review of sample results on the background of typical results and communication with the laboratory appear to be a way to resolve some of these. The conditions for such interaction were much improved for Task 4.
- Relative to target concentrations, results from analysis of blanks indicated that the approach to sampling using peristaltic pumps was successful. For Task 4, flushing volumes were increased in an attempt to further reduce TN in equipment blanks, which had been detected most frequently.
- TSS appeared to be the most variable parameter in replicate samples from an intermediate container with a median relative standard deviation of 12%, but for cBOD5, TN, and TP this measure was 3% and less. Concerns about samples obtained from intermediate containers are thus less warranted for nutrient analyses than for TSS analyses.

319 Project on Performance and Management of Advanced Onsite Systems: Keys Study Results

Validation of a Sampling Protocol (cont.):

- Detailed characterization of the treatment systems and sampling locations are very important. Particularly in treatment systems with multiple treatment steps, "influent" and "effluent" need further qualification, and may be ambiguous to a sampler encountering the treatment system or to a data analyst. In the present study this required some reclassification during data analysis from "influent" to "intermediate". For Task 4, data fields for sample location description were more extensive, and a screen for the validity of "influent" samples was developed.
- The operational and maintenance conditions of a treatment system need to be better characterized if one wants to distinguish between technical limitations of treatment and shortcomings due to operator error or lack of maintenance. The assessment protocol for Task 4 included a more detailed assessment, including characterization if the power was on, observation of problems and the dissolved oxygen concentration as a measure of aeration.
- Assessments of variability between grab samples during each event showed that TSS had the highest variability, while TP and total alkalinity had the least, followed by TN. The first grab sample of a sampling event tended to be about 20% higher in TSS and 10% in cBOD5 than subsequent grab samples. This difference did not exist for nutrient species. Given that the emphasis of the project is on nutrient treatment effectiveness, grab sampling appeared appropriate for Task 4.

319 Project on Performance and Management of Advanced Onsite Systems: Keys Study Results

Validation of a Sampling Protocol (cont.):

- There was no overall bias found between the effluent composite and average of grab samples during the same event, even though for any event there could be differences. These differences were the least for total alkalinity, TP, TN and nitrate, with more than 50% of events showing a relative difference of less that 10%.
- The between event variability as expressed by relative standard deviations, is at least twice as large as the within event variability for all parameters, except for TSS.
- Analysis for differences by weekday showed no consistent results. Flow measurements for a subset of systems, but not for all measurements, appeared to decrease from Monday through Thursday. Grab but not composite effluent sample results for TSS and cBOD5 indicated a decrease from Sunday through Thursday, but this was at least partly due to differences in the occurrence of first grab samples on each day.
- Differences in concentrations between the wet/hot and dry/cold seasons were not significant.
- Visual/olfactory assessments appeared to be able to discriminate a threshold-value of TSS (visual) and possibly TSS, ammonia, and TKN (olfactory). During Task 4, the assessment protocol was refined to use more standardized terminology.

319 Project on Performance and Management of Advanced Onsite Systems: Keys Study Results

Validation of a Sampling Protocol (cont.):

- The Hach DR/890 colorimeter showed good agreement with laboratory nitrate and ammonia measurements and less so for ortho-phosphate compared to total phosphorus. In all cases there was an indication of between study-phase variability. To address these issues the recording forms for Task 4 were revised to better capture dilution and conversion factors.
- Taylor kits provided good agreement with laboratory measurements for total alkalinity. Task 4 relied largely on Taylor kits for this measurement, with some additional laboratory measurements for confirmation. Chlorine measurements by Taylor kit could not be independently assessed. They were utilized occasionally during the implementation of Task 4 to assess the effectiveness of chlorination devices.

Preliminary Assessment of Treatment Systems:

- Maintenance and operation of treatment systems appear to be important variables that were not systematically characterized in this study. Both the sampling results of processes that require replenishment of materials and anecdotes by the samplers indicated that this is an important, but not quantified, element of performance variability.
- Overall, the addition of a phosphorus reduction treatment step, usually a media filter, improved treatment for TSS, cBOD5, nitrite-nitrogen, and total phosphorus. Systems without that treatment step had median concentration results similar to an earlier survey of ATUs in the Keys.

319 Project on Performance and Management of Advanced Onsite Systems: Keys Study Results

Preliminary Assessment of Treatment Systems (cont.):

- Typical influent concentrations of cBOD5 and TSS were consistent with domestic sewage, and total phosphorus slightly elevated. TN concentrations were about twice as high as concentrations during a study that established the feasibility of current treatment standards and as the septic tank effluent concentrations provided in Florida performance-based treatment system regulations as point of comparison. Overall, 50% of influent composite samples showed a TN concentration between 47 and 94 mg/L, compared to 15 and 43 mg/L for the effluent.
- Among the phosphorus treatment approaches sampled there were significant differences in effluent concentrations. While overall, total phosphorus was significantly reduced, the Keys treatment standard was not met in most cases, even for the better performing approaches.
- Within the treatment systems sampled, nitrification appeared to be a limiting step to nitrogen reduction. The sampling events with the most nitrified effluent achieved typically about a 75% reduction compared to their influents, while the events with the least nitrified effluent only achieved a typical TN-reduction of about 28% and did not eliminate cBOD5. Events with intermediate nitrification showed intermediate TN-reduction and some indications of occasional alkalinity limitation.

319 Project on Performance and Management of Advanced Onsite Systems: Keys Study Results

Preliminary Assessment of Treatment Systems (cont.):

- 25% of the obtained fecal coliform samples exceeded the secondary grab sample standard of 400 cfu/100 mL. Nearly half of the obtained chlorine measurements did not meet the system-required chlorine residual. Such observations confirm that aerobic treatment alone is not sufficient to meet secondary fecal coliform standards. The chlorine measurements also point to the need for monitoring the effectiveness of chlorination units.

319 Project on Performance and Management of Advanced Onsite Systems: Summary Statistics

- 16,595 systems from four main sources: the Department of Health's Environmental Health Database (EHD), the Carmody system, various county health department databases, and innovative permit files
- Over 60% of the advanced systems in Florida are contained in these five counties: Monroe, Charlotte, Brevard, Franklin, and Lee.
- Eighty-seven percent of the addresses geocoded correctly. Out of the issues that prevented an address from being geocoded, the main reasons were that the street was unable to be matched (6%), the system was unable to match the house number (4%), and that there were issues with the length of the data field (1%).
- Out of 16,595 records, 8,313 have a construction permit number, which may have different formats and 12,804 have an operating permit number. Of 16,595 records 4,649, or slightly more than a quarter, have both an operating permit and a construction permit number. 127 records did not have any permit number assigned, these were Carmody and county/innovative records that did not include such information.

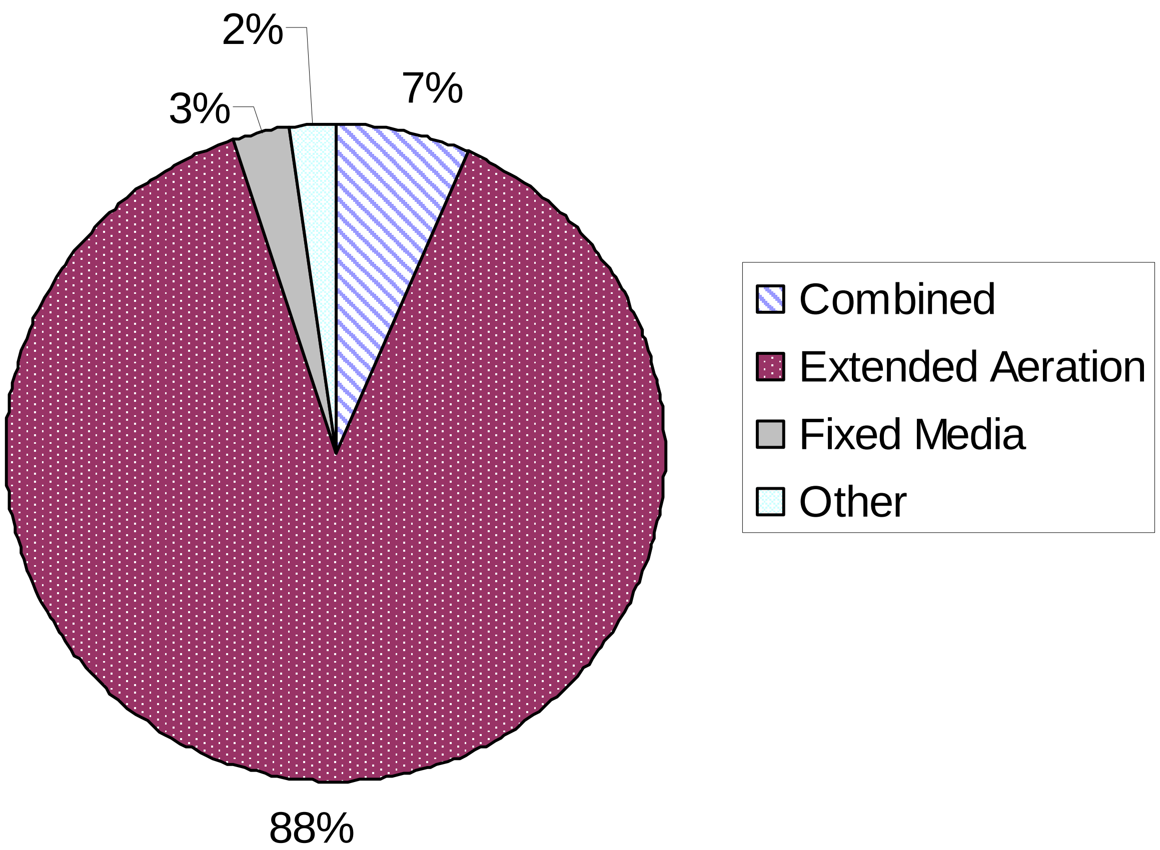
319 Project on Performance and Management of Advanced Onsite Systems: Summary Statistics

Frequency of Type of Advanced System (ATU, PBTS, Innovative, Unknown)

	Frequency	Percent
ATU	12660	76.3
Innovative	183	1.1
PBTS Non Innovative	1189	7.2
Unknown	2563	15.4
Total	**16595**	**100.0**

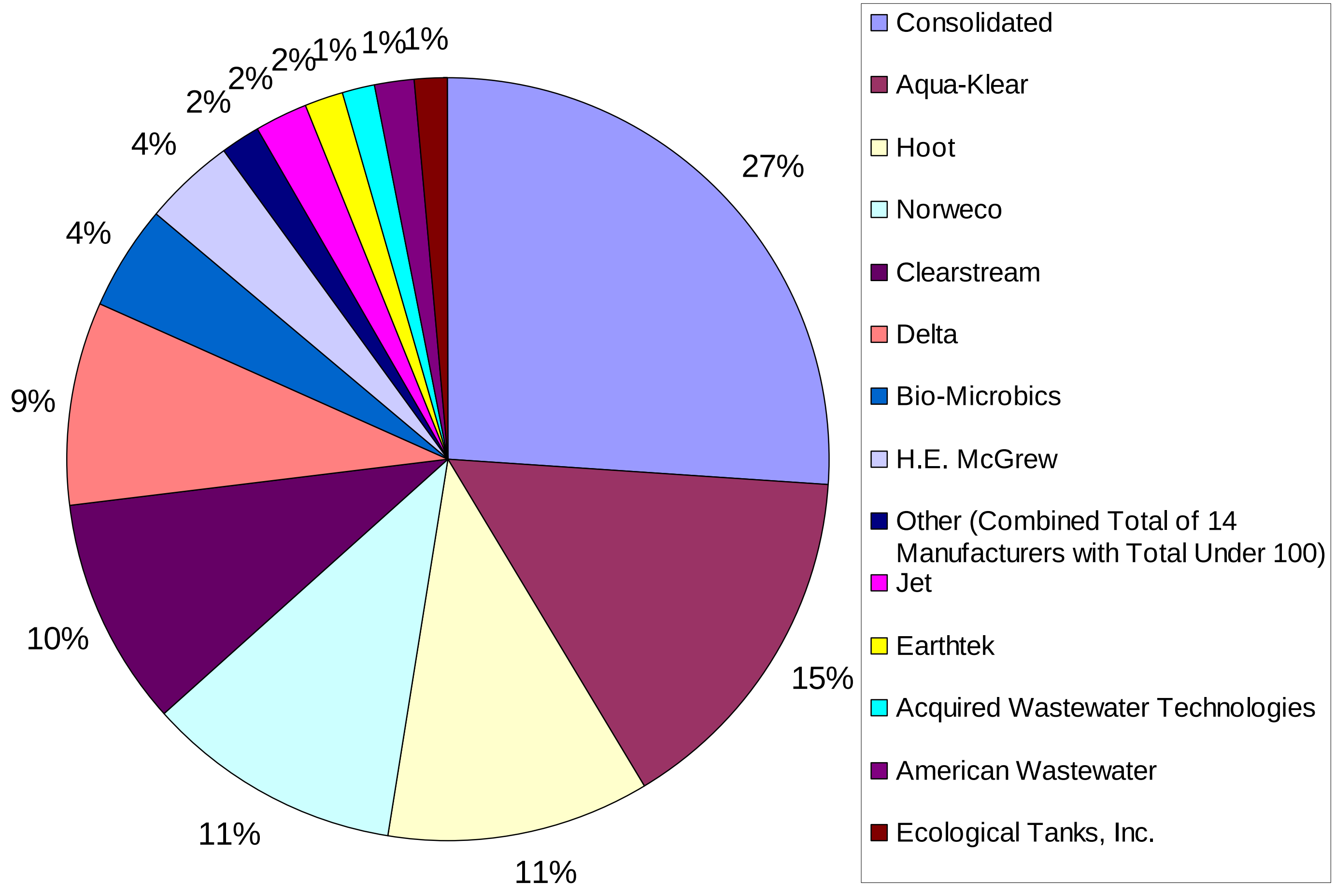
- A total of 7,173 systems in the database had a final system approval date. Of these systems, 75% were installed within 2-5 years of January 1, 2010.
- Out of a total of 16,595 systems, 9,206 (56%) had technology information

319 Project on Performance and Management of Advanced Onsite Systems: Summary Statistics



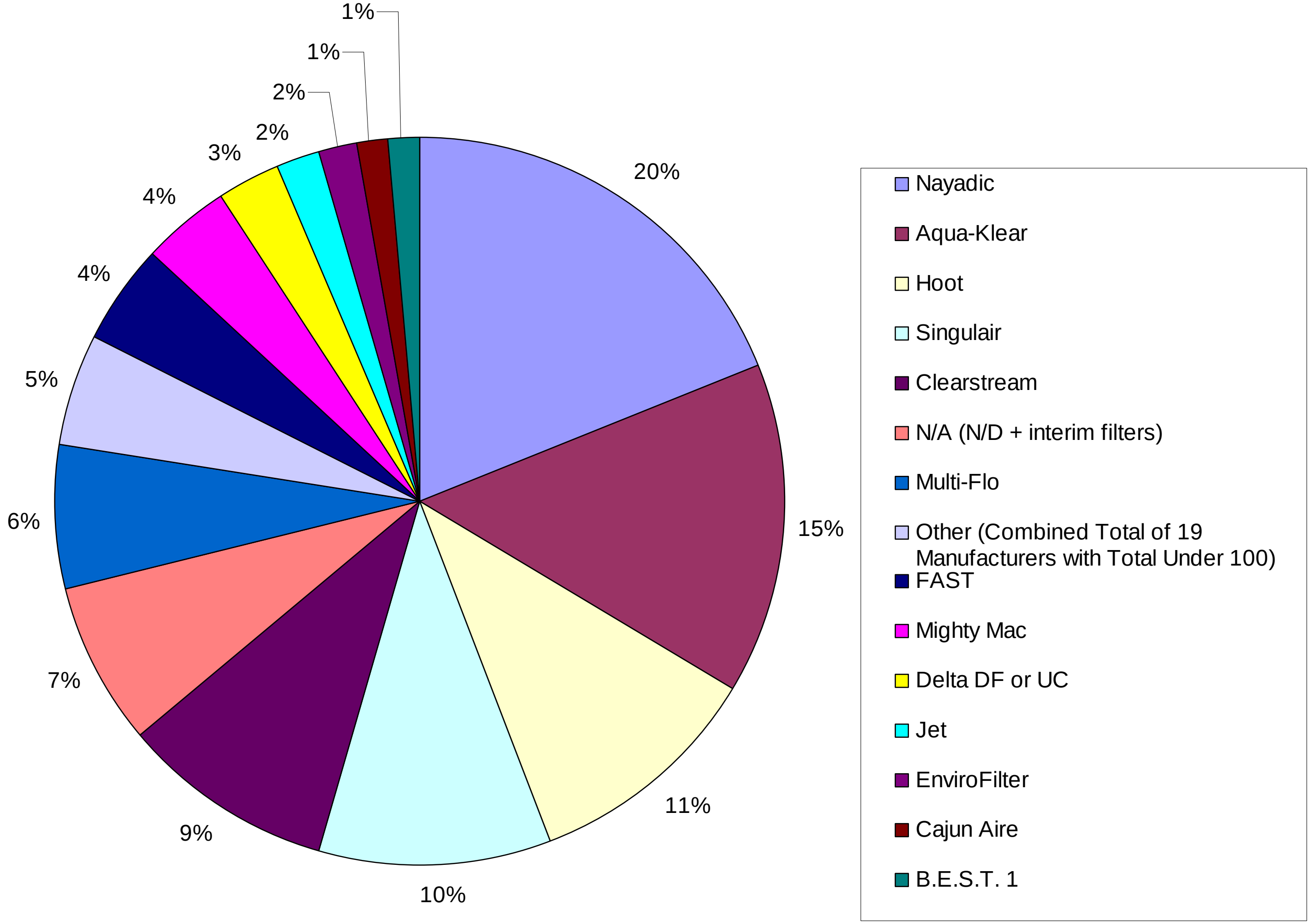
Technology Approach Information

319 Project on Performance and Management of Advanced Onsite Systems: Summary Statistics



Manufacturer Information

319 Project on Performance and Management of Advanced Onsite Systems: Summary Statistics



Product Technology Information

319 Project on Performance and Management of Advanced Onsite Systems

Progress cont. :

- Data Entry:
  - Data entry is ongoing with several bureau staff assisting
  - As of 12/20/11:
    - 395 systems need data entry
    - 707 system need a quality control review

319 Project on Performance and Management of Advanced Onsite Systems

Progress cont. :

- Management Practices
  - Database was created linking program evaluations over past 10 years with survey results for regulators and system owners/users
  - Analysis has been done and will be summarized in the final task report
  - Linking between this database and the sample results will also be done and summarized in the final task report

319 Project on Performance and Management of Advanced Onsite Systems

Progress cont. :

- Final Project Report
  - Anticipated to be written after all data entry and data analysis has been completed
  - Draft report to be presented to RRAC for review prior to finalization and submission to DEP

Other Business

Public Comment

Next Meeting

Upcoming meeting topics:

- Discussion on 319 grant report on the performance of advanced OSTDS in Florida
- Discussion on process forward with research priorities

Proposed dates for next meeting:

- Will send email to RRAC at a future date to determine next meeting

Closing Comments and Adjournment

Task 2: Database of Advanced Systems in Florida

Database Development, Database Structure, and Summary Statistics

for

DEP Agreement G0239
Department of Health Assessment of Water Quality Protection by Advanced Onsite Sewage Treatment and Disposal Systems: Performance, Management, Monitoring Project

By Elke Ursin and Eberhard Roeder

November 30, 2011

Table of Contents

List of Tables

List of Figures

1 Introduction

The database created as part of this project contains a total of 16,595 systems from four main sources: the Department of Health's Environmental Health Database (EHD), the Carmody system, various county health department databases, and innovative permit files. This report is submitted as the deliverable for Task 2 of grant G0239: "Description of advanced systems database, including fields and structure; Summary statistics of the results of the data aggregation, such as number of each type of system, number of advanced systems by county, etc." The report contains three main sections: the process description on how the data was combined into the project database, a description of the project database fields and database structure, and summary statistics for the data contained in the database.

2 Development of a Database of Advanced Treatment Systems

2.1 Method Overview

The development of a database of advanced treatment systems included the gathering of information from several data sources and several iterations of identifying duplications. The information came from two aspects of the permitting process: construction permitting for the initial construction or the repair of a system, and operating permitting for the continued operation and maintenance of a system. The sources of data were the Environmental Health Database (EHD), Carmody, County Health Department spreadsheets, and innovative permit files in the Bureau of Onsite Sewage Programs. In September 2008, project staff pursued the option of hiring an outside contractor to complete the task and solicited proposals, but negotiations with the most promising contractor were not successful. Therefore, the task needed to be completed in-house and data gathering commenced after the hiring of contract staff in June of 2009. The following sections describe the processes that led to the creation of the project database, the address list for the survey (Task 3) and the selection of treatment systems to be assessed (Task 4).

2.2 Data Sources

2.2.1 Environmental Health Database (EHD)

The environmental health database (EHD), is the successor to a previous central permitting data system of the Department of Health (Centrax). It contains both data on permits issued since EHD has been implemented and legacy data from permits issued through the previous system since the mid- to late 1990s. Depending on the county, EHD was implemented between 2007 and 2008, The legacy data tend to contain fewer data fields. This data source contains information on all systems, not just advanced systems. Data from this source were made available to the project in the form of query results by a distributed computer systems consultant in the Bureau. The bulk of the data has a nominal date of September 2009.

As a first step, candidate systems were all systems with an indication of being an ATU or a PBTS. For construction permits that included permits that had an application sub-type indicated as ATU on the application page, or where PBTS or innovative was selected as the application subtype, or that included a designation of aerobic treatment unit as distinct from a septic tank. For operating permits, active operating permits that had a check box for ATU or PBTS were selected. When both check boxes were indicated, the record was classified as PBTS. This resulted in 8,716 construction permit records and 11,636 operating permit records, or a total of 20352 records to begin with. Of course, each system should have received a construction permit and an operating permit, but both may not have been found using the criteria above. Also, there are scenarios, such as replacement of an older system with a newer system or the existence of multiple systems at one address, in which several permits may exist in the database for the same property. For the purposes of this database, which in large part was to provide addresses for a survey and for system assessment visits, one record per address was considered sufficient.

The second set of steps had the goal of linking operating permits and construction permits and the related goal of eliminating duplicate records. Sorting records by county, street address, and permit number allowed matching of street addresses with multiple permit information. Eliminating multiple addresses and requiring a complete mailing address lead to an address list of advanced system with 13,577 records. This list was utilized by the contractor for the user survey in the second half of 2010 as part of Task 3 of the overall grant project. The sorting also allowed matching of 3,727 instances of one address being associated with exactly one construction permit and exactly one operating permit. There were 2,497 records that had multiple permits at the same address. Inspection of these records showed that this included frequently streets without house numbers, and missing street addresses. Multiple construction permits or operating permits for one address were consolidated into one record by selecting the most recent permit based on an associated data field, and excluding records without identifiable addresses. With limited additional matching based on addresses that were spelled differently but referred to the same location, and city information, 13,609 records from EHD resulted for further processing. This included 3,699 addresses for which both construction and operating permit numbers were available, 4,194 for which only construction permit information were available, and 5,716 for which only operating permit information was available.

2.2.2 Carmody

Carmody is a web-based maintenance and inspection tracking system. Carmody Data Systems, Inc. is under contract with the Florida Department of Environmental Protection to offer this service to maintenance entities and health departments, as a tool to report maintenance and inspection events electronically. Carmody administers access to this tracking system. A related, publicly accessible, tool is “Septic Search ™” (septicsearch.com), which allows viewing of documents that Carmody Data Systems makes available for each system. In addition to maintenance and inspection reports, this may include other permit files, usually available for counties in which Carmody Data Systems, Inc. has performed a project to scan and electronically organize such files.

During the initial phases of the project the project contract employee had access to Carmody and its functionality to download data by county in Excel format. These data were aggregated to result in a list of all systems for which Carmody tracked maintenance and inspections. This list encompassed 14,909 records that had information up to July 2009. Not all of these systems were advanced systems, as Carmody also tracks maintenance and inspections for systems that need an operating permit for other reasons, such as commercial establishments, service entities, and systems located in industrial/manufacturing areas. The following summarizes the processing steps taken to focus on advanced systems.

The first set of steps consisted in a search for duplicates based on agreement of addresses. The record with the highest Carmody "tracking number" was generally kept for multiple records. During this search it became clear that Monroe county had two records for many addresses because the treatment system and the injection well or a gravel filter preceding the injection well (allowed only in Monroe county) were recorded separately. An additional set of data fields, "2nd component", was created to consolidate this information into one record per address. This resulted in 13,740 records.

The second set of steps aimed to eliminate those addresses that stemmed from only commercial or only industrial/manufacturing operating permits without an advanced system. Such systems are characterized in Carmody by a "management level" of "commercial" or "industrial". In order to do this, we undertook a match based on operating permit number with EHD-information. While for most cases, the Carmody "State Permit Number" corresponds to the operating permit of EHD, this match was not feasible for some counties, in particular for Charlotte, Franklin, and Sarasota, which used a different naming convention. For Monroe County, the Carmody "State Permit Number" consisted frequently of two joined operating permits, which was modified to reflect the later operating permit. The EHD-information consisted of a query of commercial and industrial operating permits, for which no advanced system indicator was present. Records, for which this EHD-operating permit and the Carmody "State Permit Number" agreed were eliminated, unless the Carmody record contained management level or component information that indicated an advanced treatment system.

After this screening, 10,466 records were left from this source. This still included many records in which management level was not indicated, and the equipment not specified ("unknown system type"). A random sample of 40 such systems indicated that many of these were indeed commercial or industrial, not advanced systems, and that the advanced systems had addresses that were part of the EHD-addresses discussed above.

2.2.3 CHD-Records and Innovative System Records

Preliminary surveys and telephone inquiries were made to the County Health Departments to determine their methods for recording operating permit data. Several counties (Miami-Dade, Duval, Escambia, Flagler, Madison, and Palm Beach) provided the Excel-spreadsheets that they use to track operating permits. We reformatted and aggregated these spreadsheets. Information from Madison County did generally not include addresses and was eventually removed from consideration.

Additional innovative system records stemmed from files in the Bureau that pertained to the permitting of innovative systems. These provided generally some information on the location, and sometimes permitting information, of systems that were installed under an experimental or innovative program. CHD and innovative information were gathered in one spreadsheet, records matched, and the result was 636 individual records. The permitting and installation of a new innovative system in Wakulla County in June of 2011 prompted the addition of one more record in the final database, which did not undergo the same preprocessing as other records.

2.3 Consolidating the Sources

2.3.1 Generating a System Address List

Initial assessments indicated limited overlap between operating permits in the state database and in Carmody, complicating efforts to develop a comprehensive database with uniform fields. In order to link records from different sources with the aim of achieving an address list of unique addresses we took the following steps:

The first step consisted of adding Carmody and CHD/innovative record information to EHD-records based on matching operating permit numbers. Subsequently all records were imported into one spreadsheet with 24,731 records.

Duplications in these records were eliminated by matching and consolidating operating permits and address information for the linked Carmody and CHD/innovative records. If the address (left 14 characters) matched between Carmody or CHD/innovative records and EHD-records, but EHD did not provide an operating permit, these were consolidated. This eliminated about 5,700 entries. The next step matched EHD-construction and operating permits based on the beginning of the address. Subsequently, for the same address, records with lower operating permit numbers were eliminated. For records that had the same, or a very similar address, and the same operating permit number, the record with less information was eliminated.

Then addresses were checked for similarities based on the first five characters. Where there appeared to be a duplication, operating and construction permit numbers and Carmody records were consolidated, and generally the EHD-address was used. This left 16,802 records. In the following overview, the relative importance of sources is indicated. The dominant sources of these were:

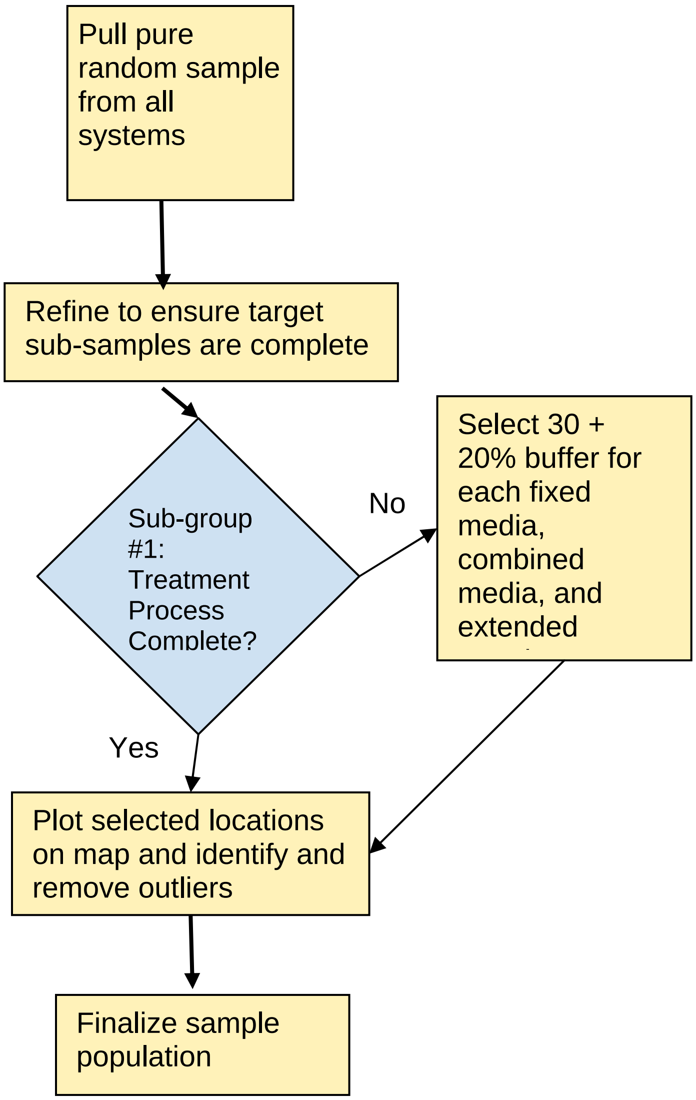
5,301	EHD provided operating permit but no construction permit information
4,058	EHD provided construction and operating permit information (other sources may corroborate information)
3,823	EHD provided construction permit but no operating permit information
3,502	Carmody information was the only source available
69	CHD sources were the only source available
39	Innovative files were the only source available
10	EHD provided construction permit and CHD provided operating permit information

At this stage, random numbers and system ID numbers based on ordering of the random numbers were assigned to each record (Figure 1). The addresses in records were checked against a mailing address database (Accumail), geocoded (MapMarker) and additional data fields added to summarize the success of geocoding and corrected addresses as described in Section 4.6. Subsequently, another search for duplicates found additional records that could be consolidated. Some of these had not been found before due to street spelling, capitalization, and city name not matching. Some resulted from Carmody and construction permit record matches for the addresses, or from Carmody matching EHD-operating permits for the permit number, but with a different address. In these cases, the construction permit address was kept. At this stage there were 16,594 records. The innovative record mentioned in Section 2.2.3 was added, to leave a final project total number of records of 16,595. Subsequently, an occasional duplicate was found during permit reviews or attempts to find a system in the field, usually due to very different or erroneous spellings of the street address, but these records were not deleted.

The focus on systems with identifiable addresses may have lead to a bias in the database against systems that can not be easily located. This bias is difficult to quantify, in part because many unidentifiable addresses stemmed from relatively recent EHD-operating permits, which may have replaced older operating permit numbers that are included in the database. To a lesser extent, addresses that could not be located, such as PO boxes, highway names, and lot numbers, appeared to be overrepresented in smaller counties.

2.3.2 Characterizing Treatment Components

The analysis of treatment technology was based on those records that could be linked with treatment component information from the data sources. Treatment component information had already been part of Carmody, CHD, and innovative information from the beginning. For EHD, the download queried the fields that had the highest potential for containing that information. For construction permits, these were the tank legends, which is suitable for those cases where the legend is completely recorded and a treatment tank legend corresponds to a treatment system. The latter condition was not always met, as some tanks can be used as septic tank or treatment system tank. For operating permits, the data field of the treatment system manufacturer and treatment was gathered. The EHD-information was compared in two configurations, the information that was associated with the permit numbers, and the information that had been condensed from multiple records, as discussed in the previous section. This resulted in a total of eight possible sources for treatment technology information.



Process:
#1 Pull random sample: have all systems with their unique identifier (address) in one long list and then create a new column titled "Random Number" with the formula "=RAND()" copied all the way down. Then select the "Random Number" column, copy, paste special, values to create a new list with actual numbers and no formulas. Delete the "Random Numbers" column with the formulas. Sort by the Random Number.

#2 Refine to ensure target sub-samples are complete: Assign a code to each of the three target groups as a separate column (i.e. for the treatment process sub-sample: F (fixed media), C (combined media), and E (extended aeration)). Then go down the pure random sample list until you have your target number (i.e. 30 each plus some extra for those that cannot be sampled for whatever reason)

Figure 1. Sample Selection Flowchart

Treatment technology component descriptions in the various sources used different designations. To unify the descriptions, we created the following categories for treatment descriptions: manufacturer, technology/product line, modifier to address configuration variations such a recirculation, and model number. Each technology was also associated with a more general treatment approach, such as extended aeration or fixed film.

To arrive at the final determination for the treatment components for an identified system, we compared the available information in a stepwise fashion:

- The first step was gathering EHD-operating information, EHD-construction information, Carmody information for the first and derived second treatment component (Carmody 1 and 2); CHD, and Innovative system information.
- The second step consolidated EHD information, and compared Carmody with CHD/innovative information
- The third step consolidated all information. If all information was equal, the EHD-information was used because this source tended to have more detailed information, such as model information. If sources disagreed with each other, we assumed that the general order of accuracy was: CHD, Innovative, EHD-operating permit, EHD-construction permit, Carmody 1, Carmody 2. This assumption could be examined at the end of permit review. The highest ranked source information was designated component 1, and the second highest was designated component 2.

3 Database Description

3.1 Description of Tables and Fields

The database had twenty one main tables. These tables provide information on the data source, system location, system technology, permit numbers, construction permit, operating permit, field evaluation, lab results, and data calibration. Appendix A contains a list of each table in the database and which fields are in each table. Each field name has an associated data type (text, number, date/time, yes/no, memo, etc.) as well as a description.

3.2 Description of Database Relationships

The tables in Appendix A were linked together in several queries that were used to develop forms for data entry and viewing. A screenshot of each form is shown in Appendix B. A CD of the project database as of November 2011 is included in Appendix C.

The relationships between the tables are mainly a one-to-one relationship based on System ID number. Some of the tables have a one-to-many relationship and are described in Table 1.

Table 1. One-to-Many Relationships Between Tables

One	Many	Description
DBsource_record_lookup	Step3&4_field_evaluation	Many field evaluations per site (some had multiple site visits in Task 5 of the project)
Step3&4_field_evaluation	Step3&4_Components	Multiple components per field evaluation (i.e. pretreatment tank, aeration chamber, clarifier, pump tank, sample port, drainfield)
Step3&4_field_evaluation	Step5_lab_results_with_QC_qualifiers	Multiple samples taken at one field evaluation event from multiple components
DBsource_record_lookup	Step4_field_analysis_form	Multiple field analysis done per site (some had multiple site visits in Task 5 of the project)
tbl Calibration	Step3&4_Components	Multiple YSI readings over several sites during day when equipment was calibrated

4 Summary Statistics

4.1 Introduction

This section contains the summary statistics of the results of the data aggregation and is broken up into several sections. The first section describes the distribution of systems in Florida by county. The second section describes the results of geocoding addresses for advanced systems in Florida. The third section describes the source of that data that was used in the project database. The fourth section provides advanced system information by manufacturer and technology. The fifth, and final section, describes the process used to select samples and a summary of the results of that selection.

4.2 Distribution of Systems

Table 2 shows the frequency of advanced systems by county and is sorted alphabetically. Table 3 shows the frequency of advanced systems by county and is sorted by highest frequency to lowest frequency. Over 60% of the advanced systems in Florida are contained in these five counties: Monroe, Charlotte, Brevard, Franklin, and Lee.

Table 2. Frequency of Advanced Systems by County (Alphabetical)

	Frequency	Percent
Alachua	19	0.11
Baker	3	0.02
Bay	17	0.10
Bradford	7	0.04
Brevard	2446	14.74
Broward	179	1.08
Calhoun	15	0.09
Charlotte	2454	14.79
Citrus	246	1.48
Clay	52	0.31
Collier	430	2.59
Columbia	23	0.14
Desoto	22	0.13
Dixie	18	0.11
Duval	464	2.80
Escambia	150	0.90
Flagler	80	0.48
Franklin	1104	6.65
Gadsden	12	0.07
Gilchrist	22	0.13
Glades	10	0.06
Gulf	60	0.36
Hamilton	16	0.10
Hardee	9	0.05
Hendry	86	0.52
Hernando	35	0.21
Highlands	28	0.17
Hillsborough	159	0.96
Holmes	8	0.05
Indian River	38	0.23
Jackson	29	0.17
Jefferson	15	0.09
Lafayette	21	0.13
Lake	125	0.75
Lee	706	4.25
Leon	111	0.67
Levy	42	0.25
Liberty	5	0.03
Madison	23	0.14
Manatee	20	0.12
Marion	331	1.99
Martin	88	0.53
Miami-Dade	299	1.80
Monroe	3436	20.71
Nassau	54	0.33
Okaloosa	25	0.15
Okeechobee	12	0.07
Orange	561	3.38
Osceola	121	0.73
Palm Beach	286	1.72
Pasco	30	0.18
Pinellas	33	0.20
Polk	228	1.37
Putnam	77	0.46
Santa Rosa	110	0.66
Sarasota	404	2.43
Seminole	142	0.86
St. Johns	100	0.60
St. Lucie	125	0.75
Sumter	40	0.24
Suwannee	77	0.46
Taylor	46	0.28
Union	1	0.01
Volusia	413	2.49
Wakulla	164	0.99
Walton	78	0.47
Washington	5	0.03
Total	**16595**	**100.00**

Table 3. Frequency of Advanced Systems by County (Highest to Lowest)

	Frequency	Percent
Monroe	3436	20.71
Charlotte	2454	14.79
Brevard	2446	14.74
Franklin	1104	6.65
Lee	706	4.25
Orange	561	3.38
Duval	464	2.80
Collier	430	2.59
Volusia	413	2.49
Sarasota	404	2.43
Marion	331	1.99
Miami-Dade	299	1.80
Palm Beach	286	1.72
Citrus	246	1.48
Polk	228	1.37
Broward	179	1.08
Wakulla	164	0.99
Hillsborough	159	0.96
Escambia	150	0.90
Seminole	142	0.86
Lake	125	0.75
St. Lucie	125	0.75
Osceola	121	0.73
Leon	111	0.67
Santa Rosa	110	0.66
St. Johns	100	0.60
Martin	88	0.53
Hendry	86	0.52
Flagler	80	0.48
Walton	78	0.47
Putnam	77	0.46
Suwannee	77	0.46
Gulf	60	0.36
Nassau	54	0.33
Clay	52	0.31
Taylor	46	0.28
Levy	42	0.25
Sumter	40	0.24
Indian River	38	0.23
Hernando	35	0.21
Pinellas	33	0.20
Pasco	30	0.18
Jackson	29	0.17
Highlands	28	0.17
Okaloosa	25	0.15
Columbia	23	0.14
Madison	23	0.14
Desoto	22	0.13
Gilchrist	22	0.13
Lafayette	21	0.13
Manatee	20	0.12
Alachua	19	0.11
Dixie	18	0.11
Bay	17	0.10
Hamilton	16	0.10
Calhoun	15	0.09
Jefferson	15	0.09
Gadsden	12	0.07
Okeechobee	12	0.07
Glades	10	0.06
Hardee	9	0.05
Holmes	8	0.05
Bradford	7	0.04
Liberty	5	0.03
Washington	5	0.03
Baker	3	0.02
Union	1	0.01
Total	**16595**	**100.00**

4.3 Geocoding Results

As part of the grant requirements, the addresses in the database were geocoded to the best extent possible in order to allow for mapping and trip planning. The results can be found in Tables 4 and 5.

Addresses were run through AccuMail, which is an address correction and validation system that determines whether a given address is a deliverable address. The program corrects misspelled addresses, corrects and adds missing zip codes, and standardizes street addresses by matching the given address with addresses from the United States Postal Service which are updated quarterly. Table 4 illustrates the success of geocoding the addresses in the database. Eighty-seven percent of the addresses geocoded correctly. Out of the issues that prevented an address from being geocoded, the main reasons were that the street was unable to be matched (6%), the system was unable to match the house number (4%), and that there were issues with the length of the data field (1%). This match rate is somewhat optimistic when compared to the raw data from EHD, as the processing leading up to the database eliminated many records without house number or street name.

Table 4. Frequency of AccuMail Codes Showing Geocoded Address Issues

	Description	Frequency	Percent
	Geocoded correctly	14471	87.20
1	Geocoded but undeliverable	62	0.37
2	Zip code not found	15	0.09
4	Too many changes required to code correctly	38	0.23
5	Street coded as alias but out of range	16	0.10
7	Unable to match street	804	4.84
8	Unable to match street based on too many unmatched components	239	1.44
9	Unable to match house number	671	4.04
12	Unknown	1	0.01
14	Incorrect suffix, directions, street name or unit	75	0.45
15	Multiple matches	22	0.13
16	Corrected field was too long to fit into the supplied field	181	1.09
Total		**16595**	**100.0**

MapMarker software was used to add latitude and longitude data based on the location information. Out of all of the systems, 86% were correctly geocoded down to the street address (Table 5). Six percent of the systems had a slightly reduced level of accuracy for geocoding based on whether the location was matched to the street, intersection, or zip code. Eight percent of the systems were not able to be matched.

Table 5. Frequency of MapMarker Result Code Information (indicates the success or failure of the geocoding operation and the quality of the match

	Frequency	Percent
No match	1401	8.44
Zip code match	36	0.22
Zip + 2 match	295	1.78
Zip + 4 match	463	2.79
Street intersection match	3	0.02
Street match	75	0.45
Street address match (highest accuracy)	14322	86.30
Total	**16595**	**100.00**

4.4 Source of Data

Information in the database came from several sources: the Department of Health's Environmental Health Database (EHD), the Carmody system, several county health department spreadsheets, and innovative permit files. There was overlap between these sources that required extensive work to avoid the occurrence of duplicate records. These matching operations based on addresses and permit numbers resulted in the final assignment of construction and operating permit numbers. Some of the final numbers did not reflect the standardized EHD-format but local county usages. This experience indicates that the variety of special-purpose data formats utilized are not easily compatible with the objective of a statewide management system.

Table 6 illustrates the sources of the construction and operating permit data in the database. Out of 16,595 records, 8,313 have a construction permit number, which may have different formats and 12,804 have an operating permit number. Of 16,595 records 4,649, or slightly more than a quarter, have both an operating permit and a construction permit number. 127 records did not have any permit number assigned, these were Carmody and county/innovative records that did not include such information. For construction permit data, Table 6 shows that while about half of the records came from EHD construction permit information and not from Carmody, nearly half of the records have a source in Carmody, and about 7% had construction permit information in Carmody but not in EHD. While there was information in the county/innovative records, only in a few cases was it the main reason for assigning permit numbers. The one record without any additional source information is the innovative system added after data processing was completed (see Section 2.2.3). For operating permit data, Table 6 shows that nearly half of the records (45%) occur both as an EHD-operating permit and as Carmody permit information. About a quarter of the operating permit records each are EHD-operating permits but not in Carmody and vice versa.

Table 6. Permit Data Source

Source	Construction Permit	Operating Permit
EHD construction permit	4196	105 (only CP)
EHD operating permit	152 (only OP)	3560
EHD permit + Carmody	3389	5732
Carmody, not same EHD-type	554	3292
County/Innovative w/o Carmody	21 (no CP)	114 (no OP)
No additional source	1	1
Total with some Information	**8313**	**12804**

The technology of the advanced system components came from several different sources: two iterations of operating or construction permit (tank) information from EHD, up to two components from Carmody, county health department spreadsheets, and innovative permit files. This resulted in up to eight potential sources that could have contributed to the final determination of what components are used for a specific system. Table 7 outlines how many of the sources provided information on components. Approximately 45% of the systems did not have any component information. Fifty percent of those records that had component information had this from a single source. This source was predominantly Carmody, with some county health department and innovative information. The systems with two sources (23% of component information) relied generally on two iterations of EHD-information (either operating or construction permit) or on the existence of two components from Carmody. Systems with three sources (23% of component information) are the first category that allows a cross-checking of component information. Out of 2119 records, 251 differed in the information between at least two sources, with about half of these due to differences between Carmody and EHD. Systems with four sources are largely located in Monroe County with one Carmody source indicating an injection well or associated filter, and the other Carmody source predominantly agreeing with the available EHD-information.

Table 7. Number of Sources with Similar Component Technology Information

Number of Sources with Similar Component Technology Information

	Frequency	Percent
0	7388	44.5
1	4631	27.9
2	2175	13.1
3	2119	12.8
4	280	1.7
5	2	.0
Total	**16595**	**100.0**

Table 8 illustrates the source of the technology information that was used in the database. This was selected through a hierarchy which put in case of conflict a preference on the data from county health departments and innovative files first, then EHD, then Carmody, and then other data sources. As can be seen in Table 8, 44.5% of the systems did not have any data. Out of those that did have data, Carmody and EHD were the predominant data sources with Carmody providing information for about a quarter of the records and EHD-operating and construction information each providing about one eighth of records with component information. Approximately 1,800 systems were matched in both EHD and Carmody, showing that there was some consistency between the two data sources.

Table 8. Source of Technology Information

Source of Technology Information

	Frequency	Percent
Carmody	4593	27.7%
EHD Construction Permit	2238	13.5%
EHD Operating Permit	2011	12.1%
CHD	297	1.8%
Innovative Permit File	67	0.4%
No information	7389	44.5%
Total	16595	100.0%

4.5 System Information

The information in the project database contains system information details that are analyzed in this section.

Table 9 illustrates the frequency of commercial and residential establishments. This field is mainly recorded on the construction permit application but the operating permit application and occasionally Carmody data provide an indication of a commercial establishment. The majority of the unknown systems did not have any construction permit information. Ninety-four percent of those that did have information were for residential systems.

Table 9. Frequency of Commercial / Residential Advanced Systems

	Frequency	**Percent**
Unknown	6381	38.45
Commercial Non I/M	457	2.75
Commercial I/M	173	1.04
Residential	9584	57.75
Total	**16595**	**100.00**

Table 10 illustrates the frequency of the type of advanced system in the database. Seventy-six percent of the systems are for ATU's and eight percent are for PBTS. Relatively few systems, about 15%, are recorded as unknown, indicating a limited potential of having included conventional systems.

Both EHD and the Carmody system have a field for recording whether a system is in an industrial/manufacturing zone or has an equivalent usage. Of 13 records listed in Carmody as industrial/manufacturing, 2 (15%) are correctly matched in EHD, 1 (8%) is incorrectly matched as commercial, and 10 (77%) had no information in EHD.

Both EHD and the Carmody system have a field for recording whether a system is a commercial system. Of 126 records in Carmody that are listed as commercial, 78 (62%) are correctly matched in EHD, 8 (6%) are incorrectly matched as residential, and 40 (32%) have no information in EHD.

Table 10. Frequency of Type of Advanced System (ATU, PBTS, Innovative, Unknown)

	Frequency	Percent
ATU	12660	76.3
Innovative	183	1.1
PBTS Non Innovative	1189	7.2
Unknown	2563	15.4
Total	**16595**	**100.0**

Table 11 illustrates the age of the advanced system from January 1, 2010, which is about six months after the data gathering for the database started, and the approximate date of when the data were imported into the database. The system installation date is entered on the construction permit and the operating permit application and was part of some CHD and innovative records. The high occurrence of unknown ages could be a result of there being fewer EHD permits in the database as well as this being a field that is not consistently completed in EHD. Of the systems with no final system approval date 8,248 (88%) did not have construction permit information. A total of 7,173 systems in the database had a final system approval date. Of these systems, 75% were installed within 2-5 years of January 1, 2010.

Table 11. Age of System from January 1, 2010

Age of System		
	Frequency	Percent
Unknown	9422	56.8
<2	431	2.6
2 - 5	5372	32.4
6 - 10	1313	7.9
11-15	47	.3
16-20	5	.0
>20	5	.0
Total	**16595**	**100.0**

Table 12 outlines the different technology approaches, manufacturers, products, and aeration subtypes for all of the systems for which data were available. These data likely reflect what has been installed over the years under a variety of approval conditions. Out of a total of 16,595 systems, 9,206 (56%) had this type of information. There were three main types of treatment technology approaches considered: extended aeration, fixed media, and combined (aeration

Table 12. Technology of Components with Sample Selection Information

Technology Approach	Manufacturer	Product	Aeration Subtype	Number of Systems	Product Sample	Subtype Sample	Approach Sample
Combined	Bio-Microbics	FAST	Diffuser	394	35	35	70
	Bionest	Bionest	Diffuser	35[1]	0		
	Jet	Jet	Aspirator	188	35	35	
Extended Aeration	Acquired Wastewater Technologies	Alliance	Diffuser	76	2	35	70
	Ecological Tanks, Inc.	Aqua Aire	Diffuser	73	2		
	Ecological Tanks, Inc.	Aqua Safe	Diffuser	56	2		
	Aqua-Klear	Aqua-Klear	Diffuser	1353	4		
	American Wastewater	B.E.S.T. 1	Diffuser	130	3		
	Acquired Wastewater Technologies	Cajun Aire	Diffuser	132	3		
	Clearstream	Clearstream	Diffuser	861	3		
	Delta	DF or UC	Diffuser	257	3		
	Delta	N/D	Diffuser	507	0		
	Hoot	Hoot	Diffuser	975	4		
	Hydro-Action	Hydro-Action	Diffuser	89	2		
	H.E. McGrew	Mighty Mac	Diffuser	357	3		
	Consolidated	Nayadic	Diffuser	1733	4		
	Consolidated	Multi-Flo	Aspirator	583	15	35	
	Consolidated	Enviro-Guard	Aspirator	3	3		
	Norweco	Singulair	Aspirator	949	17		
Fixed Media	Orenco	AdvanTex		8	6		70
	Quanics	Aerocell		5	4		
	Quanics	Biocoir		5	4		
	Carroll Environmental Technologies	Carroll Filter		1			
	Premier Tech	EcoFlo		30	9		
	EcoPure	EcoPure		19	8		

[1] Result of non-unique tank use, no systems actually installed. See text.

Technology Approach	Manufacturer	Product	Aeration Subtype	Number of Systems	Product Sample	Subtype Sample	Approach Sample
Fixed Media (cont.)	Earthtek	EnviroFilter		149	14		
	Klargester	Klargester		2	2		
	Rotodisk	Rotodisk		3	3		
	Ruck	Ruck		11	7		
	NoMound	NoMound		21	8		
	Sandfilter	Sandfilter		6	5		
Other	Injection Well	Interim filter		173	0		0
		Cromaglass		1	0		
		P-removal		19	0		
	Evapotranspiration			2	0		
			Total	**9206**			**210**

and fixed media) (Figure 2). Sand and gravel filters would fall into the fixed media category, and several experimental or innovative treatment and disposal systems that involve effluent passage through a drainfield were included in this category. While interim aggregate filters are fixed film systems, they were not included in further consideration because they are generally located after an aerobic treatment step. The “other” category captures largely systems with injection wells and evapotranspriation in Monroe County.

One of the limitations of the source data that became apparent at this stage is the designation of a treatment technology based on the tank approval number. The distributors of one innovative treatment technology, Bionest, had obtained approval to fit the technology into several tanks that can also be used as septic or other tanks. Finding the tank approval numbers in the construction records of advanced systems lead to 35 systems designated as Bionest systems, even though the distributor confirmed that no system had been installed.

The main technology approach used in Florida is extended aeration, with 88% of the systems that had product information. Over half of the systems in the database used extended aeration in the treatment process. 42% use a diffuser and 10% use an aspirator to aerate (Table 13). Systems that use a combined technology approach only accounted for 7% of the population, while fixed media had only a share of 3%.

Table 13. Use of Aeration in the Treatment Process

Aeration

	Frequency	Percent
Aspirator	1724	10.4
Diffuser	7028	42.4
Unknown	7843	47.3
Total	16595	100.0

Figure 3 illustrates the different manufacturers for the systems that had information. Fourteen manufacturers had less than 100 systems each and these were totaled together and combined under the “Other” category in Figure 3. The top five manufacturers used in Florida are Consolidated, Aqua-Klear, Hoot, Norweco, and Clearstream.

Figure 4 illustrates the different products for the systems that had information. In many but not all cases the product carries the same name as the manufacture. Nineteen products had less than 100 systems each and these were totaled together and combined under the “Other” category in Figure 4. The top five products used in Florida are Nyadic, Aqua-Klear, Hoot, Singulair, and Clearstream, which corresponds to the distribution of the respective manufacturers.

There was also information captured on the second component in series. Less than 5% of the systems in the database had any information on the second component. Of those that had information, the majority were injection wells with the Carmody system as the data source.

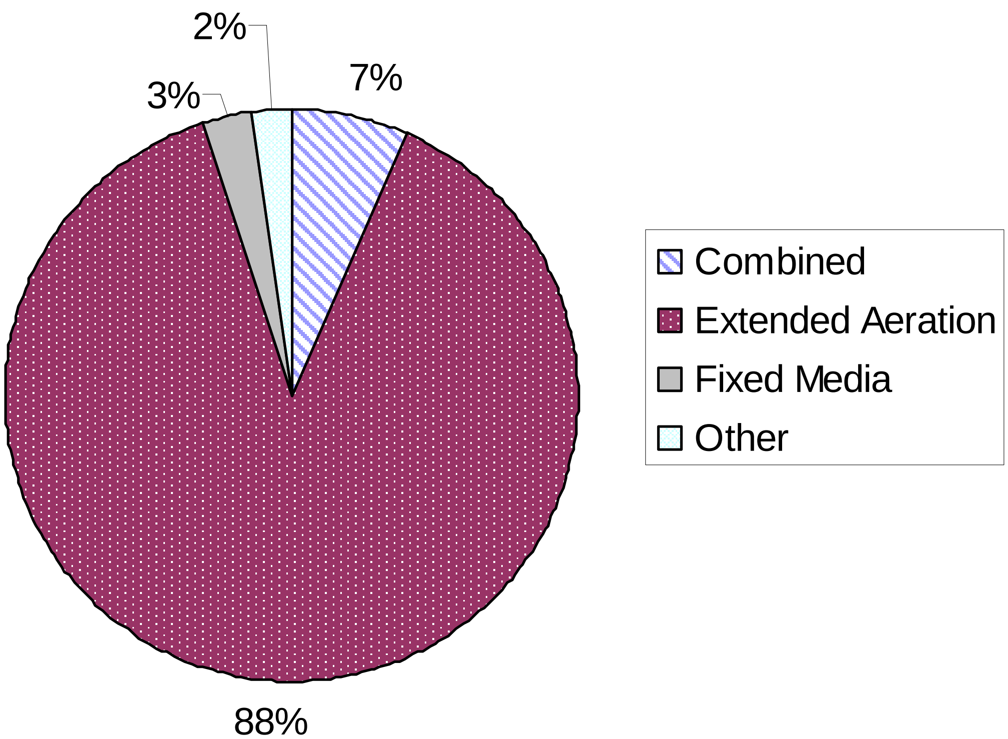


Figure 2. Technology Approach Information

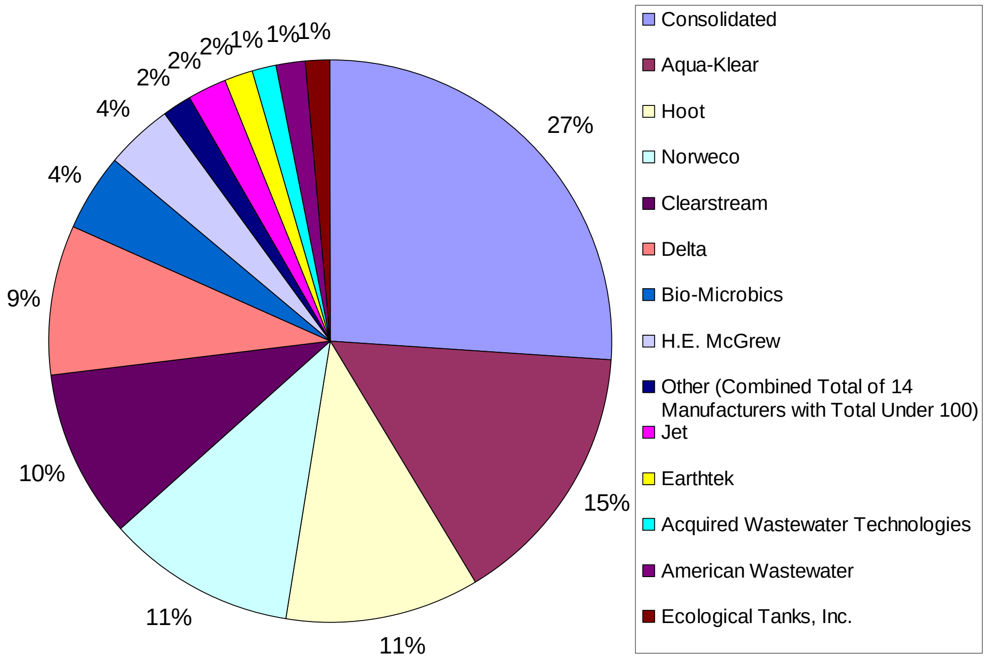


Figure 3. Manufacturer Information

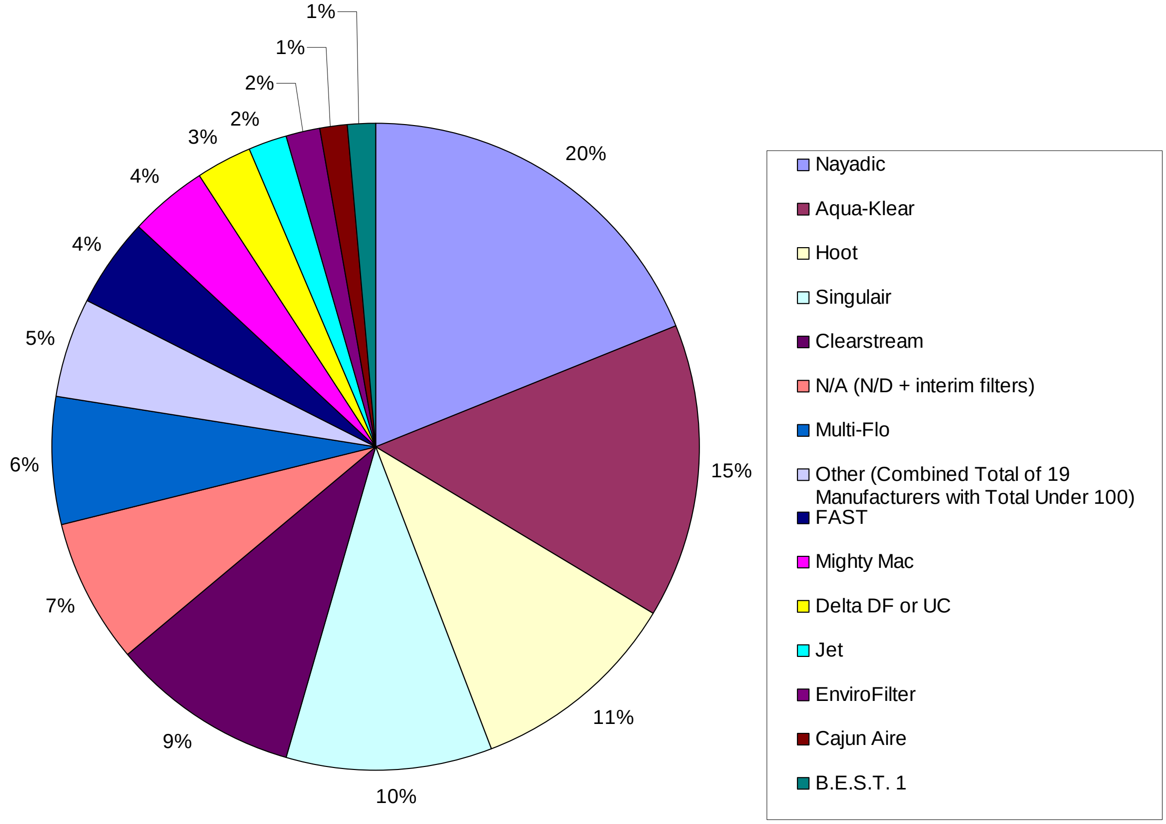


Figure 4. Product Technology Information

4.6 Sample Selection

A total of 1013 systems were selected for sampling (Table 14). These are broken up into 6 sample groups. Five hundred eighty five systems were selected based purely on a random sample taken from all of the systems (Figure 1). For those records where sufficient information existed, treatment component technologies have been categorized and this information linked to the system record based on the type of technology installed (Table 12). The treatment technologies have been grouped as either: unsaturated fixed media, combined media, and extended aeration. Additionally, aeration technology for combined media and extended aeration was subcategorized into diffuser and aspirator approaches. Records were selected to represent each of the different technology approaches. Numbers of samples for each manufacturer were proportional to the logarithm of the number of systems in the same category. The record selection used a similar approach as the overall random sample, by selecting the records with the lowest n random numbers that fulfilled the criteria. A total of 210 systems (70 from each of three technology approaches: unsaturated fixed media, combined media, and extended aeration) were selected based on technology, with 112 systems coming from the initially selected random sample, and 98 systems selected based on their technology type. Two hundred and four additional systems were selected based in a second round of random sampling. These additional systems were necessary after performing detailed permit reviews which revealed that a large number of systems (~60%) were not an active advanced system (i.e. they were either abandoned, a conventional system, connected to sewer, etc.) A few additional systems were assessed to gather data on monitoring points beneath the drainfield, account for misidentifications, and assess a couple of conveniently located additional innovative systems.

Table 14. Systems Selected for Sampling

Selected for Sampling?

	Frequency
	1
N	15581
Y-initial random sample	585
Y1-additional technology sample	98
Y2-sample for initial random sample and technology	112
Y3-second round of random samples	204
Y4-additional systems	7
Y6-drainfield monitoring samples	7
Total	16595

Appendix A: Database Description of Tables

A) Geocoded Address Results

This section of the database provides information regarding the results of geocoding the address information for locations with advanced systems. Addresses were run through AccuMail, which is an address correction and validation system that determines whether a given address is a deliverable address. The program corrects misspelled addresses, corrects and adds missing zip codes, and standardizes street addresses by matching the given address with addresses from the United States Postal Service which are updated quarterly. Latitude and longitude data are also added, using the MapMarker program through a similar address matching process, which provides mapping capabilities.

Table: DBsource_geocoded_address_results

Field name	**Data Type**	**Description**
System_set_ID	Integer	System ID number assigned for this project
FinalAddressesApr06_2010-2_ComboAddress	Text	combined address of EHD and Carmody addresses
County	Text	county
summary_city	Text	combined city of EHD and Carmody addresses
FinalAddressesApr06_2010-2_FL	Text	State
FinalAddressesApr06_2010-2_summary_ZIP	Text	combined zip of EHD and Carmody addresses
2nd address	Text	address after cleanup with accumail and geocoding
2nd county	Text	county after cleanup with accumail and geocoding
2ndcity	Text	address after cleanup with accumail and geocoding; empty city tended to be misplaced "Tallahassee" in summary_city
2ndstate	Text	state after cleanup with accumail and geocoding
2nd zip	Text	zip after cleanup with accumail and geocoding
2nd long	Double	geocoded longitude
2nd lat	Double	geocoded latitude
2nd georesult	Text	geocoding result code (indicates quality of matching)
2nd geo ACCU	Text	accumail results code (indicates

		quality of matching)

B) Permit Classification Results

This section of the database provides permit classification information from the Department of Health Environmental Health Database (EHD) and from Carmody Systems for those systems that were determined to potentially be advanced systems. Permit classification information includes such information as what permit category the system is (ATU, PBTS, etc.), whether the system is commercial or residential, etc.

Table: DBsource_permitclassifications

Field Name	Data Type	Description
System_set_ID	Integer	System ID number assigned for this project
County	Text	County
Comm/Res	Text	Commercial/Residential establishment (form DH4015, p.1)
ApplicationSubType_simplified	Text	derived field from EHD advanced system permit category simplified into fewer categories (ATU, PBTS non_innovative, Innovative, unknown, none, other (converted Keys interim systems to ATU, and Keys OWNRS to PBTS non_innovative)
ApplicationSubType	Text	EHD information on advanced system permit category (ATU, PBTS non_innovative, Innovative, PBTS innovative, Keys interim) DH4015 p.1
PBInnovativeComponent	Text	EHD innovative component ??
EHD_Ind_man_Field1	Text	EHD industrial/manufacturing zoning info (DH4015 p.1)
EHD_OPType	Text	EHD operating permit type (DH4081)
Management Level	Text	Carmody Management level (can be ATU, PBTS, commercial, industrial)
CM_commercial	Text	derived field from Carmody management level to indicate commercial establishment
CM_Management_level_simplified	Text	derived field from Carmody management level to indicate application subtype (see ApplicationSubType_simplified)
Component Flagging	Text	Carmody component flagging

		information
2nd component	Text	Carmody 2nd component flagging information
result_com/res	Text	result commercial/residential information based on EHD (primary) and Carmody information: Residential/Commercial/0 (0= no information)
result_ATU/PB/Inn	Text	result advanced system permit category based on EHD (primary) and Carmody information: ATU/PBTS_non_innovative/innovative /unknown/other (sand filters are other)
result_IM	Text	result IM zoning information based on EHD (primary) and Carmody information (no for records that had no indication of IM zoning):no/IM

C) Permit Number Results

This section of the database provides information on permit number data on potential advanced OSTDS from the Environmental Health Database, Carmody, County Health Department spreadsheets, and innovative paper files. A more condensed subset of this information is also in the table “DBsource_record_lookup”

Table: DBsource_permitnumbers

Field Name	Data Type	Description
System_set_ID	Integer	System ID number assigned for this project
County	Text	County
CP_Combined	Text	Construction Permit number based on combining all data (EHD, Carmody, CHD, innovative) (is also in "dbsource_componentstechnology")
OP_Combined	Text	Operating Permit number based on combining all data (EHD, Carmody, CHD, innovative) (is also in "dbsource_componentstechnology")
CP_CentraxPermitNumber	Text	Construction Permit number based on EHD only

FinalSystemApprovalDate	Date/Time	Final system approval date based on EHD
OP_CentraxPermitNumber	Text	Operating Permit number based on EHD only
OPDate	Date/Time	From operating permit information in EHD: date of OP issue
SepticApplicationID	Text	SepticApplicationID (from EHD)
Old_carmodyID	Integer	ID number from previous Carmody download table
Tracking No	Text	Carmody field: tracking number
County Sanitary Permit No	Text	Carmody field: County Sanitary Permit No
State Permit No	Text	Carmody field: State Permit No
Eb_CHD+innovative_rev1_CHD _ID	Text	ID number from 319 table Eb_CHD+innovative_rev1_CHD_ID= ID of CHD and innovative files
CHD_ConstAP	Text	from CHD-files: ConstAP number for application (CENTRAX-identifier)
CHD_ConstOSTDSNumber	Text	from CHD-files: ConstOSTDSNumber (Centrax identifier)

D) Record Lookup Results

This section of the database provides information on whether a site was selected for sampling mostly based on a random number that was assigned to a system. This section also includes some information on permit numbers from various sources.

Table: DBsource_record_lookup

Field Name	Data Type	Description
System_set_ID	Integer	System ID number assigned for this project
Random Number	Double	random number assigned to system
Selected for Sampling?	Text	selected as part of initial samples Y=random sample; Y1=sample for technology evaluation only; Y2=sample for both technology evaluation and random sample; Y3= additional random sample systems; Y4=other system; Y5=; Y6=Charlotte monitoring well system
County	Text	county

FinalSystemApprovalDate	Date/Time	Final System Approval date based on most recent construction
OPDate	Date/Time	latest operating permit date
CP_CentraxPermitNumber	Text	construction permit number (newest for address)
OP_CentraxPermitNumber	Text	operating permit number (newest for address)
CHD_ConstPermit	Text	construction permit number based on CHD/innovative data
CHD_ID	Integer	ID in CHD/Innovative record table
CHD_OperPermit	Text	operating permit number based on CHD/innovative data
Old_carmodyID	Integer	ID in Old Carmody table

E) Components Technology Results

This section of the database provides information on the technology of the components in the advanced system. The source of this information came from the Environmental Health Database, Carmody, County Health Department spreadsheets, and innovative permit files. Information such as the manufacturer, the treatment approach, and model are included. Because data came from many different sources, quality assurance fields are also included showing the results of various data checks that were done to help determine confidence in the result.

Table: DBsource_componentstechnology

Field Name	**Data Type**	**Description**
System_set_ID	Integer	System ID number assigned for this project
sum_infosources	Integer	number of different data source in which information about this system was found
CP check	Text	result of check if two different versions of the EHD-download agreed on technology in the construction permit and which information to use
OP check	Text	result of check if two different versions of the EHD-download agreed on technology in the operating permit and which information to use
CM check	Text	result of check if Carmody provides technology information
CHD_inn check	Text	result of check if CHD and innovative

		sources agree on technology and which information to use
EHD_check	Text	result of check if operating and construction permit information in EHD agree on technology and which information to use
Car/CHD_inn	Text	result of check if Carmody and the CHD/innovative sources agree on technology and which information to use
EHD_other	Text	result of check if EHD and other (Carmody/CHD/innovative) agree on technology and which information to use
source_final	Text	Source from which the technology information has been taken for the first(main) component
Comb_Component	Text	Combined component information for first component
Comb_Man	Text	combined manufacturer information
Comb_Appr	Text	combined treatment approach
Comb_Techn	Text	combined technology/product line information
Comb_Modifier	Text	combined modifier for technology/product line
Comb_Model	Text	combined model number
Comb_aeration	Text	combined aeration approach (based on a lookup table with product line information)
Comb_aeration_comments	Text	comments on aeration approach
2nd_source	Text	Source from which the technology information has been taken for the second component (most frequently injection wells in Monroe County)
2ndComb_Component	Text	Combined component information for second component
2ndComb_Man	Text	combined manufacturer information
2ndComb_Appr	Text	combined treatment approach
2ndComb_Techn	Text	combined technology/product line information
2ndComb_Modifier	Text	combined modifier for

		technology/product line
2ndComb_Model	Text	combined model number
2nd Comb_aeration	Text	combined aeration approach (based on a lookup table with product line information)
2nd Comb_aeration_comments	Text	comments on aeration approach
Legend1_comb	Text	combined legend for the first tank
legend2_comb	Text	combined legend for the second tank (looks like some problems here 438 records have this, but not all have component information, and several conflicts)

F) Treatment Unit Description

This section of the database provides information on the description of the treatment unit to ensure consistency for data entry and analysis. This description includes the manufacturer, the product line, the modifier, and the model.

Table: manuf_productlin_modif_mod

Field Name	Data Type	Description
ID	Autonumber	Unique ID number for each treatment unit
Man_Proline_modif_model	Text	Condensed technology information: manufacturer_productline_modifier_ model
Pretreatment_compartment	Text	Pretreatment compartment (default value) "none" Or "part of ATU" Or "separate and required" Or Is Null
Clarifier_compartment	Text	Clarifier compartment (default value) "none" Or "part of ATU" Or Is Null

G) Manufacturer Contact Information

This section of the database provides contact information for manufacturers of unit used in Florida.

Table: Manufacturer_Contact_Information

Field Name	Data Type	Description
ID	Autonumber	Unique ID number for each manufacturer
DB_MANUFACTURER	Text	Name of manufacturer from the database

current_manufacturer	Text	Name of current manufacturer if different from database
MODELS	Text	Models of units manufacturers
ADDRESS	Text	Mailing address
Second Address	Text	Second mailing address
City	Text	City
State	Text	State
Zipcode	Text	Zip code
Country	Text	Country
Primary number	Text	Primary phone number
Alternative number	Text	Alternate phone number
WEBSITE ADDRESS	Text	Website
Contact person	Text	Person to contact
Contact Number	Text	Phone number of contact person
Contact E-mail	Text	Email of contact person
Regulatory advisors	Text	Name of regulatory advisor
Regulatory number	Text	Phone number of regulatory advisor
Florida Contact Name	Text	Name of Florida contact
Florida Contact phone	Text	Phone number for Florida contact
Florida Contact e-mail	Text	Email of Florida contact

H) Drainfield Materials

This section of the database provides information on drainfield materials to ensure consistency for data entry and analysis. This data came from EHD.

Table: Drainfield_Materials

Field Name	Data Type	Description
ID	Autonumber	Unique ID number for each drainfield material
CodeID	Number	Unique identifier from EHD
DisplayDescriptionText	Text	Description of drainfield material from EHD

I) Owners Survey Tracking Information

This section of the database provides tracking information for the owner's survey on user perceptions of advanced OSTDS in Florida. This data came from FSU for work done under Task 3 of the grant agreement. A separate database was created under Task 3 with tracking information for all of the different user group surveys. This is included here as some of the information for the owner's survey tracking was used in developing the queries and forms in the main project database. This table was created to keep track of when surveys were mailed, when they were returned, list the reason why a survey may have been returned undeliverable, list when a survey was re-mailed, and what the overall status is of the surveys.

Table: tblSurveyOwnersTracking

Field Name	**Data Type**	**Description**
ID	Long integer	Unique ID number for each tracking number
track	Double	Tracking number for each survey
line	Double	Line from the original excel spreadsheet sent to FSU
Sampgrp	Double	Sample group number
Locate	Double	Numerical code: 1 – Residential, 2 – Commercial, and 3 – Unknown
loctxt	Text	Text for numerical Locate field: 1 – Residential, 2 – Commercial, and 3 – Unknown
Type	Double	Type of system: 1 – Residential ATU, 2 – Commercial ATU, 3 – Unknown ATU, 4 – Residential PBTS, 5 – Commercial PBTS, 6 – Unknown PBTS, 7 – Residential Innovative, 8 – Commercial Innovative
Septic	Double	Type of permit: 1 – ATU, 2 – PBTS, 3 - Innovative
Septtxt	Text	Text for type of permit: 1 – ATU, 2 – PBTS, 3 - Innovative
Source	Text	Source of data (construction permit or operating permit)
CentraxPermitNumber	Text	Construction permit number from EHD
OperatingPermitNumber	Text	Operating permit number from EHD
County	Text	County where system is located from EHD
CompleteStreetAddress	Text	Street address where system is located from EHD
City	Text	City where system is located from EHD
State	Text	State where system is located from EHD
Zip	Text	Zip code where system is located from EHD

OwnerFirstName	Text	First name of owner from EHD
OwnerLastName	Text	Last name of owner from EHD
OwnerAll	Text	Combined first and last name of owner
OwnerOrganization	Text	Organization from EHD
FinalName	Text	Final name used on letters (either data from OwnerAll or “Current Resident”)
occcupant	Text	If there was a name in the FinalName field, “or Current Resident” was entered in this field
title2	Text	Second title
OwnerHomePhone	Text	Home phone number from EHD
Comm/Res	Text	Commercial or residential from EHD
ApplicationSubType	Text	Subtype of application from EHD
FinalSystemApprovalDate	Text	Final system approval date from EHD
Tank1Size	Text	Size of the first tank from EHD
Tank1Legend	Text	Legend of the first tank from EHD
Tank1Manufacturer	Text	Manufacturer of the first tank from EHD
Tank2Size	Text	Size of the second tank from EHD
Tank2Legend	Text	Legend of the second tank from EHD
Tank2Manufacturer	Text	Manufacturer of the second tank from EHD
PBInnovativeComponent	Text	Component information from EHD
SepticApplicationID	Text	Application ID number from EHD
ApplicationFinalInspectionID	Text	Application final inspection ID number from EHD
OPUnitSize	Text	Size of the treatment unit from EHD operating permit
OPUnitName	Text	Model of the treatment unit from EHD operating permit
OPDFSize	Text	Drainfield size from EHD operating permit
OPLotSize	Text	Lot size from EHD operating permit
DateReturn	Text	Date survey was returned
instrument_status	Double	0 unreturned, 1 returned complete, 2 returned mail issues, 3 returned undeliverable, 4 returned new address, 5 second return, 6 out of district, 7 deceased, 8 returned not

		interested/blank, 9 N/A, 10 could not find new address
newstatus	Double	A “1” was put into the field if the surveys were returned undeliverable and given to DOH for remailing
complete	Text	Survey completed
julystatus	Text	Status as of July
Instrument_new_administrator or owner name	Text	New mailing name
newadd1	Text	New mailing address #1
newadd2	Text	New mailing address #2
newcity	Text	New city
newstate	Text	New state
newzip1	Text	New zip code #1
Newzip2	Text	New zip code #2
remail_status	Text	Status of remailing survey
remail_date	Text	Date survey was remailed
comments	Text	Comments

J) Owners Survey Results

This section of the database provides information on the results of the owner’s survey on user perceptions of advanced OSTDS in Florida. This data came from FSU for work done under Task 3 of the grant agreement. A separate database was created under Task 3 with survey results for all of the different user group surveys. This is included here as some of the information in the owner survey was used in developing the queries and forms in the main project database.

Table: tblSurveyOwnersCompleted

Field Name	**Data Type**	**Description**
ID	Long integer	Unique ID number for each tracking number
track	Double	Tracking number for each survey
enteredby	Text	Initials of person who entered the survey results
date	Date/Time	Date/time when survey results were entered
Sampgrp	Double	Sample group number
Locate	Double	Numerical code: 1 – Residential, 2 – Commercial, and 3 – Unknown
loctxt	Text	Text for numerical Locate field: 1 –

		Residential, 2 – Commercial, and 3 – Unknown
Type	Double	Type of system: 1 – Residential ATU, 2 – Commercial ATU, 3 – Unknown ATU, 4 – Residential PBTS, 5 – Commercial PBTS, 6 – Unknown PBTS, 7 – Residential Innovative, 8 – Commercial Innovative
Septic	Double	Type of permit: 1 – ATU, 2 – PBTS, 3 - Innovative
Septtxt	Text	Text for type of permit: 1 – ATU, 2 – PBTS, 3 - Innovative
Source	Text	Source of data (construction permit or operating permit)
Qu1	Double	Reference the code book submitted previously for Task 3
Qu1txt	Text	Reference the code book submitted previously for Task 3
Qu1oth	Text	Reference the code book submitted previously for Task 3
Qu2	Double	Reference the code book submitted previously for Task 3
Qu2txt	Text	Reference the code book submitted previously for Task 3
Qu3	Double	Reference the code book submitted previously for Task 3
Qu4	Double	Reference the code book submitted previously for Task 3
Qu5a	Double	Reference the code book submitted previously for Task 3
Qu5b	Double	Reference the code book submitted previously for Task 3
Qu5c	Double	Reference the code book submitted previously for Task 3
Qu5d	Double	Reference the code book submitted previously for Task 3
Qu5e	Double	Reference the code book submitted previously for Task 3
Qu5f	Double	Reference the code book submitted previously for Task 3
Qu5g	Double	Reference the code book submitted

		previously for Task 3
Qu5h	Double	Reference the code book submitted previously for Task 3
Qu5hoth	Text	Reference the code book submitted previously for Task 3
Qu6a	Double	Reference the code book submitted previously for Task 3
Qu6b	Double	Reference the code book submitted previously for Task 3
Qu6c	Double	Reference the code book submitted previously for Task 3
Qu6d	Double	Reference the code book submitted previously for Task 3
Qu6e	Double	Reference the code book submitted previously for Task 3
Qu6f	Double	Reference the code book submitted previously for Task 3
Qu6g	Double	Reference the code book submitted previously for Task 3
Qu6h	Double	Reference the code book submitted previously for Task 3
Qu6i	Double	Reference the code book submitted previously for Task 3
Qu6j	Double	Reference the code book submitted previously for Task 3
Qu6joth	Text	Reference the code book submitted previously for Task 3
Qu7	Double	Reference the code book submitted previously for Task 3
Qu7oth	Text	Reference the code book submitted previously for Task 3
Qu8	Double	Reference the code book submitted previously for Task 3
Qu8oth	Text	Reference the code book submitted previously for Task 3
Qu9	Double	Reference the code book submitted previously for Task 3
Qu10	Double	Reference the code book submitted previously for Task 3
Qu10oth	Text	Reference the code book submitted previously for Task 3

Qu11	Double	Reference the code book submitted previously for Task 3
Qu12	Double	Reference the code book submitted previously for Task 3
Qu13	Double	Reference the code book submitted previously for Task 3
Qu14a	Double	Reference the code book submitted previously for Task 3
Qu14b	Double	Reference the code book submitted previously for Task 3
Qu14c	Double	Reference the code book submitted previously for Task 3
Qu15a	Double	Reference the code book submitted previously for Task 3
Qu15b	Double	Reference the code book submitted previously for Task 3
Qu15c	Double	Reference the code book submitted previously for Task 3
Qu15d	Double	Reference the code book submitted previously for Task 3
Qu15e	Double	Reference the code book submitted previously for Task 3
Qu15f	Double	Reference the code book submitted previously for Task 3
Qu15g	Double	Reference the code book submitted previously for Task 3
Qu15h	Double	Reference the code book submitted previously for Task 3
Qu15i	Double	Reference the code book submitted previously for Task 3
Qu15ioth	Text	Reference the code book submitted previously for Task 3
Qu16txt	Text	Reference the code book submitted previously for Task 3
Qu17	Double	Reference the code book submitted previously for Task 3
Qu18atxt	Text	Reference the code book submitted previously for Task 3
Qu18btxt	Text	Reference the code book submitted previously for Task 3
Qu19	Double	Reference the code book submitted

		previously for Task 3
Qu19oth	Text	Reference the code book submitted previously for Task 3
Qu20a	Double	Reference the code book submitted previously for Task 3
Qu20b	Double	Reference the code book submitted previously for Task 3
Qu20c	Double	Reference the code book submitted previously for Task 3
Qu20d	Double	Reference the code book submitted previously for Task 3
Qu20e	Double	Reference the code book submitted previously for Task 3
Qu20eoth	Text	Reference the code book submitted previously for Task 3
Qu21	Double	Reference the code book submitted previously for Task 3
Qu21oth	Text	Reference the code book submitted previously for Task 3
Qu22	Text	Reference the code book submitted previously for Task 3
Qu23atxt	Text	Reference the code book submitted previously for Task 3
Qu23b	Double	Reference the code book submitted previously for Task 3
Qu23c	Double	Reference the code book submitted previously for Task 3
Qu23dtxt	Text	Reference the code book submitted previously for Task 3
Qu23e	Double	Reference the code book submitted previously for Task 3
Qu23f	Double	Reference the code book submitted previously for Task 3
Qu23gtxt	Text	Reference the code book submitted previously for Task 3
Qu23h	Double	Reference the code book submitted previously for Task 3
Qu23hoth	Text	Reference the code book submitted previously for Task 3
Qu23itxt	Text	Reference the code book submitted previously for Task 3

Qu23j	Double	Reference the code book submitted previously for Task 3
comments	Memo	Comments on data entry
CentraxPermitNumber	Text	Construction permit number from EHD
OperatingPermitNumber	Text	Operating permit number from EHD
County	Text	County were system is located from EHD
CompleteStreetAddress	Text	Street address where system is located from EHD
City	Text	City where system is located from EHD
State	Text	State where system is located from EHD
Zip	Text	Zip code where system is located from EHD
OwnerFirstName	Text	First name of owner from EHD
OwnerLastName	Text	Last name of owner from EHD
OwnerAll	Text	Combined first and last name of owner
OwnerOrganization	Text	Organization from EHD
FinalName	Text	Final name used on letters (either data from OwnerAll or “Current Resident”)
occcupant	Text	If there was a name in the FinalName field, “or Current Resident” was entered in this field
title2	Text	Second title
OwnerHomePhone	Text	Home phone number from EHD
Comm/Res	Text	Commercial or residential from EHD
ApplicationSubType	Text	Subtype of application from EHD
FinalSystemApprovalDate	Text	Final system approval date from EHD
Tank1Size	Text	Size of the first tank from EHD
Tank1Legend	Text	Legend of the first tank from EHD
Tank1Manufacturer	Text	Manufacturer of the first tank from EHD
Tank2Size	Text	Size of the second tank from EHD
Tank2Legend	Text	Legend of the second tank from EHD
Tank2Manufacturer	Text	Manufacturer of the second tank from EHD
PBInnovativeComponent	Text	Component information from EHD

SepticApplicationID	Text	Application ID number from EHD
ApplicationFinalInspectionID	Text	Application final inspection ID number from EHD
OPUnitSize	Text	Size of the treatment unit from EHD operating permit
OPUnitName	Text	Model of the treatment unit from EHD operating permit
OPDFSize	Text	Drainfield size from EHD operating permit
OPLotSize	Text	Lot size from EHD operating permit
OPDate	Text	Operating permit date from EHD

K) Step 1: Record ID Results

This section of the database provides information on the results of the Step 1 permit file review which consisted of assessing the completeness of the permit files as well as documenting basic information on document requests, the status of the permit file review, and quality control review information.

Table: Step1_recordID_results

Field Name	**Data Type**	**Description**
System_set_ID	Integer	System ID number assigned for this project
Address_change	Yes/No	Were address changes needed? (address usually located on the upper portion of the document)
Permit_number_change	Yes/No	Were permit number changes (OP or CP) needed? (permit number located on the upper right corner of the construction permit)
Which permit number change	Text	If there was a permit number change, which was it "add CP";"add OP";"change CP";"change OP"
System_status_is	Text	Status of system based on initial information from CHD: abandoned before file request; abandoned after file request; active; active but conventional system; not_existent; not_on_file; permit_for_ME_IM_or_facility
System_treatment system	Text	Category of system based on permit

category_is		files: "ATU"; "PBTS non_innovative"; "Innovative"; "PBTS innovative"; "Keys interim"; "other"
Construction_info_available?	Yes/No	Does the file contain construction information (permit or drawings)? (if any information is received regarding construction permit check this box)
Operating_info_available?	Yes/No	Does the file contain operating permit, maintenance entity and inspection information? (if any information is received regarding operating permit check this box)
Comments_on_file_search	Memo	Additional comments about finding the file and the system
Requested_files_when	Date/Time	On what date did were the files requested from CHD?
Requested_files_from_whom	Text	From whom were the files requested from CHD?
Received_files_when_1st attempt	Date/Time	On what date did were the files received by state health office in response to the first attempt?
Source_Field 1st	Text	What was the source of document collection? Carmody, EHD or County files, Laserfiche
Reviewed_1st by	Text	Who reviewed the file?
Reviewed_1st on (mm/dd/yyyy)	Date/Time	What date did the review occur?
2nd_attempt_Ommitted_documents	Text	This represents the second attempt to notify CDH regarding omitted documents?
2nd_ Date_Requested	Date/Time	Date the second request was made for omitted documents?
Received_files_when_2nd attempt	Date/Time	On what date did were the files received by SHO in response to the second attempt?
Source_Field 2nd	Text	What was the source of document collection? Carmody, EHD or County files, Laserfiche
3rd_attempt_Ommitted_document	Text	This represents the third attempt to notify CHD regarding omitted documents?
3rd_Date_Requested	Date/Time	Date the third request was made to notify CHD regarding omitted

		documents?
Received_files_when_3rd attempt	Date/Time	On what date did were the files received by state health office in response to the third attempt?
Source_Field 3rd	Text	What was the source of document collection? Carmody, EHD or County files, Laserfiche
Reviewed_final by	Text	Who reviewed the file? (The final review of all documents)
List_of_requested_documents_received	Text	List of requested documents that have been received
All requested documents received?	Yes/No	Did we receive all documents requested?
Reviewed_final comments	Text	Final comments on source data collection
Reviewed_final on (mm/dd/yyyy)	Date/Time	What date did the review occur?
Complete	Yes/No	All documents are accounted for or no additional information is needed
Construction_ Permit_Application Received	Yes/No	Is DH4015 p.1 included in the file or in EHD?
Site_Evaluation_Received?	Yes/No	Has this file been received? (typically acquired from form DH4015 page 3)
Construction_Permit_Received?	Yes/No	Is DH4016 included in the file or in EHD?
Final_Inspection_Received?	Yes/No	Has this file been received? (Form 4016 page 2 of 3)
Site_Plan_Received?	Yes/No	Is a site plan included in the file? (scaled drawing which included the approximate location of system and drainfield)
Engineer_Design_Drawing_Received?	Yes/No	Are the drawings by the engineer present? (drawing of the systems created by an engineer)
As-Built_Received?	Yes/No	Is an as-built in the file? (unscaled drawing of system and drainfield)
Operating_Permit_Received?	Yes/No	Has this file been received? (Form DH4013 (03/97))
Operating_Permit_Application_Received?	Yes/No	Has this file been received? (Form DH 4081 page 1)
Operating_Permit_Application_Comments	Text	Comments regarding operating permit application (Generally located on form

		DH4013 under condition of operation)
Maintenance_Entity_Contract_Received?	Yes/No	Has this file been received? (Approved Maintenance Entity provider)
Inspection_Checklist_Received?	Yes/No	Has this file been received? (This checklist represents what the CHD uses to uniformly inspect advanced systems)
File_Activity_Checklist_Received?	Yes/No	Has this file been received? (This checklist represents any written log and/or journal regarding the system)
CHD_Inspection_Reports_Received?	Yes/No	Has this file been received?
Maintenance_Entity_Inspection_Reports_Received?	Yes/No	Has this file been received? (This document contains service provided at the time of the ME inspection)
Enforcement_Action_For_Advanced_System_Received?	Yes/No	Has this file been received? (List the last documented enforcement action)
PBTS/Innovative_System_Design_Calculations_Received?	Yes/No	Has this file been received? (Typically found with required PBTS Engineer documents)
PBTS/Innovative_System_Design_Criteria_Received?	Yes/No	Has this file been received? (Typically found with required PBTS Engineer documents)
PBTS/Innovative_Soil_Treatment_Description_Received?	Yes/No	Has this file been received? (Typically found with required PBTS Engineer documents)
PBTS/Innovative_Contingency_Plan_Received?	Yes/No	Did the engineer provide contingency instructions? (Typically found with required PBTS Engineer documents)
PBTS/Innovative_Certification_of_Design_Received?	Yes/No	Is the certification of design included in the application package? (Typically found with required PBTS Engineer documents)
PBTS/Innovative_Operation and_Maintenance_Manual_Received?	Yes/No	Did the engineer include an operation and maintenance manual? (Typically found with required PBTS Engineer documents)
PBTS/Innovative_Applicant_Cover_Letter_Received?	Yes/No	if this is an innovative system, are homeowner acknowledgement form and CHD/SHO review form included?
PBTS/Innovative_Cert_of_compl	Yes/No	Did the engineer provide a certificate

iance_received?		of compliance after the installation? (Typically found with required PBTS Engineer documents)
PBTS/Innovative_Monitoring_Requirements_Recieved?	Yes/No	Did the engineer provide a list of monitoring requirements for the system? (Typically found with required PBTS Engineer documents)
QC_check_by	Text	Initials of QC checker
QC_check_on	Date/Time	Short date of QC check
QC_results	Text	Result of QC review: complete and agrees with records; partial and agrees with records; missing some fields; data entry errors; missing some and errors
QC Comments Step 1	Memo	Comments on the QC review for Step 1
QC Review Status	Text	Status of QC review (final, follow-up)
DateModified	Date/Time	Date that this field was modified, autoentered
Primary key	Long Integer	Primary key for this table

L) Step 2a: Construction Permit File Results

This section of the database provides information on the results of the Step 2a permit file review which consisted of reviewing construction permit file information.

Table: Step2a_const_permit_file_results

Field Name	**Data Type**	**Description**
System_set_ID	Integer	System ID number assigned for this project
CP_Soil_Profile complete?	Yes/No	Is the soil profile filled out correctly and completely DH4015 p.3?
Employee#SignPermit	Long Integer	Employee number from the CEHP who signed off on the permit
CP_permit signed and approved	Yes/No	Is the construction permit signed and approved in the file?
final inspection form signed and approved?	Yes/No	Is the final inspection signed and approved in the file?
FinalSystemApprovalDate	Date/Time	Final date when system was final approved

Enforcement_Action	Yes/No	Is there enforcement action document relative to construction included in the file (including failed construction inspections)?
Source_Asbuilt	Text	Who drew the as-built?
CP_comments	Memo	Comments on completeness of construction permit file
Permit_Comments	Memo	Comments from the actual construction permit
Engineer_designed	Yes/No	Was the system designed by an engineer?
application_type	Text	Application type checked on application form DH4015 p.1
application_type_comments	Text	Comments on application (variance, which multiple types were checked?)
CP_Commercial/residential	Text	Does the construction permit show this as commercial or residential system?
ResidentialOrCommercialText	Text	Does the operating permit show this as commercial or residential system?
Establishment_type	Text	Type of establishment DH4015 p.1
Establishment_type2-New	Text	Type of establishment DH4015 p.1 for second type of establishment using system
Usable property_size (acres)	Single	Property size given on site evaluation or similar DH4015 p.3 in acres
Usable property_size (feet)	Double	Property size given on site evaluation or similar DH4015 p.3 in square feet
Estimated_sewage_flow_(tableI)	Single	Estimated sewage flow (Table I) DH4015 p.3
Authorized sewage flow (gpd)	Long Integer	Authorized sewage flow DH4015 p.3
Site_elevation (in)	Single	Elevation of proposed site (in) DH4015 p.3
Changes_to_Site_Evaluation	Yes/No	Check this box if changes to the site evaluations data dump occurred?
site elevation above/below	Text	Indicator of elevation of site above/below
EWSWT elevation (in)	Single	What is the estimated wet season water table as shown on the site evaluation? Inches below = -

EWSWT elevation above/below	Text	Indicator of elevation of EWSWT above/below
Application_date	Date/Time	When was system construction permit originally applied for? (mm/dd/yyyy) DH4015 p.1
ApplicationCompleteDate	Date/Time	Date when application was complete
Permit_Issue_date	Date/Time	When was permit issued (DH4016 p.1)
Construction_approval_date	Date/Time	When was construction approval given on DH4016 p.2
Construction_permit_approval_date_changed?	Yes/No	Was a change to the EHD-obtained construction permit approval date made based on the permit review?
Changes_to_Construction_permit_application	Yes/No	Check this box if changes to the Construction permit data dump occurred?
Changes_to_final_system_approval_date?	Yes/No	Was a change to the EHD-obtained final system approval date made based on the permit review?
permit_source	Text	Source of information on permitting (flow, authorized flow, setbacks, application)
tank 1 legend	Text	Legend 1 of tank (DH4016 p.2)
tank 2 legend	Text	Legend 2 of tank (DH4016 p.2)
Grease_Trap	Long Integer	Is a grease trap present? 1=yes; 0=no
Drainfield_Cp_Application_Size	Text	Drainfield size annotated on Construction permit application. (DH 4016 p.2)
DF1_Permit	Double	Size of drainfield #1 on the construction permit
DF2_Permit	Text	Size of drainfield #2 on the construction permit
Tank1Units	Text	Units for tank #1 (gal/gpd)
Tank2Units	Text	Units for tank #2 (gal/gpd)
Tank1	Double	Size of tank #1 on the final inspection
Tank2	Double	Size of tank #2 on the final inspection
Drainfield_TypeCode	Double	Unique identifier from EHD for the drainfield type (same as number in Drainfield_Materials table)
DocumentNumber	Text	Document number from EHD

DrainfieldInstallation_DosingPumpsNumber	Double	Number of dosing pumps
DF1_Final	Double	Size of drainfield #1 on the final inspection
DF2_Final	Text	Size of drainfield #2 on the final inspection
IndustrialManufacturingOrEquivalent	Text	Is this industrial/manufacturing or its equivalent?
Drainfield_flow_type	Text	How does water get into drainfield and soil? "drip";"gravity";"lift-dosed";"LPDS";"unknown"
Drainfield_dosing	Text	Is there a dosing pump -> dosing from DH4016 p.2?
Drainfield_type	Text	Drainfield type relative to ground surface "fill"; "mound"; "standard/subsurface"; "unknown"
Drainfield_config	Text	Drainfield configuration "bed"; "trench"; "unknown"
Drainfield_material	Text	What is the material used in the drainfield (manufacturer; product)
elevation_of_constructed_drainfield_(in)	Double	Numerical value of constructed elevation of drainfield above/below benchmark (DH 4016 p.2)
elevation_of_constructed_drainfield_above/below	Text	Indicator of constructed elevation of drainfield above/below benchmark (DH 4016 p.2)
ElevationOfProposedSystemSiteInchesOrFeet-New	Text	Is the elevation of the system site in inches or feet?
Drainfield comments	Text	Any additional comments on drainfield?
Authorized sewage flow increase	Yes/No	Was authorized sewage flow increase allowed due to PBTS?
SetbackSurfaceWater	Text	What is the setback to the surface water from the final inspection?
Setback reductions_horizontal?	Yes/No	Was a horizontal setback reduction allowed due to PBTS?
Setback reductions_vertical	Yes/No	Was a vertical setback reduction allowed due to PBTS?
Drainfield_size_reduction	Text	What drainfield size reduction was taken for the pretreatment (common numbers are 0, 25, 30, 40%)

Monitoring_locations_shown?	Text	Are monitoring locations shown or indicated in the file?
Monitoring_locations_where?	Text	What are the monitoring locations, if indicated?
Operating_manual_available?	Text	Is there an operation manual, including inspection procedures for this unit or references included?
Monitoring_instructions	Memo	What are the monitoring instructions?
Monitoring_requirements	Memo	What are the monitoring requirements?
Sampling_Requirements_in_permit	Text	Are sampling requirements specified?
Variance?	Yes/No	Has a variance been applied for?
QC Comments Step 2a	Memo	Comments on the QC review for Step 2a
DateModified	Date/Time	Date that this field was modified, autoentered
Primary Key	Long Integer	Primary key for this table

M) Step 2b: PBTS Review Results

This section of the database provides information on the results of the Step 2b PBTS review which consisted of reviewing information in the permit files.

Table: Step2b_PBTSreview_results

Field Name	**Data Type**	**Description**
System_set_ID	Integer	System ID number assigned for this project
PBTS_Present	Yes/No	Is this a PBTS?
PBTS_application signed and sealed?	Yes/No	Is the PBTS application package signed and sealed? (4015 page 1)
Performance_standard_class	Text	Qualitative performance standard: "advanced sec.";"adv.sec.cBOD5/TSS (drip/DFred.)"; "advanced ww."; "adv.ww.cBOD5/TSS (drip/DFred.)"; "baseline"; "Florida Keys"; "secondary"; "sec.CBOD5/TSS (drip/DFred.)"; "ATU";"nitrogen"; "DFred."; "not specified"; "unknown"
cBOD5 (mg/L)	Long Integer	Numerical performance standard (if specified)

TSS(mg/L)	Long Integer	Numerical performance standard (if specified)
TN(mg/L)	Long Integer	Numerical performance standard (if specified)
TP(mg/L)	Long Integer	Numerical performance standard (if specified)
fecal coliform (cfu/100mL)	Long Integer	Numerical performance standard (if specified)
comments_performance_standard	Text	Comments on performance standards (e.g. if not based on annual averages)
Engineer_required_maintainance/monitoring	Text	What frequency of maintenance and monitoring did the engineer specify?
Are_there_sampling_requirements?	Yes/No	Did the engineer specify sampling requirements?
Sampling_Requirements	Text	What are the sampling requirements?
Additional comments	Memo	Additional comments on the engineer's work
DateModified	Date/Time	Date that this field was modified, autoentered
QC Comments Step 2b	Memo	Comments on the QC review for Step 2b
HistoricalSampleResults	Yes/No	Are there any historical sample results for this system?
Primary Key	Long Integer	Primary key for this table

N) Step 2c: Treatment Train Results

This section of the database provides information on the results of the Step 2c review on the treatment train information.

Table: Step2c_treatmenttrain_results

Field Name	**Data Type**	**Description**
System_set_ID	Integer	System ID number assigned for this project
Changes_to_previous_info	Yes/No	Was any of the previous information changed?
Which changes?	Memo	What information was added or changed?
Multiple_treatment_units_#	Long Integer	How many treatment units are there for this system permit?
Multiple_treatment_units_same	Text	If there are multiple units are they the

		same or different?
Multiple_treatment_units_config	Text	If there are multiple treatment units, are they in series or in parallel? "in series"; "parallel"; "unknown"
Dosing_into_treatment	Text	Is the treatment system(s) (in contrast to the drainfield) dosed?
Trash or pretreat tank/compartment	Text	Is there a trash tank or compartment present? Tank; 1st compartment; Absent
Pretreatment_vol(g)	Long Integer	Pretreatment tanks/compartment volumes (g)
Manufacturer_list	Long Integer	Manufacturer of treatment system (database info)
Manuf_Prodline_modif_model	Long Integer	Manufacturer_Product line_modifier_model of treatment system (database info)
Modifier of configuration	Text	Modifier of treatment system "with recirc";
ATU_compartment_vol(g)	Long Integer	Treatment compartment volume (g)
ATU_treatment_capacity (gpd)	Long Integer	Nominal treatment capacity (gpd)
Recirc_presence	Text	None (usual); present (drip systems will have recirculation present); questionable; unknown
Recirc_from	Text	From which compartment/tank does recirculation start (e.g. branch from discharge pipe to...)
Recirc_to	Text	To which compartment/tank does recirculation flow to
Recirc_rate	Text	Ratio recirculation flow/discharge flow
Clarifier_qualitative	Text	Compartment within ATU; separate tank; absent; unknown
Clarifier_vol(g)	Long Integer	Clarifier volume (gallons)
additional_tank1_qualitative	Text	Filter or recirculation tank or compartment description qualitative: absent; mineral aggregate; P-removal; recirculation; other
additional_tank2_qualitative	Text	Filter or recirculation tank or compartment description qualitative:

		absent; mineral aggregate; P-removal; recirculation; other
P-reduction approach	Text	P-reduction material: NONE; AOS; LECA; BRICK_CHIPS; MID-FLOC
P_red_tank_vol(g)	Long Integer	P-reduction tank or compartment volume (gal)
P-red_sat_unsat	Text	If P-reduction provided: saturated upflow; saturated downflow; unsaturated downflow
DOSE_tank_qualitative	Text	Dosing tank description: absent; part of ATU; part of filter tank; separate tank; other
DOSE_tank_vol(g)	Long Integer	Dosing tank/compartment volume (gal)
DOSE_PUMP	Text	None; lift dose; low-pressure dose; drip irrigation
Chlorination	Text	None; in dosing tank; in separate tank; in P-filter tank
Discharge_to	Text	WELL; DRAINFIELD
Monitoring_locations where	Memo	Description of monitoring locations
Grease_interceptor_to	Text	Where does the grease interceptor discharge to
DateModified	Date/Time	Date that this field was modified, autoentered
QC Comments Step 2c	Memo	Comments on the QC review for Step 2c
Primary Key	Long Integer	Primary key for this table

O) Step 2d: Operating Permit File Results

This section of the database provides information on the results of the Step 2d permit file review which consisted of reviewing operating permit file information.

Table: Step2d_operating_permit_file_results

Field Name	Data Type	Description
System_set_ID	Integer	System ID number assigned for this project
General_operating_permit_question	Text	General questions and/or changes with regards to operating permit documentation
Application_for_OP	Yes/No	Is the OP application on file?

Date_of_OP_application	Date/Time	Date of most recent OP application on file
OriginalApplicationDate	Date/Time	Date of the original OP application
Approval date on OP application	Date/Time	Approval date on latest OP application
Operating_permit_approval_date_changed?	Yes/No	Was a change to the EHD-obtained most recent OP application permit approval date made based on the permit review?
Type of OP application	Text	Aerobic / Commercial / IM (indicate if multiple)
Aerobic	Long Integer	Is the aerobic system checkbox checked?
Commercial	Long Integer	Is the commercial system checkbox checked?
IndustrialManufacturing	Long Integer	Is the industrial/manufacturing system checkbox checked?
PerformanceBased	Long Integer	Is the performance-based system checkbox checked?
TypeOfOP-Checkboxes	Text	Result of which check box was checked, indicates the type of operating permit (Aerobic, Commercial, Industrial/Manufacturing, PBTS)
New OP application?	Text	Is this a new, amended or renewal OP application?
Installation_approved_date	Date/Time	Installation approval date per operating permit application
Manufacturer on OP_app	Text	Manufacturer per information on operating permit application
ATU_type_on OP_application	Text	ATU type per information on operating permit application
>1500 gpd unit	Text	Is >1500 gpd indicator on OP application yes or no
multiple ATUs	Text	Are multiple ATUs used on site indicated on OP application?
PBandInnovativeID	Double	ID number for PBTS and Innovative System from EHD
Operating permit ever issued?	Yes/No	Has an operating permit ever been issued?
TreatmentUnitCapacity	Double	Capacity of treatment unit listed on

		the operating permit application
TreatmentUnitUnits	Text	Is the Treatment Unit Capacity in gallons or gpd?
GreaseTrapGallons	Double	Capacity of the grease trap listed on the operating permit application
DosingTankGallons	Double	Capacity of the dosing tank listed on the operating permit application
DrainfieldSizeSquareFeet	Double	Size of the drainfield listed on the operating permit application
DrainfieldDescription	Text	Description of the drainfield listed on the operating permit application
LotSizeSquareFeet	Double	Lot size in square feet listed on the operating permit application
SqFtAcres	Text	Is the lot size in square feet or acres?
ApprovedBusinessTypes	Text	Types of approved businesses
DrainfieldType	Text	Type of drainfield (mound, subsurface, etc.)
DrainfieldLayout	Text	Layout of drainfield (trenches, bed, etc.)
Operating conditions on OP	Memo	What, if any conditions are on the OP (none, sampling, etc.)
Expiration of latest operating permit	Date/Time	Expiration data of latest operating permit
PermitIssueDate	Date/Time	Date OP was issued
How many days past due?	Long Integer	How many days is the permit past due?
Operating permit current?	Yes/No	Is there a current operating permit present? Current = 6/30/10 or later
Documentation for lack of OP	Text	Is there a reason given for the lack of a current operating permit (vacant house, enforcement ongoing)?
Changes_to_OP_permit_Application	Yes/No	Check this box if changes were made to the operating permit application data dump
Changes_to_Operating_permit	Yes/No	Check this box if changes were made to the operating permit data dump
Effective_date_of_previous OP_permit_year_completed	Date/Time	Date of beginning of most recent permit year completed by 3/31/2010 (first half of permits issued 4/1/2008-3/31/2009, second half of permits issued 4/1/2007-3/31/2008, year

		before permit issued after 3/31/09, 3/31/2009 for systems w/o permit on 3/31/09
Inspection_1_by_CHDs	Yes/No	Is there an inspection report completed by the CHD for the permit year?
Inspection_1_by_Me	Yes/No	Is there a first inspection report completed by the ME for the permit year?
Inspection_2_by_Me	Yes/No	Is there a second inspection report completed by the ME for the permit year?
Inspection_>2_by_Me	Yes/No	Are there additional inspection reports completed by the ME for the permit year (ATU>1500 gpd; boreholes in Keys)?
Maintenance_Entity_Contract	Yes/No	Is there a valid ME contract included in the files?
Maintenance_Contract_Expiration	Date/Time	When does the most recent ME contract expire?
Last_ ME_Inspection	Date/Time	What was the date of the most recent ME inspection?
Monitoring_submitted	Memo	Was sampling result were submitted by ME?
Technical Problems?	Memo	What were any technical problems noted on the inspection reports or elsewhere?
Description of violations	Text	Describe any violations documented in the file
Violation observed when?	Date/Time	When was the violation observed? (most recent occurrence)
ME sent notice of discontinuation	Date/Time	When did the ME send a notice to the CHD that the owner will not continue maintenance agreement? (most recent occurrence)
CHD Sent reminder to ME	Date/Time	When did the CHD send a reminder to ME to renew operating permit? (most recent occurrence)
CHD sent reminder to owner	Date/Time	When did the CHD send a reminder to owner to get operating permit/maintenance contract? (most recent occurrence)

CHD sent NOV to owner	Date/Time	When did the CHD send a notice of violation to owner about ME/OP requirement? (most recent occurrence)
CHD sent notice of intended action	Date/Time	When did the CHD send a notice of intended action to owner/ME? (most recent occurrence)
CHD sent administrative complaint	Date/Time	When did the CHD send an administrative complaint to owner/ME? (most recent occurrence)
CHD sent citation	Date/Time	When did the CHD send a citation to owner/ME? (most recent occurrence)
Enforcement action results?	Memo	What enforcement action results are documented in the file
PBandInnovativeID2	Text	ID number 2 for PBTS and Innovative System from EHD
ATU_type_on OP_application2	Text	Type of ATU on OP application #2
PBandInnovativeID3	Text	ID number 3 for PBTS and Innovative System from EHD
ATU_type_on OP_application3	Text	Type of ATU on OP application #3
PBandInnovativeID4	Text	ID number 4 for PBTS and Innovative System from EHD
ATU_type_on OP_application4	Text	Type of ATU on OP application #4
PBandInnovativeID5	Text	ID number 5 for PBTS and Innovative System from EHD
ATU_type_on OP_application5	Text	Type of ATU on OP application #5
PBandInnovativeID6	Text	ID number 6 for PBTS and Innovative System from EHD
ATU_type_on OP_application6	Text	Type of ATU on OP application #6
DateModified	Date/Time	Date that this field was modified, autoentered
General Questions	Text	List any general questions/comments about this record
QC Comments Step 2d	Memo	Comments on the QC review for Step 2d
Primary Key	Long Integer	Primary key for this table

P) Step 3 & 4: Components

This section of the database provides information on the results of the component details from the Step 3 & 4 field evaluation.

Table: Step3&4_Components

Field Name	**Data Type**	**Description**
ComponentID#	Long Integer	Automatic generated number for this system's component information
System_set_ID	Long Integer	System ID number assigned for this project
ComponentEvalDate	Date/Time	Date that the component was evaluated
ComponentType	Text	Type of component
ComponentOrder	Long Integer	Order of the component (1-10)
ComponentTypeRecirculationFrom	Long Integer	If recirculation was selected as a component type, which component is it coming from
ComponentTypeRecirculationTo	Long Integer	If recirculation was selected as a component type, which component is it going to
ComponentTypeFilterTankMedia	Text	If filter tank was selected as a component type, what sort of media is it?
ComponentTypeDisinfectionOther	Text	If disinfection was selected as a component type and the type of disinfection was listed as other, what is it?
ComponentTypeOther	Text	If other was selected as the component type and it is not a sampling port, what is it?
ComponentFunction	Text	Function of component
ComponentFunctionOther	Text	If other was selected as the component function, what is it?
ComponentMaterial	Text	Material of component CO-concrete FG-fiberglass PE-polyethylene OT-other ___________
ComponentMaterialOther	Text	Description of the component material if it is other
Tank structural condition	Text	0-structually sound, 1-rebar exposed, 2-spalling, 3-corrosion, 4-roots inside of compartment, 5-cracks, 6-deflection, 7-inlet seal missing/broken, 8-outlet seal missing/broken, 9-holes, 10-lid broken/missing, 11-manhole

		cover missing/broken, 12-other
ConditionOther	Text	If other was listed for the tank structural condition, what is it?
LiquidLevelOutlet	Text	Liquid level relative to outlet (in) (NA for pump tank)
LiquidLevelOutletAbove/Below	Text	Liquid level relative to outlet above or below
LiquidLevelInlet	Text	Liquid level relative to outlet (in) (NA for pump tank)
LiquidLevelInletAbove/Below	Text	Liquid level relative to outlet above or below
LiquidLevelHigher	Text	Evidence liquid level has been higher
LiquidLevelDropped	Text	Evidence liquid level dropped (no pump)
Non-sewageInflow	Text	Evidence of non-sewage inflow
Watertight	Text	Appears to be watertight (no visual leaks)
OilyFilm/Sheen	Text	Oily film/sheen present
OdorIntensity/Quality	Text	Intensity: 0 None perceivable 1 barely perceivable 2 faint but identifiable 3 easily perceivable 4 Strong Quality: SEP Septic EARTHY Earthy/Musty/Moldy CHEM Chemical SOUR Sour/Rancid/Putrid OTH Other_____ N/A
SampleTaken	Yes/No	Sample taken?
ScumDepth	Long Integer	Depth of scum in inches
ScumColor	Text	Color of scum BL Black BR Brown MU Mustard GR Gray WH White TAN Tan OTH Other_____ NO None
ScumColorOther	Text	Description of other color for scum color if selected
ScumClarity/Structure	Text	CLEAR Clear CLOUD Cloudy MILK Milky MUD Muddy FLOC Flocked GRA Grainy FLU Fluffy
ClearZoneDepth	Long Integer	Depth of clear zone in inches
ClearZoneColor	Text	Color of clear zone BL Black BR

		Brown MU Mustard GR Gray WH White TAN Tan OTH Other_____ NO None
ClearZoneColorOther	Text	Description of other color for clear zone color if selected
ClearZoneClarity/Structure	Text	CLEAR Clear CLOUD Cloudy MILK Milky MUD Muddy FLOC Flocked GRA Grainy FLU Fluffy
SludgeDepth	Long Integer	Depth of sludge in inches
SludgeColor	Text	Color of sludge BL Black BR Brown MU Mustard GR Gray WH White TAN Tan OTH Other_____ NO None
SludgeColorOther	Text	Description of other color for sludge color if selected
SludgeClarity/Structure	Text	CLEAR Clear CLOUD Cloudy MILK Milky MUD Muddy FLOC Flocked GRA Grainy FLU Fluffy
Comments	Memo	Comments on component
YSIStationDescription	Text	Description of station where YSI readings were taken (i.e. pump tank). Should match type of component field.
YSIDate	Date/Time	Date in yy/mm/dd for YSI reading
YSITime	Date/Time	Time in hr:min YSI reading was taken
YSIWaterTemp	Double	Water temperature
YSIDO	Double	Dissolved oxygen
YSI%Sat	Double	Percent saturation
YSI%SatTrend	Text	Trend for dissolved oxygen
YSIORP	Double	Oxygen reduction potential
YSICond	Double	Specific Conductance
YSISalinity	Double	Salinity
YSIpH	Double	pH
Step3&4ID	Long Integer	Primary key from Step3&4_field_evaluation table
SampleLocation	Text	AC-aeration chamber CL-clarifier DS-disinfection ND- not determined OT-other MF-media filter PO-phosphorus sorption PU- pump/dosing/ recirc chamber SP-sampling port TT-

		trash/pretmt tank PEB-pre-cleaned EB FBL-field blank FEB-field-cleaned EB

Q) Step 3 & 4: Field Evaluation

This section of the database provides information on the results of the Step 3 & 4 field evaluation.

Table: Step3&4_field_evaluation

Field Name	**Data Type**	**Description**
Step3&4ID	Long Integer	Unique value to identify this sample event
QC Comments Step 3	Memo	Comments on the QC review for Step 3
Step3FormDate	Date/Time	Date of initial system evaluation
Step3FormSampler	Text	Name of sampler for initial system evaluation
System_set_ID	Long Integer	System ID number assigned for this project
Date#1PreviousMEVisit	Date/Time	Date of first previous ME visit
Date#2PreviousMEVisit	Date/Time	Date of second previous ME visit
DatePreviousCHDInsp	Date/Time	Date of the previous CHD inspection
OperatingPermitCurrent	Text	Is the Operating Permit current?
MaintenanceContractCurrent	Text	Is the Maintenance Contract current?
MaintenanceEntityPresent?	Yes/No	Is the Maintenance Entity present for this site visit?
CHDPresent?	Yes/No	Is the CHD present for this site visit?
Owner/UserPresent?	Yes/No	Is the Owner/User present for this site visit?
SiteVisitAnnouncedBy	Text	Who announced the site visit
SiteVisitAnnouncedTo	Text	Who was notified of the site visit
SiteVisitAnnounced#Days	Long Integer	How many days in advance was the site visit announced?
SystemInfoComments	Memo	Comments on the system information gathered
AccessToSite	Text	Permission given, Open, Obstructed (locked gate/fence), Denied, Other
BaseForInitialSystemEvaluation	Text	Observation from afar, Observation of above-ground parts and control panels, Probing of system location, Permit records

HowManySystems	Text	None found, One, More than one
CommentsIfNoSystems	Memo	If there is not a system, provide a comment
SystemSketchSource	Text	Source of the system sketch
Surfacing/Breakouts	Text	Are there signs of surfacing or breakouts near the treatment system?
Tank/Lid/CoverBroken/Missing	Text	Are tanks, lids, or access covers broken or missing?
Settling/erosion	Text	Are there any signs of settling or erosion near the system components?
VehicularTraffic	Text	Does it appear as though the system is subject to vehicular traffic?
Encroachment	Text	Is there any encroachment onto the system?
EncroachmentWithin5Ft	Text	If yes, what is within 5ft of system?
EncroachmentWithin5FtOther	Text	If Other was checked for Encroachments within 5 ft, what is the reason
OdorIntensity	Text	Evaluate intensity of odor within 10ft of perimeter of system
OdorQuality	Text	Evaluate quality of odor within 10ft of perimeter of system
OdorQualityOther	Text	If Other was checked for Odor Quality, what is the description
OdorSource	Memo	What is the source of the odor, if present?
SoundIntensity	Text	Evaluate intensity of sound (except alarm) within 10ft of perimeter of system
SoundSource	Text	Evaluate source of sound (except alarm) within 10ft of perimeter of system
SoundComments	Memo	Any comments on the sound evaluation?
Watertight	Text	Does the system appear water-tight?
WaterEnterOrLeave	Text	If not watertight, does the water seem to enter or leave the system?
WaterEnter/LeaveFrom	Text	If not watertight, where does the water enter or leave?
WaterEnter/LeaveFromOther	Text	If water enters/leaves from "other", what is the description?

AlarmsOn	Text	Are any alarms on?
AlarmsOnReason	Text	What alarm is on
AlarmsOnReasonOther	Text	If "other" was checked for the reason the alarm is on, describe here
AssessSewageFlow	Text	Is there a means to assess sewage flow? (water meter, event counter, flow meter)
MeterReading	Long Integer	If there is a means to assess sewage flow and influent is available for sampling, document meter reading
SystemEvaluationComments	Memo	Comments on the system evaluation
Alterations/SiteChanges	Text	Any landscape construction, utility work, or changes in drainage patterns?
Obstructed	Text	Has system been obstructed?
Additions	Text	Any apparent recent additions to the building(s) connected to system?
ComponentsMissing/Modified	Text	Are any components missing or modified?
ComponentsNotDetermined	Yes/No	Were the components not determined?
ComponentsNotDeterminedReason	Memo	Reason why components were not determined, if applicable
ComponentsComments	Memo	Comments on components list
ControlPanelVisible	Text	Is control panel for treatment system visible?
ControlPanelAccessible	Text	Is control panel for treatment system accessible?
PowerOnFromIndicator	Text	Does power indicator, if present, indicate that power is on?
PowerOnFromAerator	Text	Does operation of system (aerator) indicate that power is on?
PowerOff	Text	Does it appear that the power is switched off?
PowerComments	Memo	Comments on the power assessment
AlarmPresent	Text	Is an alarm present for the treatment unit?
AlarmPresentYes	Text	If yes, which of the following are operational?
DosingTankAlarm	Text	Is an alarm present for the dosing tank, if tank is present?

DosingTankAlarmPresentYes	Text	If yes, which of the following are operational?
TreesInDF	Text	Are there any trees in the drainfield?
DrainfieldVegetation	Text	Relative to surrounding areas, how does the vegetation on the drainfield look?
VegetationLocation	Memo	Location of drainfield vegetation listed in "drainfield vegetation" field
Ponding	Text	Is there evidence that there is ponding in the drainfield?
PondingDescription	Text	Description of ponding
PondingDescriptionObPortInches	Long Integer	Number of inches of standing water in observation port
PondingDescriptionOther	Text	Ponding description if "other" selected
DrainfieldComments	Memo	Comments on the drainfield evaluation
SamplePort	Text	Is there an effluent sample port installed?
SamplePortLocation	Text	Where is the sample port?
SamplePortType	Text	Type of sample port
SamplePortOdor	Text	Was the odor checked, not checked, or N/A?
SamplePortOdorIntensity	Text	Evaluate intensity of odor within the sample port
SamplePortOdorQuality	Text	Evaluate quality of odor within the sample port
SamplePortOdorQualityOther	Text	If Other was checked for Sample Port Odor Quality, what is the description?
TreatmentTankAccess	Text	Can you get access to the treatment tank?
AccessLocation	Text	Location of access to treatment tank
AccessLocationBuried	Long Integer	Number of inches access location is buried
AccessCoversFastened	Text	Are access covers securely fastened?
AccessCoversOperable	Text	Are access covers in operable condition?
Post-TreatmentTankAccess	Text	Can you get access to the post-treatment tank?
Post-TreatmentTankAccessLocation	Text	Location of access to post-treatment tank
Post-	Long	Number of inches access location to

TreatmentTankAccessLocation Buried	Integer	post-treatment tank is buried
Post-TreatmentTankAccessCovers Fastened	Text	Are access covers to post-treatment tank securely fastened?
Post-TreatmentTankAccessCoversOp erable	Text	Are access covers to post-treatment tank in operable condition?
InfluentSample	Text	Is it feasible to obtain an influent sample from this system?
InfluentSampleLocation	Text	Location of influent sample
AccessToSewageComments	Memo	Comments on access to sewage
Step4FormDate	Date/Time	Date of system operation evaluation
Step4FormSampler	Text	Name of sampler for system operation evaluation
Region	Long Integer	Region sampler works in: 1=Monroe, 2=Charlotte, 3=Lee, 4=Statewide, 5=Volusia, 6=Headquarters
Time	Date/Time	Time of assessment
CloudCover%	Long Integer	Percent cloud cover
RainfallCurrent	Text	1 None 2 Light 3 Moderate 4 Heavy
RainfallPrev7Days	Long Integer	Amount of rainfall over the previous 7 days in inches
DateLastPumpout	Date/Time	Date of the last pumpout
AerationPresent	Text	Is an aeration chamber present?
AerationAcess	Text	Is there access to the aeration chamber?
AerationMixing	Text	Is there mixing in the aeration chamber
AerationMixingComment	Memo	Comments on mixing in aeration chamber
SSVSampleTaken	Text	Was a Settled Sludge Volume Test sample obtained?
SSVSettledBegin	Long Integer	Volume in mL/L of settled sludge at beginning
SSVFloatingBegin	Long Integer	Volume in mL/L of floating sludge at beginning
SSVBeginTime	Long Integer	Number of minutes after obtaining sample when volume of settled and

		floating sludge was measured
SSVSettledEnd	Long Integer	Volume in mL/L of settled sludge at end
SSVSettledEndQualifier	Text	Qualifier for SSV Settled End
SSVFloatingEnd	Long Integer	Volume in mL/L of floating sludge at end
SSVEndTime	Long Integer	Number of minutes after obtaining sample when volume of settled and floating sludge was measured
BiomassColor	Text	Color of biomass
BiomassColorOther	Text	If Other was checked for Biomass Color, what is the description
BiomassStructure	Text	Structure of biomass
Supernatant	Text	Cloudy or clear
Attached-GrowthPlugging	Text	Attached-growth media plugging?
Attached-GrowthFloating	Text	Attached-growth media floating?
Attached-GrowthMediaReplaced	Text	Attached-growth media replaced?
MediaFilter	Text	Is there a media filter?
MediaFilterDevice	Text	What is the device for the media filter?
MediaFilterDistribution	Text	Is there uniform distribution over the media filter?
MediaFilterOperation	Text	Is the media filter operating properly?
MediaFilterPonding	Text	Is there ponding associated with the media filter?
MediaFilterComments	Memo	Comments on the media filter
MediaFilterSumpPonding	Text	Is there ponding in the media filter sump?
GravityDrainage	Text	Is gravity drainage operational?
SolidsBuildupSump	Text	Is there solids buildup in the sump area?
UnderdrainVents	Text	Are underdrain vents present?
UnderdrainVentsOperable	Text	Are the underdrain vents operable?
ChlorinationSystem	Text	Is there a chlorination system present?
ChlorinationManufacturer	Text	Manufacturer of chlorination system
Chlorinator	Text	Info on the chlorinator
Dechlorinator	Text	Info on the dechlorinator
ChlorinationSystemModel	Text	Model number of the chlorination system
ChlorinationMethod	Text	Tablet, Liquid

ChlorinationCondition	Text	Does the unit appear in good condition?
ChlorinationLocation	Long Integer	Location of chlorination: Location in/after tank #___
TabletChlorinatorOperable	Text	Chlorinator appears operable
ChlorineTabletsPresent	Text	Are chlorine tablets in place?
TabletsTouchEffluent	Text	Are the tablets in contact with effluent?
ContactChamberOperable	Text	Is the contact chamber operable?
FreeChlorineResidual	Double	Free chlorine residual ppm
TotalChlorineResidual	Long Integer	Total chlorine residual ppm
EffluentScreenLocation	Text	Location of effluent screen / tertiary filter
EffluentScreenClogging	Text	Evidence of clogging of effluent screen / tertiary filter?
QC Check By	Text	Who performed QC check
Task 5 Site	Yes/No	Was this a Task 5 site?

R) Step 4: Field Analysis Form

This section of the database provides information on the results of the Step 4 field analysis form.

Table: Step4_field_analysis_form

Field Name	Data Type	Description
System_set_ID	Long Integer	System ID number assigned for this project
FieldAnalysisID	Long Integer	Automatically generated number to associate with this sample
Sampler	Text	Name of the sampler
TestStripExpDate	Date/Time	Date that the test strip brand/lot expires
Sample#	Long Integer	Number of the sample within this sampling event (1-6)
SAMPLE_DATE	Date/Time	Date - Short
SAMPLE_TIME	Date/Time	Time - Medium
SampleType	Text	Eff =effluent Inf=Influent Tap=tap water QC=quality control
SampleLocation	Text	AC-aeration chamber CL-clarifier DS-disinfection ND- not determined OT-other MF-media filter PO-phosphorus

		sorption PU- pump/dosing/ recirc chamber SP-sampling port TT-trash/pretmt tank PEB-pre-cleaned EB FBL-field blank FEB-field-cleaned EB
SampleMethod	Text	i=intermediate container d=directly from free fall, spigot etc. p=peristaltic pump
Original/Duplicate	Integer	01-original sample 02-duplicate
LabSampleTaken	Yes/No	Was a lab sample taken?
Color	Text	BLack BRown MUstard GRay WHite TAN OTher ______ NOne
Clarity	Text	Clear Cloudy Milky Muddy Flocced Grainy Fluffy
OdorIntensity	Long Integer	0 None perceivable 1barely perceivable 2 faint but identifiable 3 clearly perceivable 4 strong
OdorQuality	Text	Septic Earthy/Musty/Moldy Chemical Sour/Rancid/Putrid Other______ N/A
HACH_Apparent_Color	Long Integer	Value for apparent color from HACH Colorimeter DR/890
HACH_Apparent_Color_qualifier	Text	Qualifier for apparent color from HACH Colorimeter DR/890
HACH_Turbidity	Long Integer	Value of turbidity from HACH Colorimeter DR/890
HACH_Turbidity_qualifier	Text	Qualifier for turbidity from HACH Colorimeter DR/890
HACH_NH4-N	Double	Value of NH3-N from HACH Colorimeter DR/890
HACH_NH4-N_qualifier	Text	Qualifier for NH3-N from HACH Colorimeter DR/890
HACH_NO3-N	Double	Value of NO3-N from HACH Colorimeter DR/890
HACH_NO3-N_qualifier	Text	Qualifier for NO3-N from HACH Colorimeter DR/890
HACH_PO4	Double	Value of PO4 from HACH Colorimeter DR/890
HACH_PO4-P	Double	Value of PO4-P (=PO4 *.3261) from HACH Colorimeter DR/890
HACH_PO4-P_qualifier	Text	Qualifier for PO4-P from HACH

		Colorimeter DR/890
pH(Taylor)	Double	Taylor Kit pH
pH(Taylor)_qualifier	Text	Qualifier Taylor Kit pH
Alkalinity(Taylor)	Double	Taylor Kit total alkalinity
Alkalinity(Taylor)_qualifier	Text	Qualifier Taylor Kit total alkalinity
PO4 (strip)	Double	Test strip (mg/L) PO4
NO3 (strip)	Double	Test strip (mg/L) NO3-N
NO2 (strip)	Double	Test strip (mg/L) NO2-N
NH4-N (strip)	Double	Test strip (mg/L) NH3-N
Total Alkalinity (strip)	Double	Test strip (mg/L) total alkalinity
Cl (strip)	Double	Test strip (mg/L) Cl
pH (strip)	Double	Test strip
AnalystsInitials	Text	Initials of analyst
AnalysisHours	Long Integer	Analysis done within ____ hours
Comments	Memo	Comments on field analysis
QC to do	Text	Lab values seem odd, need checking; comments of changes
DateCreated	Date/Time	Date that this field was created, autoentered
DateModified	Date/Time	Date that this field was modified, autoentered
pH YSI Calibration Successful?	Yes/No	Was the YSI calibration successful for pH?
DO YSI Calibration Successful?	Yes/No	Was the YSI calibration successful for dissolved oxygen?
ORP YSI Calibration Successful?	Yes/No	Was the YSI calibration successful for specific conductance?
QC Comments Step 4b	Memo	Comments on the QC review for Step 4b
Step3&4ID	Long Integer	Step 3&4 ID number

S) Calibration Results

This section of the database provides information on the calibration results for the field evaluation.

Table: tbl Calibration

Field Name	Data Type	Description
ID	Long Integer	Primary key

Date	Date/Time	Date of calibration
Meter #	Text	Which meter
Initials	Text	Who performed the calibration? Use ER1 for Eb in Monroe, ER2 for Eb in Charlotte, ER3 for Eb with Keith, ER4 for Eb in Volusia
Dissolved Oxygen Result	Text	What was the result of the dissolved oxygen calibration? Pass; Calibration trouble; Incomplete no a.m., Incomplete no p.m.
Dissolved Oxygen Standard	Double	Enter standard in here:
Dissolved Oxygen Reading	Double	Enter reading in here for those that failed
Specific Conductance Result	Text	What was the result of the specific conductance calibration? Pass; Calibration trouble; Incomplete no a.m., Incomplete no p.m.
Specific Conductance Standard	Double	Enter standard in here for those that failed
Specific Conductance Reading	Double	Enter reading in here for those that failed
pH Result	Text	What was the result of the pH calibration? Pass; Calibration trouble; Incomplete no a.m., Incomplete no p.m.
pH Standard	Double	Enter standard in here for those that failed
pH Reading	Double	Enter reading in here for those that failed
Comments	Memo	Overall comments
pH Data Useable?	Text	Are the pH data useable for this date?
Dissolved Oxygen Data Useable?	Text	Are the Dissolved Oxygen data useable for this date?
Specific Conductance Data Useable?	Text	Are the Specific Conductance data useable for this date?

T) Samplers Region

This section of the database provides information on the region where samplers were located. By grouping samplers by region, the calibration results could be assigned to a specific instrument.

Table: TblSamplersRegion

Field Name	Data Type	Description
Sampler Initials	Text	Initials of sampler
Primary Key	Long Integer	Primary key
Region	Long Integer	Region sampler works in: 1=Monroe, 2=Charlotte, 3=Lee, 4=Statewide, 5=Volusia, 6=Headquarters

U) Lab Results

This section of the database provides information on the lab results of the sampling efforts. Information from several labs have been combined into one table along with an analysis of the quality control review.

Table: TblSamplersRegion

Field Name	Data Type	Description
Step5_lab_results_System ID	Double	System ID number assigned for this project
Step5_lab_results_Sample Type	Text	Eff =effluent Inf=Influent Tap=tap water QC=quality control
Step5_lab_results_Sampling Location	Text	AC-aeration chamber CL-clarifier DS-disinfection ND- not determined OT-other MF-media filter PO-phosphorus sorption PU- pump/dosing/ recirc chamber SP-sampling port TT-trash/pretmt tank PEB-pre-cleaned EB FBL-field blank FEB-field-cleaned EB
Step5_lab_results_Sampling Method	Text	i=intermediate container d=directly from free fall, spigot etc. p=peristaltic pump
Step5_lab_results_Original/Duplicate	Text	01-original sample 02-duplicate
Step5_lab_results_Sampler	Text	Sampler name
Wo_Number	Double	Work order number from the analyzing lab
Step5_lab_results_Sample_Id	Text	Sample ID from chain of custody form
Lab_Sample_Id	Text	Lab assigned sample ID number
Matrix	Text	W – water, WW – wastewater
Date Collected	Date/Time	Date sample was collected
Time Collected	Date/Time	Time sample was collected

Date Received	Date/Time	Date sample was received
Time Received	Date/Time	Time sample was received
Sample_temp_preservation intact?	Text	Was the sample temperature and preservation intact?
DOH NELAP certification number	Text	DOH NELAP certification number
Total Alkalinity_Method	Text	Analysis method for Total Alkalinity
Total Alkalinity Result	Double	Total Alkalinity result
Total Alkalinity RL	Double	Total Alkalinity reporting limit
Total Alkalinity MDL	Double	Total Alkalinity method detection limit
Total Alkalinity Units	Text	Units Total Alkalinity was measured in
Total Alkalinity DF	Double	Dilution factor for Total Alkalinity
Total Alkalinity Analysis Date	Date/Time	Total Alkalinity analysis date
Total Alkalinity Analysis Time	Date/Time	Total Alkalinity analysis time
Total Alkalinity Flag	Text	Total Alkalinity flag
Total Alkalinity Comments	Text	Total Alkalinity Comments
Total CBOD_Method	Text	Analysis method for CBOD5
CBOD5 Result	Double	CBOD5 result
CBOD5 RL	Double	CBOD5 reporting limit
CBOD5 MDL	Double	CBOD5 method detection limit
CBOD5 Units	Text	Units CBOD5 was measured in
CBOD5 DF	Double	Dilution factor for CBOD5
CBOD5 Analysis Date	Date/Time	CBOD5 analysis date
CBOD5 Analysis Time	Date/Time	CBOD5 analysis time
CBOD5 Flag	Text	CBOD5 flag
CBOD5 Comments	Text	CBOD5 Comments
TKN Method	Text	Analysis method for TKN
TKN Result	Double	TKN result
TKN RL	Double	TKN reporting limit
TKN MDL	Double	TKN method detection limit
TKN Units	Text	Units TKN was measured in
TKN DF	Double	Dilution factor for TKN
TKN Analysis Date	Date/Time	TKN analysis date
TKN Analysis Time	Date/Time	TKN analysis time
TKN Flag	Text	TKN flag
TKN Comments	Text	TKN Comments
Nitrate-Nitrite Method	Text	Analysis method for Nitrate-Nitrite
Nitrate-Nitrite Result	Double	Nitrate-Nitrite result
Nitrate-Nitrite RL	Double	Nitrate-Nitrite reporting limit
Nitrate-Nitrite MDL	Double	Nitrate-Nitrite method detection limit
Nitrate-Nitrite Units	Text	Units Nitrate-Nitrite was measured in

Nitrate-Nitrite DF	Double	Dilution factor for Nitrate-Nitrite
Nitrate-Nitrite Analysis Date	Date/Time	Nitrate-Nitrite analysis date
Nitrate-Nitrite Analysis Time	Date/Time	Nitrate-Nitrite analysis time
Nitrate-Nitrite Flag	Text	Nitrate-Nitrite flag
Nitrate-Nitrite Comments	Text	Nitrate-Nitrite Comments
TSS Method	Text	Analysis method for TSS
TSS Result	Double	TSS result
TSS RL	Double	TSS reporting limit
TSS MDL	Double	TSS method detection limit
TSS Units	Text	Units TSS was measured in
TSS DL	Double	Dilution factor for TSS
TSS Analysis Date	Date/Time	TSS analysis date
TSS Analysis Time	Date/Time	TSS analysis time
TSS Flag	Text	TSS flag
TSS Comments	Text	TSS Comments
Total Nitrogen Method	Text	Analysis method for Total Nitrogen
Total Nitrogen Result	Double	Total Nitrogen result (calculated by adding TKN and Nitrate-Nitrite)
Total Nitrogen RL	Double	Total Nitrogen reporting limit
Total Nitrogen MDL	Double	Total Nitrogen method detection limit
Total Nitrogen Units	Text	Units Total Nitrogen was measured in
Total Nitrogen DF	Double	Dilution factor for Total Nitrogen
Total Nitrogen Analysis Date	Date/Time	Total Nitrogen analysis date
Total Nitrogen Analysis Time	Date/Time	Total Nitrogen analysis time
Total Nitrogen Flag	Text	Total Nitrogen flag
Total Nitrogen Comments	Text	Total Nitrogen Comments
Total Phosphorus Method	Text	Analysis method for Total Phosphorus
Total Phosphorus Result	Double	Total Phosphorus result
Total Phosphorus RL	Double	Total Phosphorus reporting limit
Total Phosphorus MDL	Double	Total Phosphorus method detection limit
Total Phosphorus Units	Text	Units Total Phosphorus was measured in
Total Phosphorus DF	Double	Dilution factor for Total Phosphorus
Total Phosphorus Analysis Date	Date/Time	Total Phosphorus analysis date
Total Phosphorus Analysis Time	Date/Time	Total Phosphorus analysis time
Total Phosphorus Flag	Text	Total Phosphorus flag
Total Phosphorus Comments	Memo	Total Phosphorus Comments
Total Alkalinity QC	Text	QC results for Total Alkalinity
CBOD5 QC	Text	QC results for CBOD5
TKN QC	Text	QC results for TKN

Nitrate-Nitrite QC	Text	QC results for Nitrate-Nitrite
TSS QC	Text	QC results for TSS
Total Nitrogen QC	Text	QC results for Total Nitrogen
Total Phosphorus QC	Text	QC results for Total Phosphorus
Step5_lab_results_QC Comments	Text	Comments on QC results
Step5_lab_results_Region	Double	Region where sample was taken
Step5_fecal_lab_resultstable_ Sampler	Text	Sampler name for fecal sample collection
Step5_fecal_lab_resultstable_System ID	Double	System ID number assigned for this project for fecal sample taken
Step5_fecal_lab_resultstable_Sample Type	Text	Eff =effluent Inf=Influent Tap=tap water QC=quality control
Step5_fecal_lab_resultstable_Sampling Location	Text	AC-aeration chamber CL-clarifier DS-disinfection ND- not determined OT-other MF-media filter PO-phosphorus sorption PU- pump/dosing/ recirc chamber SP-sampling port TT-trash/pretmt tank PEB-pre-cleaned EB FBL-field blank FEB-field-cleaned EB
Step5_fecal_lab_resultstable_Sampling Method	Text	i=intermediate container d=directly from free fall, spigot etc. p=peristaltic pump
Step5_fecal_lab_resultstable_Original/Duplicate	Text	01-original sample 02-duplicate
Step5_fecal_lab_resultstable_Sample_Id	Text	Sample ID from fecal sample chain of custody form
Fecal_Lab_Sample_Id	Text	Fecal lab assigned sample ID number
Fecal Date Collected	Date/Time	Date sample was collected
Fecal Time Collected	Date/Time	Time sample was collected
Fecal Date Received	Date/Time	Date sample was received
Fecal Time Received	Date/Time	Time sample was received
Fecal Sample temp_preservative intact?	Text	Was the sample temperature and preservation intact?
Fecal Lab DOH NELAP certification number	Text	DOH NELAP certification number
Fecal Method	Text	Analysis method for Fecal Coliform
Fecal Result	Double	Fecal Coliform result
Fecal RL	Text	Fecal Coliform reporting limit
Fecal MDL	Text	Fecal Coliform method detection limit

Fecal Units	Text	Units Fecal Coliform was measured in
Fecal DF	Double	Dilution factor for Fecal Coliform
Fecal Analysis Date	Date/Time	Fecal Coliform analysis date
Fecal Analysis Time	Text	Fecal Coliform analysis time
Fecal Flag	Text	Fecal Coliform flag
Fecal Comments	Text	Fecal Coliform Comments
PREPDATE	Date/Time	Date fecal sample was prepped
PREPTIME	Text	Time fecal sample was prepped
Fecal QC	Text	QC results for fecal samples
Step5_fecal_lab_resultstable_QC Comments	Text	Comments on QC results for fecal samples
Step5_fecal_lab_resultstable_Region	Double	Region where fecal sample was taken

Appendix B: Database Forms

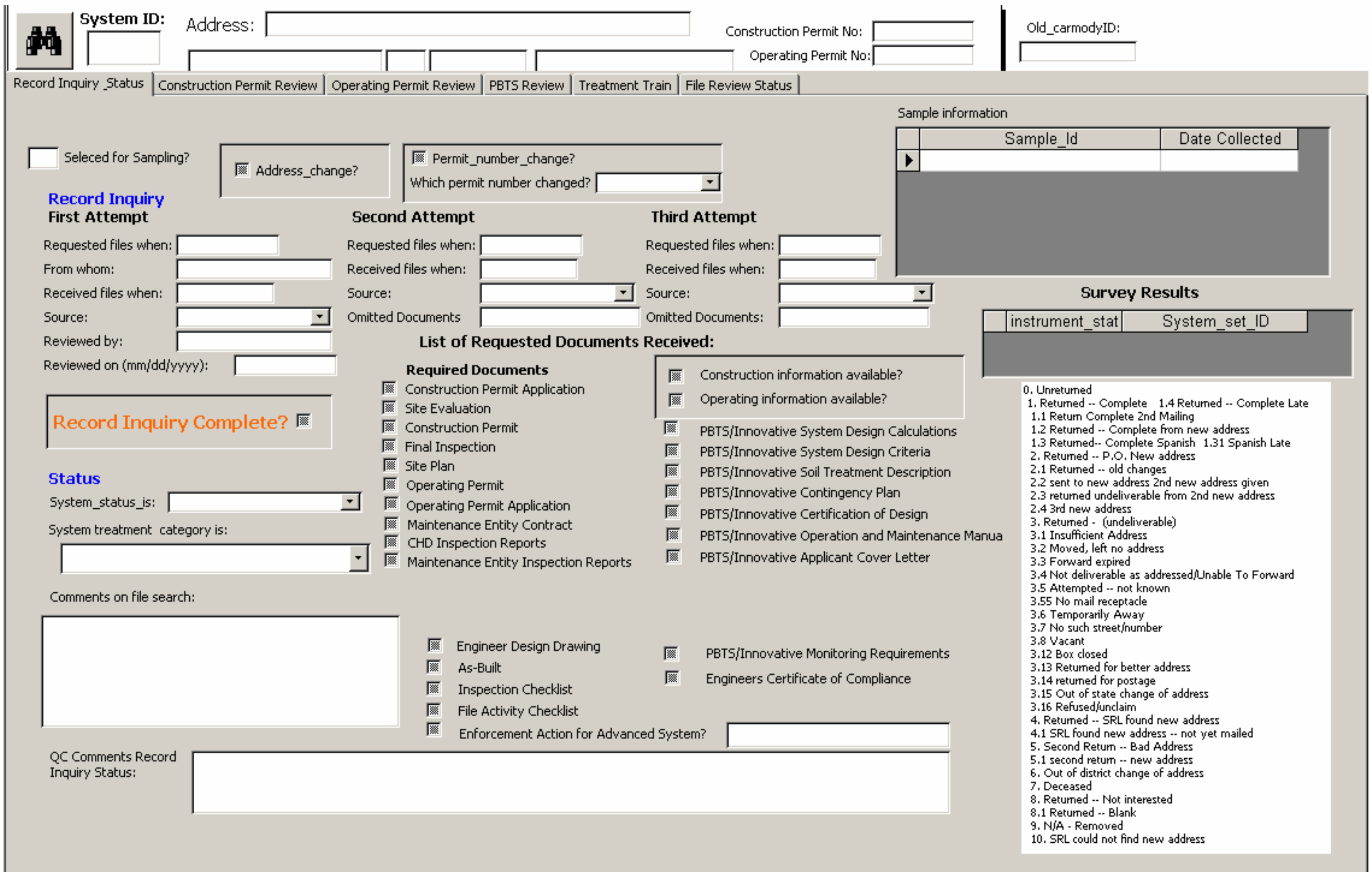


Figure 1. Screenshot of Step 1 Record Review Form Page 1

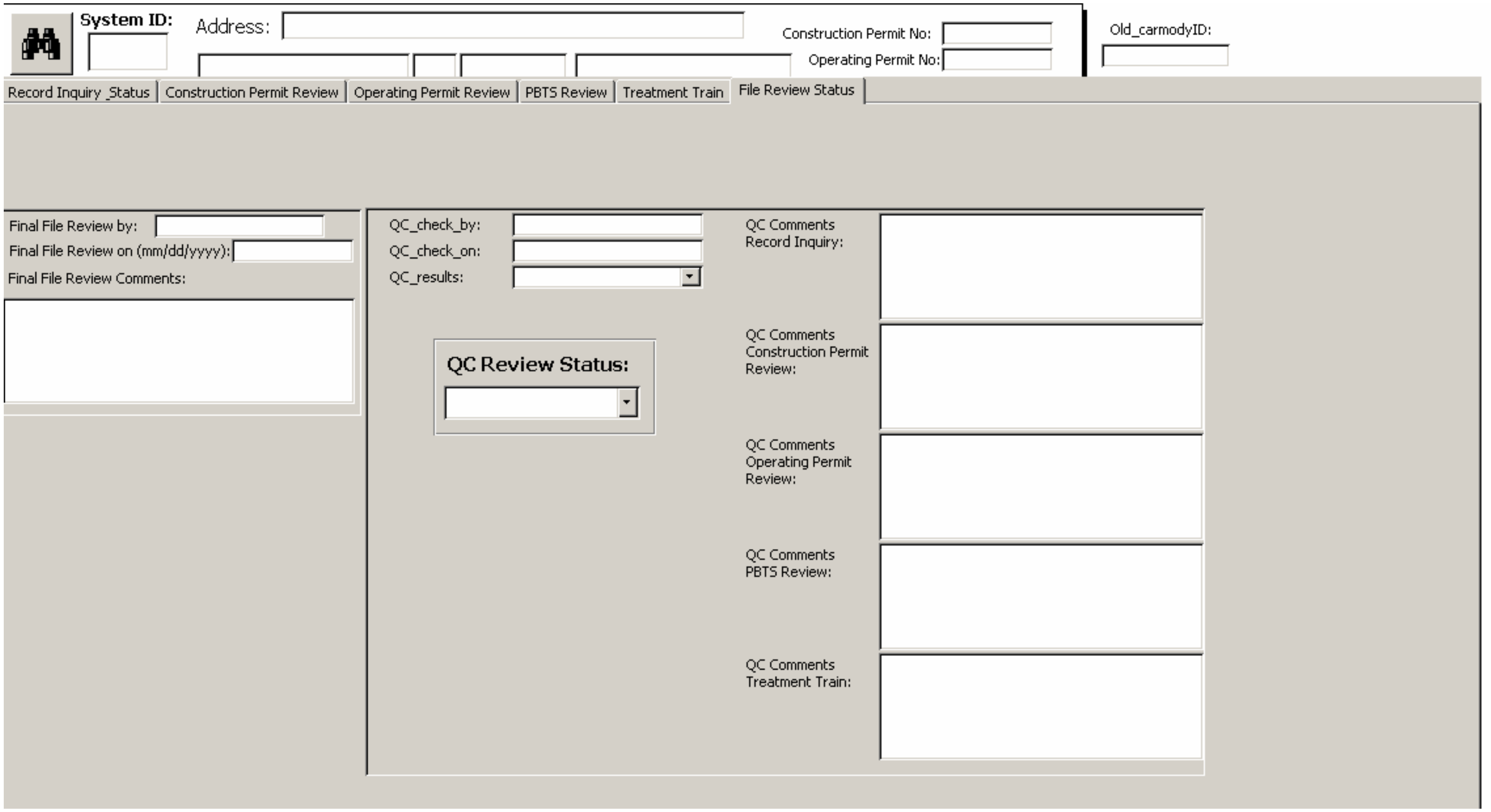
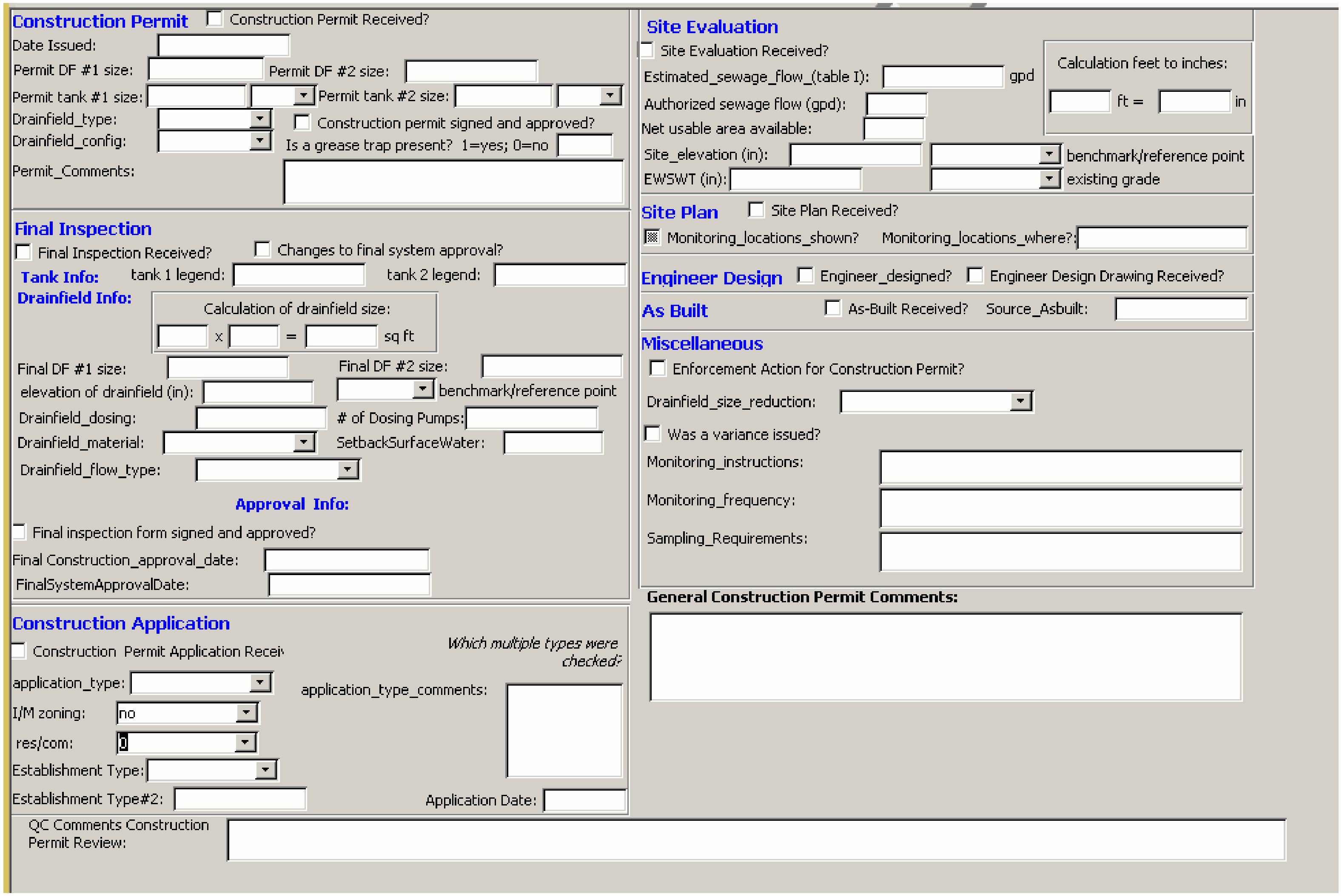


Figure 2. Screenshot of Step 1 Record Review Form Page 2



Construction Permit
Construction Permit Received?
Date Issued:
Permit DF #1 size: Permit DF #2 size:
Permit tank #1 size: Permit tank #2 size:
Drainfield_type:
Construction permit signed and approved?
Drainfield_config:
Is a grease trap present? 1=yes; 0=no
Permit_Comments:

Final Inspection
Final Inspection Received?
Changes to final system approval?
Tank Info: tank 1 legend: tank 2 legend:
Drainfield Info:
Calculation of drainfield size:
x = sq ft
Final DF #1 size: Final DF #2 size:
elevation of drainfield (in): benchmark/reference point
Drainfield_dosing: # of Dosing Pumps:
Drainfield_material: SetbackSurfaceWater:
Drainfield_flow_type:
Approval Info:
Final inspection form signed and approved?
Final Construction_approval_date:
FinalSystemApprovalDate:

Construction Application
Construction Permit Application Recei
Which multiple types were checked?
application_type:
application_type_comments:
I/M zoning: no
res/com: 0
Establishment Type:
Establishment Type#2:
Application Date:

Site Evaluation
Site Evaluation Received?
Estimated_sewage_flow_(table I): gpd
Calculation feet to inches:
ft = in
Authorized sewage flow (gpd):
Net usable area available:
Site_elevation (in): benchmark/reference point
EWSWT (in): existing grade

Site Plan
Site Plan Received?
Monitoring_locations_shown? Monitoring_locations_where?:

Engineer Design
Engineer_designed? Engineer Design Drawing Received?

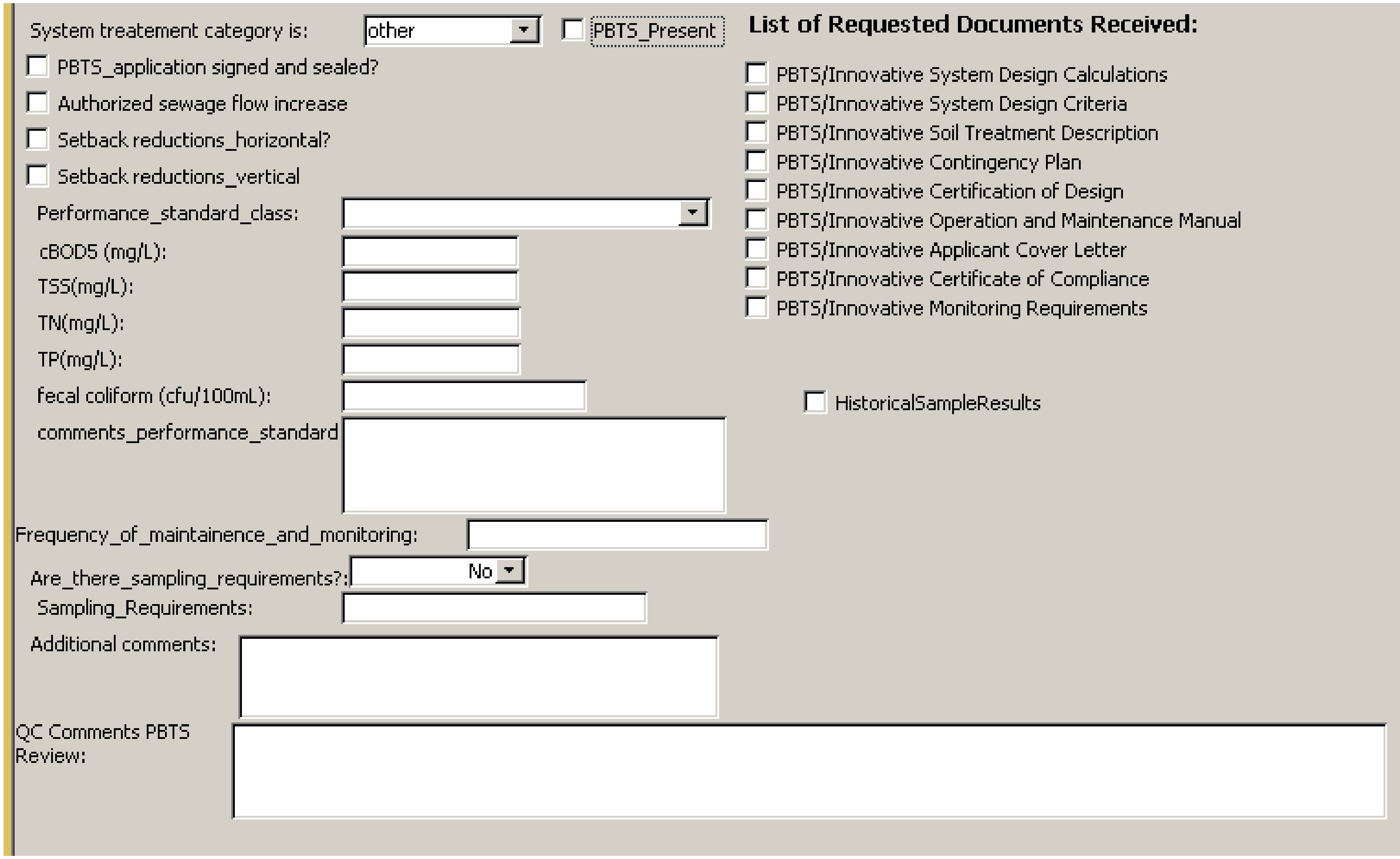
As Built
As-Built Received? Source_Asbuilt:

Miscellaneous
Enforcement Action for Construction Permit?
Drainfield_size_reduction:
Was a variance issued?
Monitoring_instructions:
Monitoring_frequency:
Sampling_Requirements:

General Construction Permit Comments:

QC Comments Construction Permit Review:

Figure 3. Screenshot of Step 2a Construction Permit Review Form



System treatement category is: other
PBTS_Present

List of Requested Documents Received:

- PBTS/Innovative System Design Calculations
- PBTS/Innovative System Design Criteria
- PBTS/Innovative Soil Treatment Description
- PBTS/Innovative Contingency Plan
- PBTS/Innovative Certification of Design
- PBTS/Innovative Operation and Maintenance Manual
- PBTS/Innovative Applicant Cover Letter
- PBTS/Innovative Certificate of Compliance
- PBTS/Innovative Monitoring Requirements

HistoricalSampleResults

- PBTS_application signed and sealed?
- Authorized sewage flow increase
- Setback reductions_horizontal?
- Setback reductions_vertical

Performance_standard_class:
cBOD5 (mg/L):
TSS(mg/L):
TN(mg/L):
TP(mg/L):
fecal coliform (cfu/100mL):
comments_performance_standard
Frequency_of_maintainence_and_monitoring:
Are_there_sampling_requirements?: No
Sampling_Requirements:
Additional comments:
QC Comments PBTS Review:

Figure 4. Screenshot of Step 2b PBTS Review Form

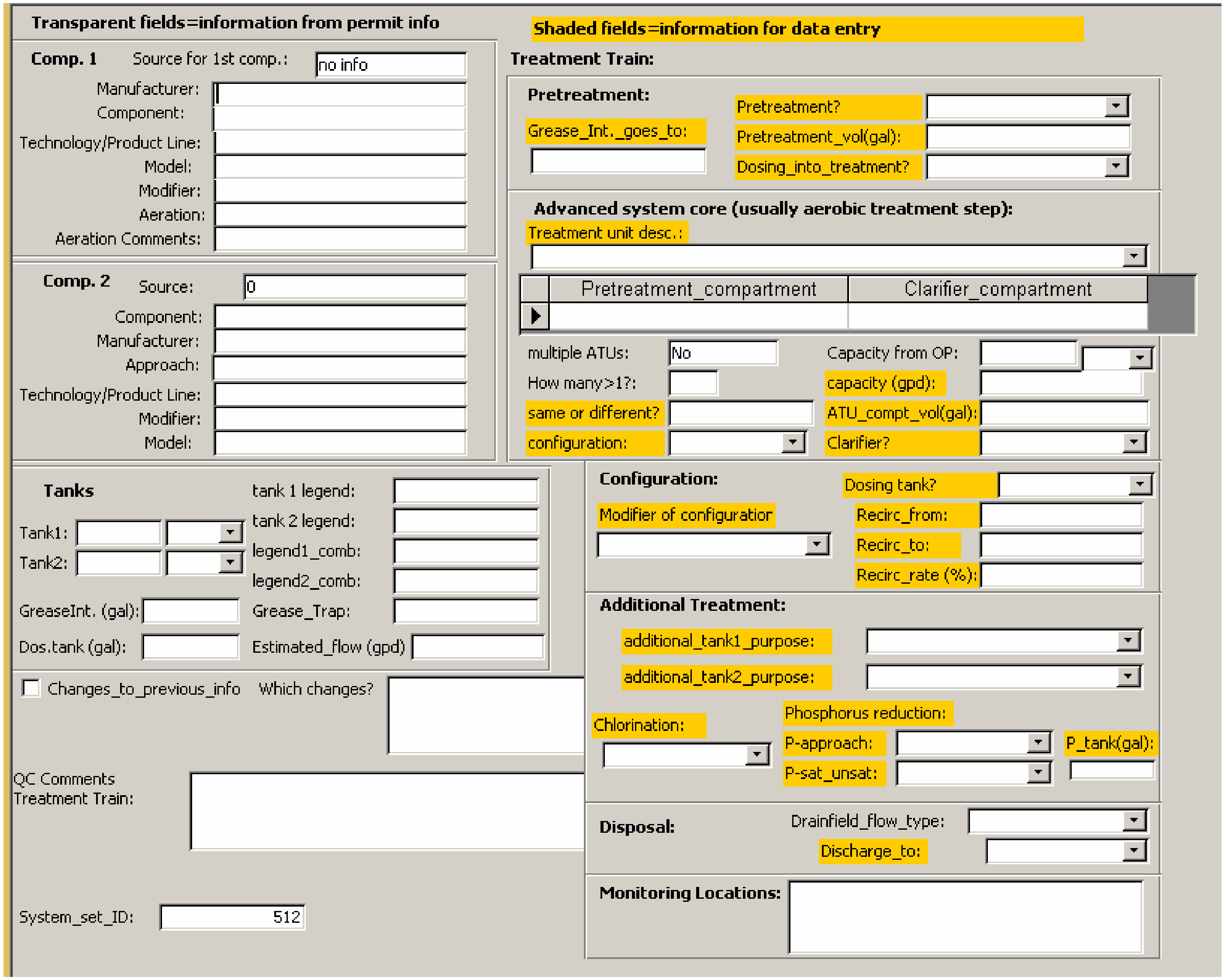


Figure 5. Screenshot of Step 2c Treatment Train Form

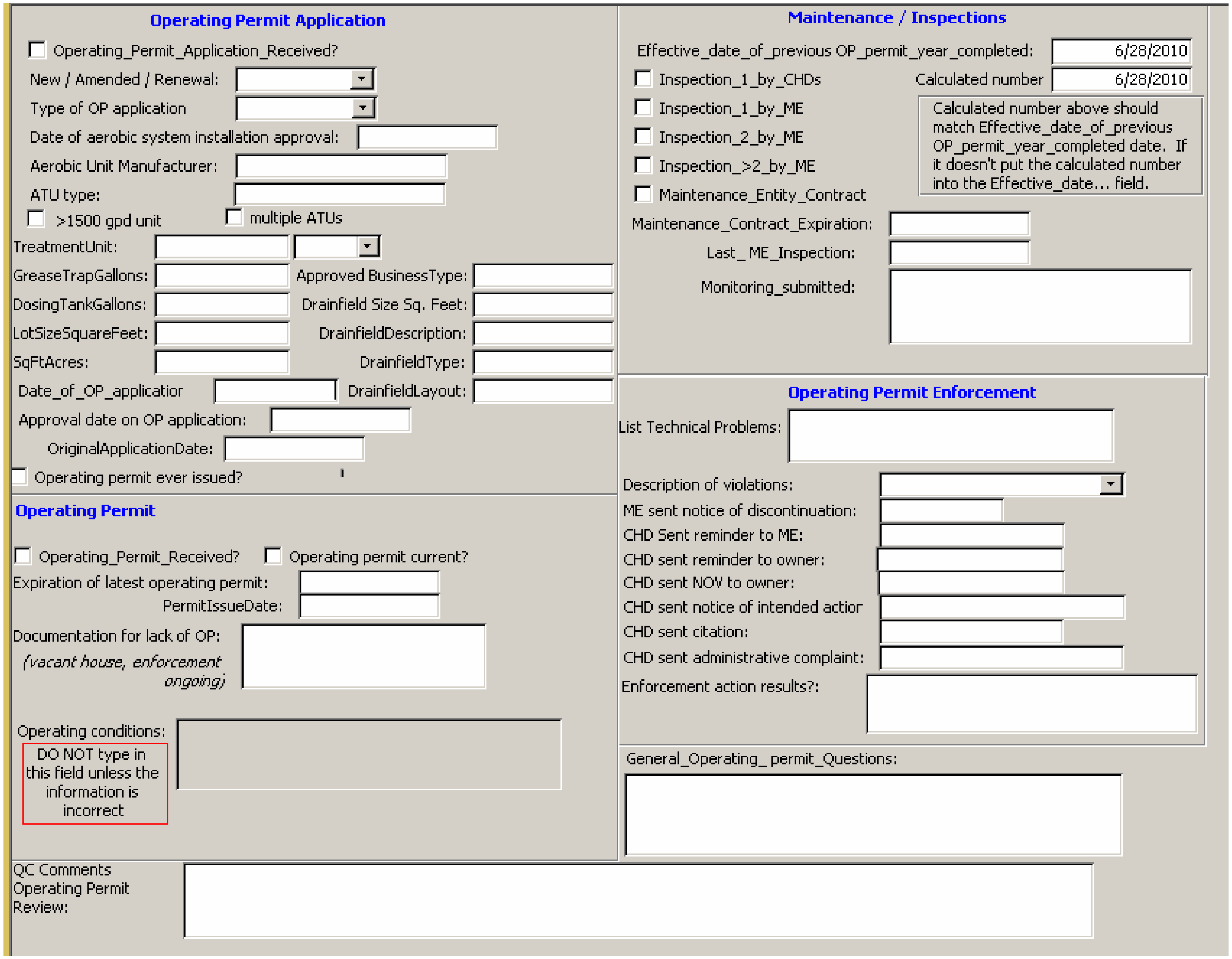


Figure 6. Screenshot of Step 2d Operating Permit Review Form

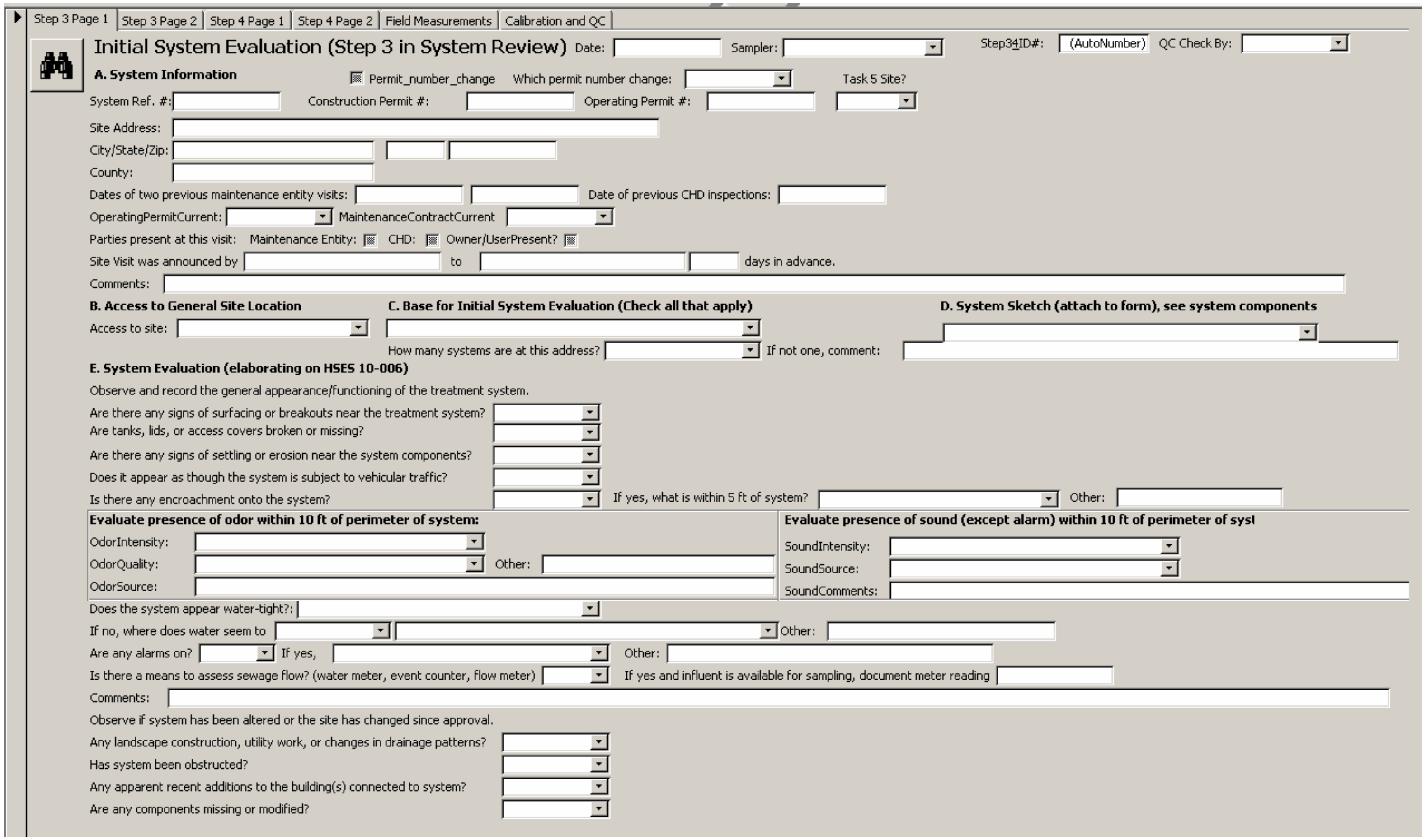


Figure 7. Screenshot of Step 3 & 4 Field Evaluation Data Entry Form Step 3 Page 1

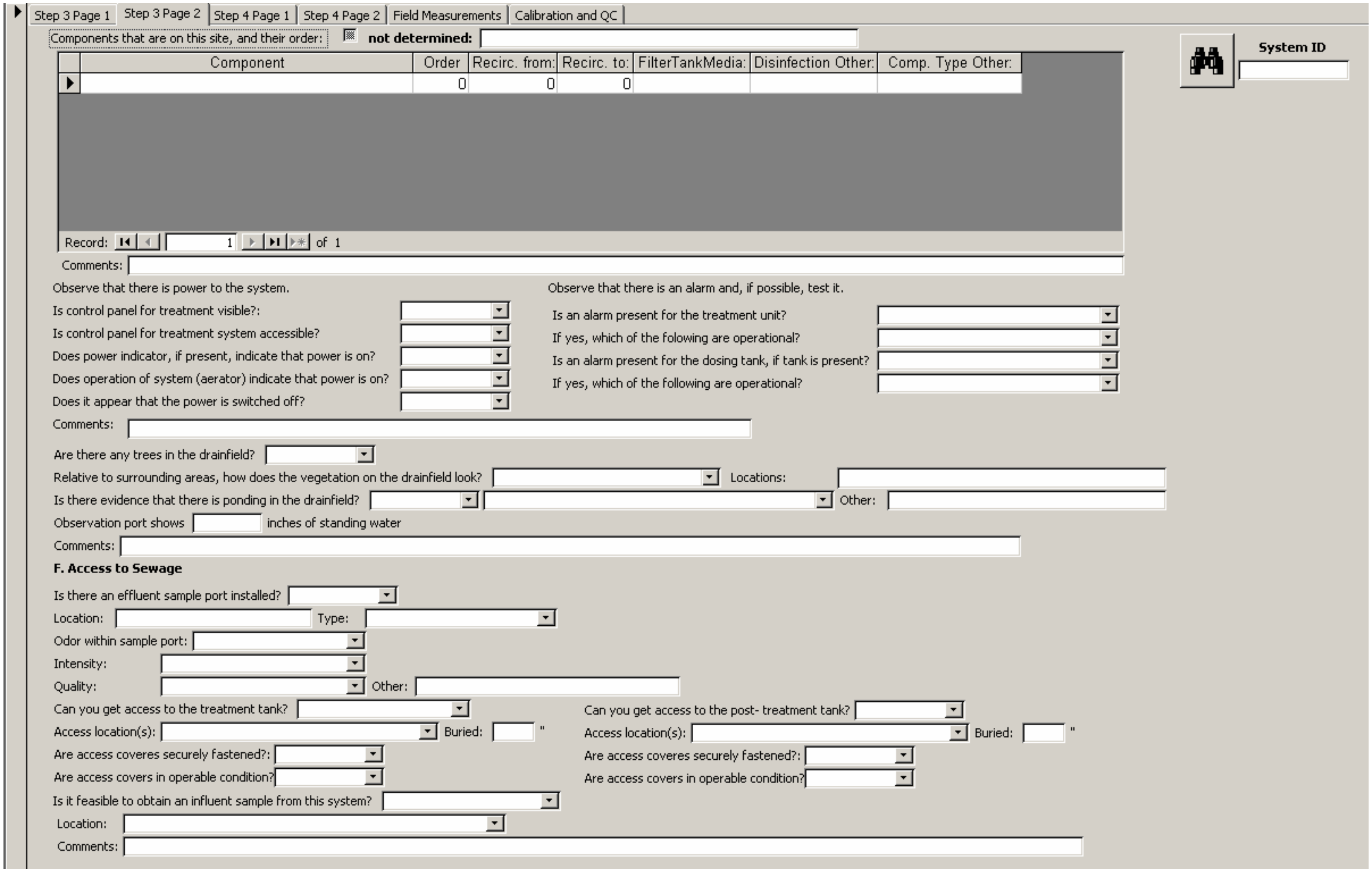


Figure 8. Screenshot of Step 3 & 4 Field Evaluation Data Entry Form Step 3 Page 2

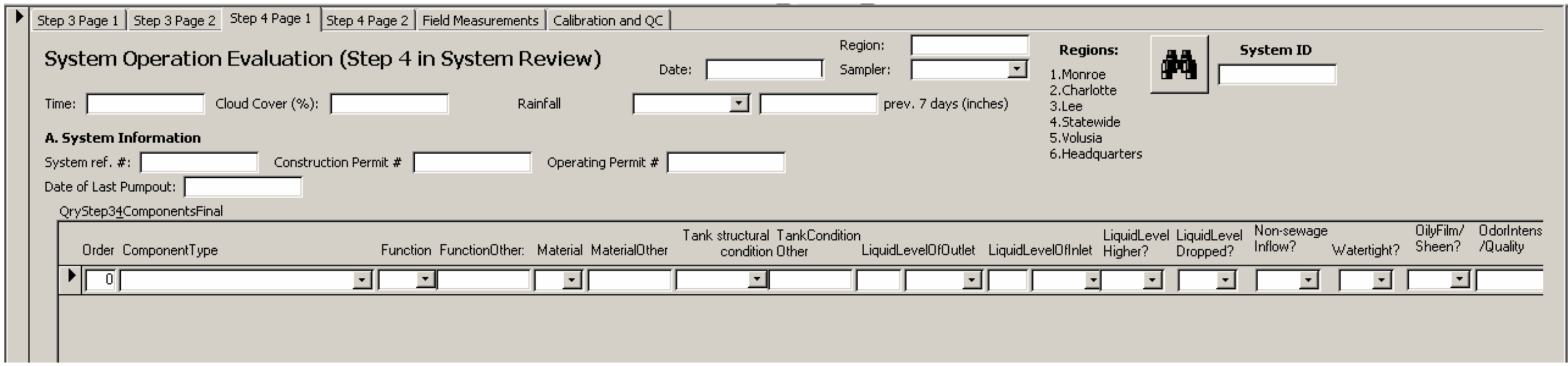


Figure 9. Screenshot of Step 3 & 4 Field Evaluation Data Entry Form Step 4 Page 1 Part 1

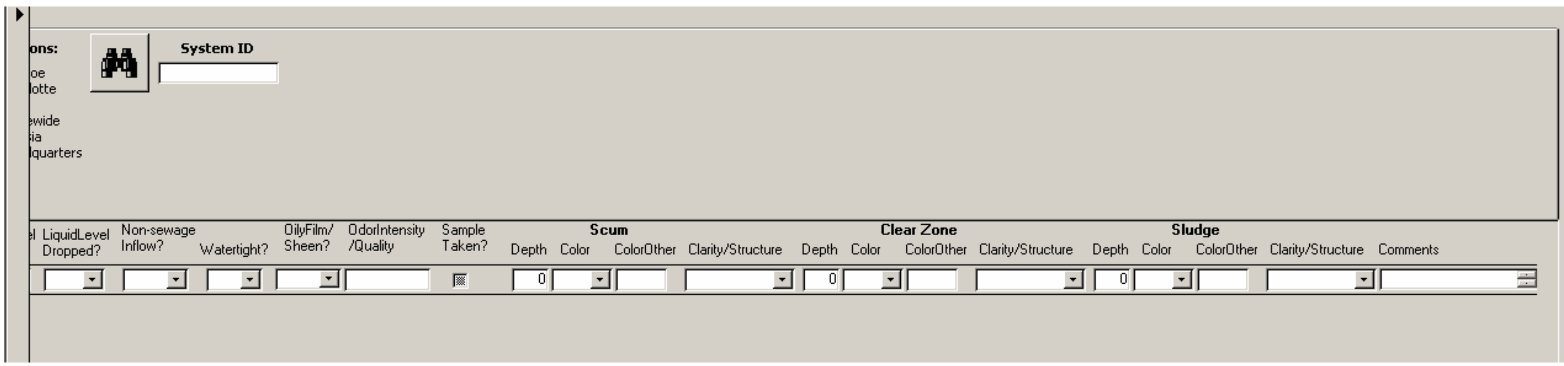


Figure 10. Screenshot of Step 3 & 4 Field Evaluation Data Entry Form Step 4 Page 1 Part 2

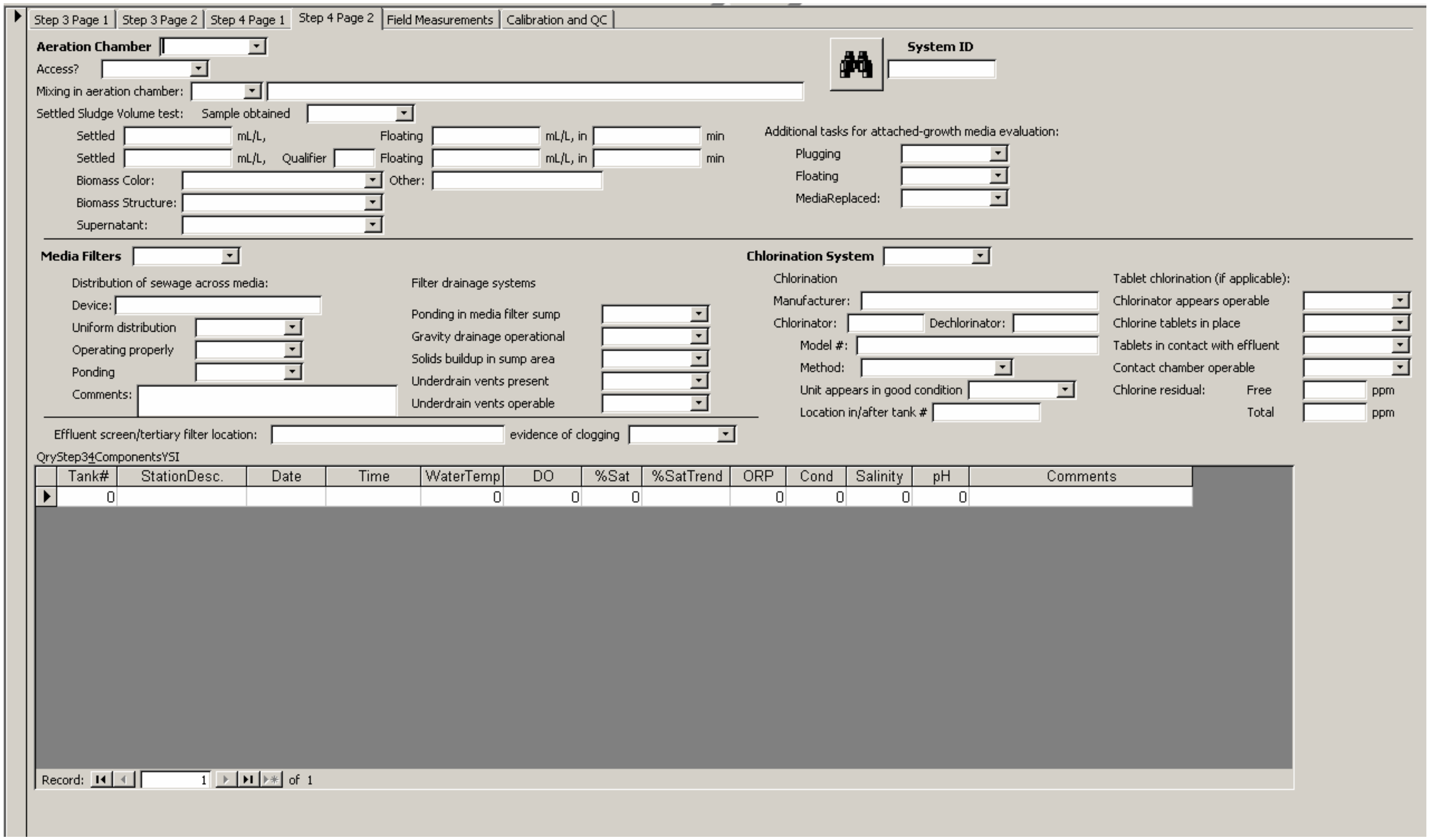


Figure 11. Screenshot of Step 3 & 4 Field Evaluation Data Entry Form Step 4 Page 2

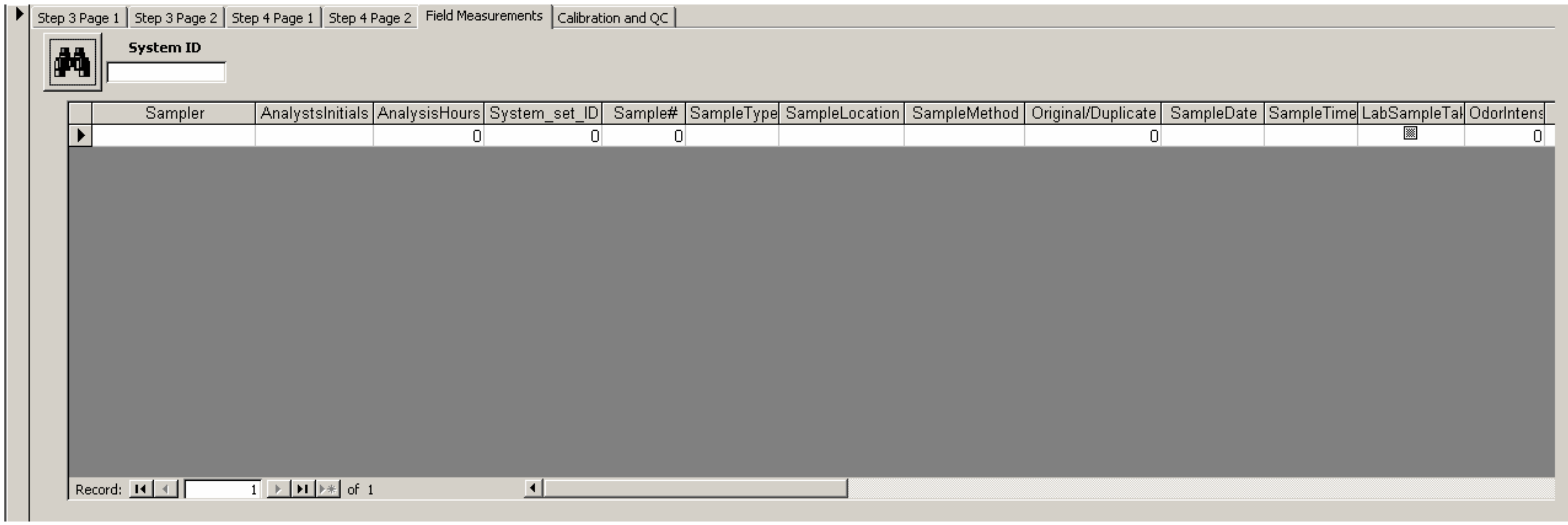


Figure 12. Screenshot of Step 3 & 4 Field Evaluation Data Entry Form Field Measurements Part 1

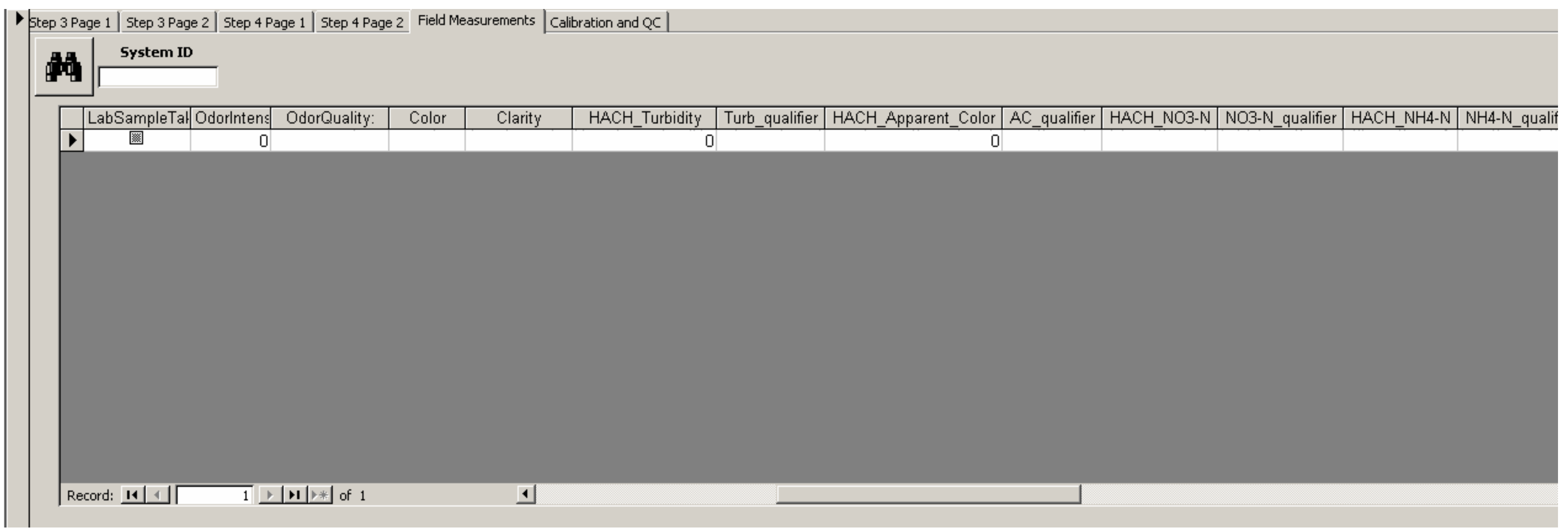


Figure 13. Screenshot of Step 3 & 4 Field Evaluation Data Entry Form Field Measurements Part 2

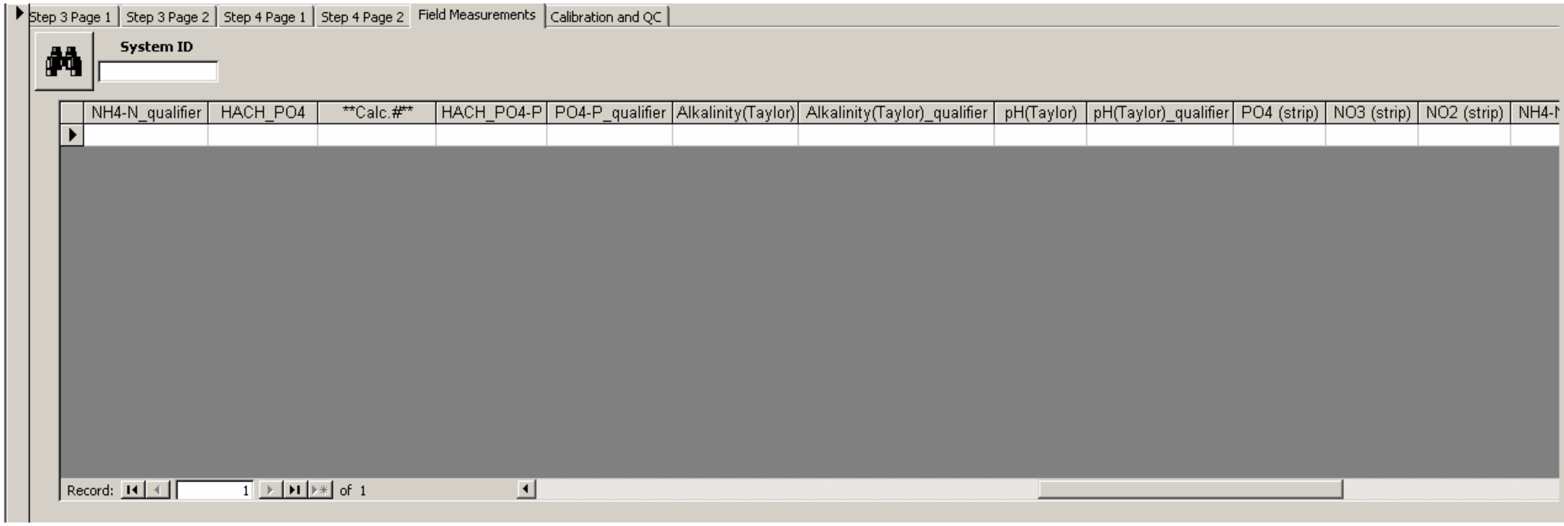


Figure 14. Screenshot of Step 3 & 4 Field Evaluation Data Entry Form Field Measurements Part 3

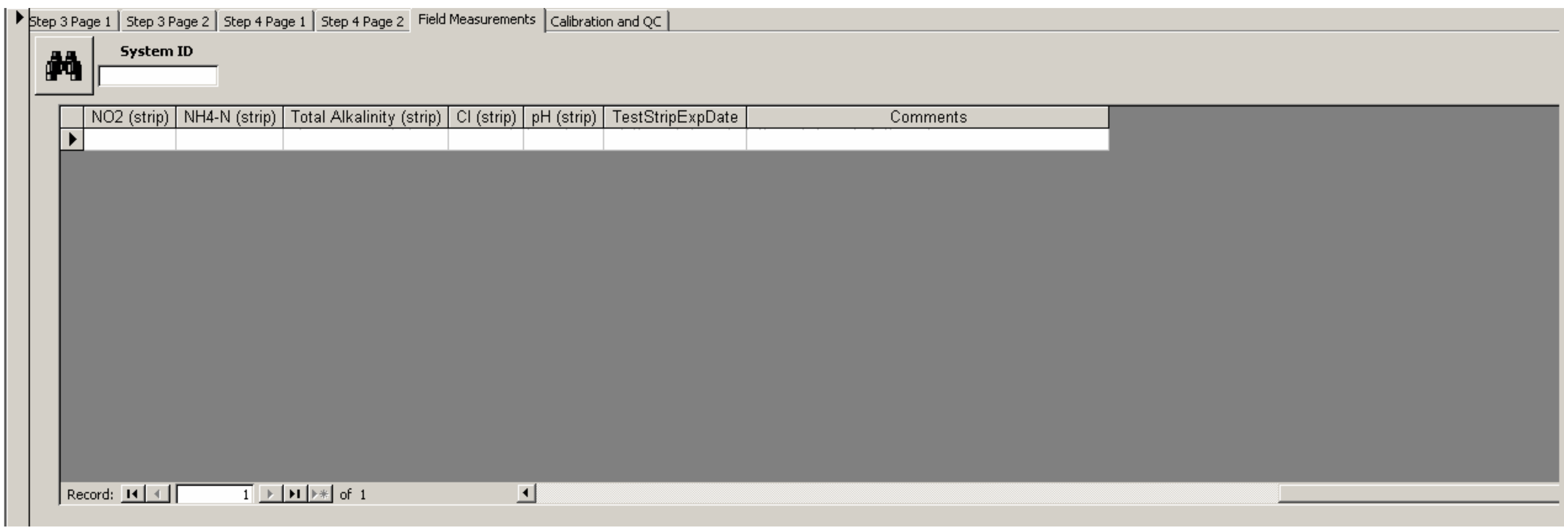


Figure 15. Screenshot of Step 3 & 4 Field Evaluation Data Entry Form Field Measurements Part 4

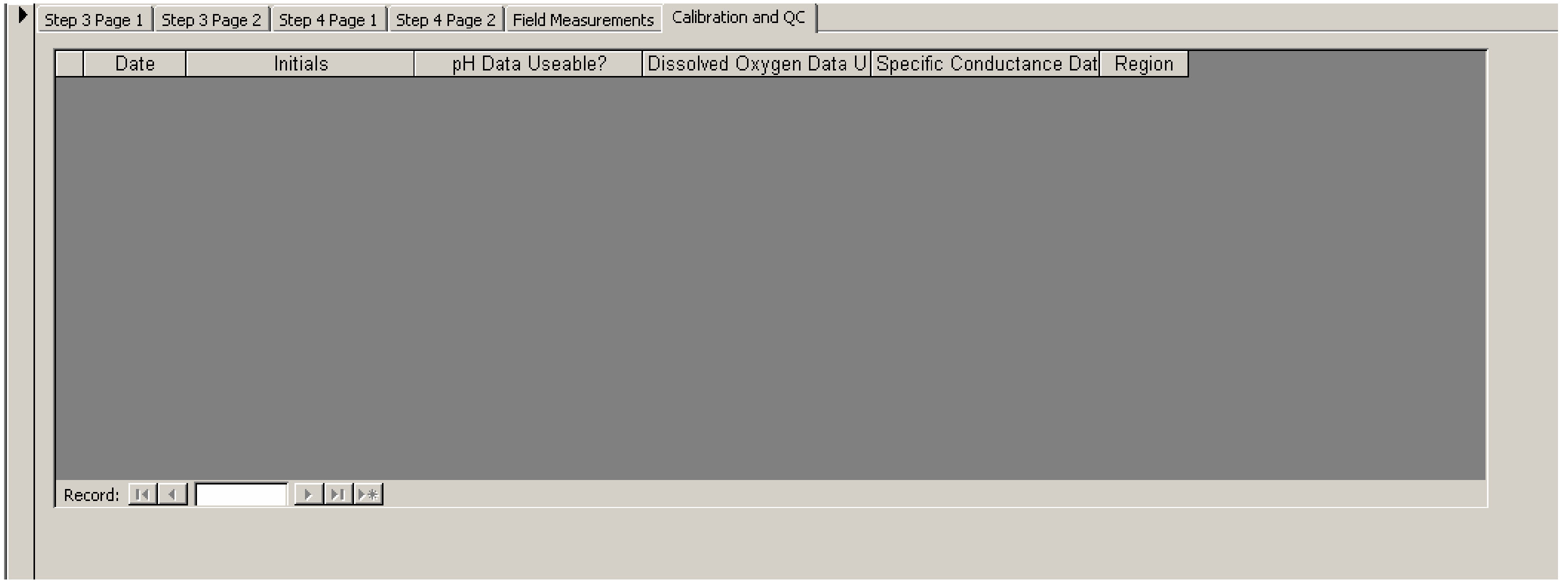


Figure 16. Screenshot of Step 3 & 4 Field Evaluation Data Entry Form Calibration and QC Results

Appendix C: Electronic Database