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ANALYSIS OF EXISTING COMMUNITY-SIZED DECENTRALIZED WASTEWATER TREATMENT SYSTEMS

by

Susan M. Parten, P.E.

Community Environmental Services, Inc. (CES)

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ABSTRACT AND BENEFITS

Abstract:

Only limited information has previously been compiled on the long-term performance of large-scale decentralized or community-sized wastewater collection and treatment/disposal systems for use by practitioners, planners, regulators, and decision makers. Factors contributing to the shortage of information vary by region and regulatory jurisdiction. Due to their age and condition, many of these systems may soon require upgrading or replacement to meet current requirements. Adding to the need to compile good quality performance data for large-scale decentralized systems is the perception that property developers frequently arrange for wastewater service that results in the least short-term investment rather than the lowest life-cycle costs. Such choices are likely based largely on the absence of readily available information that could help with that decision-making process. By contrast, centralized systems are often at least partially planned, funded, and managed by utilities that are ultimately accountable to rate-payers who provide an accompanying driver to minimize life-cycle costs. Far more operations and performance data has been compiled and made available to the public for larger centralized systems.

This nationwide study has gathered data/information for and examined the performance of large-scale decentralized and small community wastewater systems with flows ranging from 5,000 to 50,000 gallons per day with at least five years of operating history. The study covers systems handling domestic waste flows only (residential and commercial facilities) that have been designed and constructed in accordance with regulatory requirements and accepted industry practices applicable to the particular state or region. Systems relying either on soil/land disposition or direct discharge of effluent were included in those studied. The results of the project will better enable designers, regulators, and the industry as a whole to better assess and select decentralized systems used to serve certain types of facilities in various geographic settings.

Benefits:

- ♦ Provides performance data on large/community-scale decentralized wastewater systems in regions throughout the U.S., for which such data was not previously readily available, and enables designers, regulators, and industry practitioners to examine the performance of certain types of systems operating in specific geographic settings.
- ♦ References systems by types of facilities served, method(s) of treatment, and final effluent disposition, type of management entity, and other descriptive information as available.
- ♦ Provides capital and operating cost information for systems of varying types and sizes.

Keywords: Large decentralized wastewater systems; small community wastewater systems; performance analysis and evaluation; large-scale onsite wastewater systems.

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CHAPTER 1.0

INTRODUCTION

1.1 Background and Basis for Research

Approximately 23% of the estimated 115 million occupied homes in the United States are served by onsite and cluster wastewater systems (1999 U.S. Census Data). Decentralized wastewater management thus remains a reality for a large percentage of the U.S. population. Due to suburban and exurban/rural sprawl trends as well as the country's infrastructure funding challenges, decentralized wastewater systems will continue to be a part of sustainable water policy far into the future. The effective planning, design, installation, and maintenance of sustainable decentralized systems require comprehensive, reliable information on their long-term performance. With such information, decentralized wastewater management options can be fairly compared with centralized options, planners and local government officials can make more informed decisions, engineers and other consultants can have more confidence in expected performance, and end users can be more informed about how best to care for their systems and what to expect with regards to future maintenance demands and their associated costs.

Previously only limited information on the long-term performance of large-scale decentralized, or community sized wastewater collection and treatment/disposal systems had been compiled for use by practitioners, planners, and other decision makers. Factors contributing to the shortage of compiled information on these systems vary by region and regulatory jurisdiction. In many cases, the data exists in consultants' engineering files, operators' files, and in regulatory agency records. Valuable information also exists in the minds of the people that have been involved with these systems, including the aforementioned professionals, as well as stakeholders such as property owners and residents served by the system.

Long-term performance data is critical for a number of reasons. Performance that may have been considered adequate at the time of initial permitting and start-up may not be considered acceptable under today's water quality standards and goals. There is a need to base performance evaluation and reporting not only on permitting criteria and monitoring data set forth at the time the system was initially permitted, but also on current knowledge of environmental and public health impacts and evolving regulatory requirements. Due to their age and condition, many of these systems may soon require upgrading or replacement to meet current requirements. There is a need to base performance evaluation and reporting not only on permitting criteria and monitoring data set forth at the time the system was initially permitted, but also on current knowledge of environmental and public health impacts and evolving regulatory requirements.

Contributing to the need to compile good quality performance data for large-scale decentralized systems is the perception that property developers frequently arrange for wastewater service that results in the least short-term investment rather than the lowest life-cycle costs. By contrast, centralized systems are often at least partially planned, funded, and managed by utilities that are ultimately accountable to rate-payers, with an accompanying driver to minimize life cycle costs. The large-scale decentralized wastewater infrastructure selected for serving multi-family developments, for example, would likely be very different in many cases if long-term performance, reliability, and operation and maintenance costs weighed more heavily in the decision-making. It is often difficult to persuade developers to invest in infrastructure based on long-term costs and other considerations that tend to be more consumer-oriented because system ownership is usually transferred soon after construction.

It is therefore important to include in the evaluation of decentralized system performance some of the same measures used for centralized systems (such as long-term operational reliability, and long-term costs), while recognizing some of the key differences. Based on limited currently available data it can be argued that properly constructed and operating land/soil based treatment processes – when considering nutrient management, buffering capabilities of soils, and the biological treatment capabilities of many soil types - can in many cases yield significantly higher levels of overall treatment than is typically achieved or required for stream discharged effluent from centralized systems.

In order to fairly compare wastewater management options, it is essential to have adequate performance data of a quality that allows for a direct comparison among both centralized and decentralized alternatives. The performance of processes typically used for centralized treatment systems, such as activated sludge processes for secondary treatment is relatively well-established and costing is likewise fairly straightforward. These exercises are complicated when many types of decentralized systems are evaluated, due in part to the great variety of decentralized/onsite system design options that may be considered to meet site-specific needs. Cost comparisons should not only include those associated with treatment per gallon of wastewater, but should also consider the collection system used; that is, cost avoidance from shorter or lower maintenance sewer lines such as effluent collection systems. The potentially more complex maintenance and regulatory requirements inherent to a larger number of decentralized systems as compared with a smaller number of full-time staffed centralized systems must also be considered.

This study covers domestic large-scale decentralized and small community wastewater systems with flows ranging from 5,000 to 50,000 gallons per day, and with at least five years of operating history. The systems for which data has been gathered and evaluated are considered representative of the universe of systems in use and, as such include a range of collection system types, treatment processes, final effluent disposition methods, and management frameworks. Systems relying either on soil/land disposition or direct discharge of effluent have been included in those studied, due to the importance of both categories of systems to overall industry issues and considerations relative to wastewater planning. The project results are intended to provide valuable information to facilitate more informed decisions by policy-makers and regulators for wastewater systems policy and planning. The performance data and evaluations will support the development and implementation of improved planning and design practices and provide a better basis for cost comparisons of wastewater service options.

1.2 Project Organization

The project has been conducted in two overall phases: 1) Phase 1 involved the identification of systems meeting the study criteria, organizing that information by system type and geographical region, and selecting a representative number of systems for detailed study; 2)

In Phase 2 of the study, detailed information and performance data was gathered, organized and compiled into databases and evaluated for each system studied.

The major task areas performed for Phases 1 and 2 of the project are described below.

Phase 1: Data Identification, and Collection and Evaluation Strategy Development

1. Communications with regulatory authorities throughout the U.S. and literature searches/reviews were conducted to identify potential sources of data and information for systems relevant to the study.
2. Private sector entities such as utilities, engineers and operators were contacted to inquire about the availability of systems performance data and other information.
3. Systems were identified in each major U.S. region for systems meeting the wastewater flow and age criteria in the study, as that information was found to be available.
4. The types and level of detail for data found to be available for systems were determined.
5. In states/regions where effluent quality data was found to only be available through physical reviews of regulatory files, a representative number of systems were identified for which detailed data gathering would be attempted.

Phase 2: Data Gathering, Analysis and Reporting

1. Based on the availability of data identified in Phase 1, team members obtained and organized performance data from those sources.
2. Data was compiled into either Excel spreadsheet databases for subsequent analyses, or Word documents summarizing various types of reported information.
3. Telephone discussions were conducted with system owners, operators, and regulatory agencies regarding systems performance and observations relevant to the study.
4. The factors to be used in evaluating system performance were determined based on the level/extent of information that could typically be obtained for most systems.
5. Statistical data summaries were compiled for each system for which effluent quality data was obtained. Graphical representations of those summaries were then developed.
6. In addition to this report on the research findings, a pamphlet summarizing key findings was prepared targeting audiences such as state and local planners and regulators, engineers, system owners, community leaders and the interested public.

Phase 1 of the study continued for approximately one year, with some Phase 2 activities beginning during the first year while some Phase 1 systems identification work was still underway.

CHAPTER 2.0

RESEARCH APPROACH

2.1 Identification of Data Sources by Category

It was recognized very early in the project that there are various ways of defining "decentralized" wastewater systems. It was therefore necessary for the project team and Project Subcommittee to discuss and agree upon a definition that would offer the most valuable final results for the study.

It was determined that only domestic wastewater systems serving either residential or commercial facilities with flows in the applicable range would be included, and that systems treating industrial waste streams would be excluded from this study. Systems were also to have been in service at least approximately five years to be included in the study, so that there would have been ample start-up time and sufficient period of service to allow operational trends to emerge.

While decentralized wastewater systems are likely most often considered those relying on some method of land/soil dispersal (surface or subsurface), there are clearly many small community and commercial systems generating flows between 5,000 and 50,000 gallons per day that rely on direct discharge of treated effluent to surface waters. In recognition of the importance of both categories of systems to overall industry issues and considerations relative to wastewater planning and cost-effectiveness comparisons with centralized options and between decentralized approaches, systems relying on either land dispersal or direct discharge were included in the study.

In identifying potential sources of effluent quality data for systems, varying levels of confidence were recognized as tending to correlate with data generated by and available from different sources. The following general categories were identified as possible sources of performance data/information for systems:

- Formally validated data (independently verified for quality assurance);
- Regulatory compliance data;
- Routine monitoring data (for operational controls and tracking, and beyond that required for regulatory compliance);
- Peer-reviewed forum presentation data;
- Technical forum (not peer reviewed) presentation data; and
- Demonstration system operational data.

The levels of confidence associated with the quality of data generated from the above situations tend to run from highest to lowest as one proceeds down the list. There are realistically very few systems for which the first set of conditions would apply. Most available data for systems in the applicable size range was seen as likely being associated with regulatory compliance reporting. In that it is perceived as also having a higher confidence level than other potential sources, regulatory sources were targeted for most of the data-gathering efforts. Other sources of data with perhaps lower levels of confidence were perceived as important to pursue, but with an understanding that there would be additional considerations in the use of that data.

One of the reasons that data obtained from regulatory sources was considered to be the most valuable to the study is that such bodies of data would pertain to systems having wide ranges of design, construction and operation approaches and qualities. It was the intent of the study to evaluate the performance of systems designed and permitted in accordance with applicable requirements, but to not specifically focus attention on those having either lesser or better performance. In that way, on average, it was hoped that the resulting evaluation would more effectively lead to recommendations for improving system performance where needed, and to offer the basis for more "state-of-the-industry" comparisons between wastewater service options. Systems identified randomly from regulatory lists would hopefully eliminate any data-skewing that might occur with approaches that might use more preferential systems selections.

Case studies and demonstration projects offer a good opportunity for research and to educate the public about certain types of systems, although such systems are often not typical in terms of either the attention given to their design, construction and ongoing care, or the type of system. There are usually definite reasons for selecting certain systems for demonstration. Such projects do however offer good opportunities for benchmarking the performance of systems, and so are considered important to this study in that respect.

2.2 Identification of Systems for Obtaining Regulatory Compliance Data

Each state in the U.S. tends to vary at least somewhat from others in the manner by which systems are categorized for the purposes of permitting and assuring regulatory compliance. States also vary considerably in the ways in which tracking of compliance occurs. The complexity and variations increase greatly when considering both land/soil dispersal systems and "discharge" systems.

Not only do many states define "discharge" differently as related to permitting through the National Pollution Discharge Elimination System (NPDES) at the state level, states use different flow "breakpoints" and other criteria for determining whether systems are permitted at the state or county/local level, their monitoring requirements, and a variety of other compliance measures. To determine who best to contact for identifying systems and data applicable to the study, it was first necessary to determine which regulatory/permitting authorities would have jurisdiction over systems in the applicable size range, for both soil dispersal and direct discharge categories of final effluent disposition.

In order to include as many systems (and accompanying data) as possible in the applicable size and age range, it was determined that all states in the U.S. would be contacted to explore the types of information available from each state and where that information could be found. In an effort to make this process more efficient, a variety of industry resources were consulted to identify appropriate contact information for each state for different categories of systems of interest. Those resources included various products from the National Small Flows Clearinghouse and a report by the U.S. EPA's UIC Program for Class V injection wells (*The Class V Underground Injection Control Study, Volume 5, Large-Capacity Septic Systems*). Although an NSFC draft work product proved to be the most helpful in identifying appropriate contact entities and persons overseeing certain categories of systems of interest to the study, a significant number of further inquiries were needed to develop accurate and complete contact information.

The types of information sought from regulatory oversight authorities for systems included:

- Permitted and/or design flow;
- Date the system went into service;
- Type of facilities served (e.g., church, youth/recreational camp, subdivision/homes, grocery store, etc.)
- Geographic location
- Method(s) of treatment used
- Method of collection
- Method of final effluent disposition (discharge, surface application, or some method of subsurface dispersal)
- Owner information
- Type of operation/management (public versus private)
- Performance/effluent quality requirements ("limits")
- Location, form and availability of monitoring data.

Permitting authorities from each U.S. state were contacted by telephone and/or email to identify systems and potentially available sources of information relevant to the study. States were found to vary greatly in their approaches to record-keeping, with most states not maintaining up to date electronic databases for domestic wastewater systems in the applicable size range for this study. States also differ greatly in their systems' reporting requirements, with some states requiring no reporting of monitored parameters for large scale decentralized wastewater systems using land/soil dispersal.

Very few states were found to maintain electronic databanks containing most of the above information. For example, in cases where databases might indicate the method of treatment used, the collection method was usually not reported. Even where treatment methods were generally indicated, electronic databases rarely contained sufficient detail to clearly profile the various unit processes where multiple ones were used. For some states requiring NPDES permitting for systems using surface application of treated effluent and for which databases of systems were found to exist, it was often not reported in the database whether the system land applied effluent or relied on direct discharge. A few states contacted were in the process of developing databases that would provide certain items of information listed above, but were not available at the time. For some states, it was simply not clear whether databanks of interest might exist, or whether contact had just not been made with the correct person to inform team members about its availability and content. For land/soil dispersal systems in the size range of interest, a number of states rely on county/local permitting for those systems and do not maintain significant records for them.

As it became clear that the type and availability of data/information relevant to the study was likely only going to be found in a limited number of states around the country, several major U.S. geographic regions were identified from which to attempt to gather a representative amount of data/information for systems. Those regions consist of:

- New England States
- Mid-Atlantic States
- Southeastern States
- South-Southwestern States
- Midwest and Upper Midwestern States
- Central and Western Mountain States
- West Coast States

Figure 2-1 shows the states included in each of the above regions. In cases where available information has not been identified from at least one state in a region, further steps were taken to do so. At the conclusion of this Phase 1 task, systems data/information was identified that was targeted for gathering from at least one state in each of the seven major regions.

Figure 2-2 shows the levels of information that were identified as being available from states across the U.S. Green states are those for which at least a certain amount of systems performance data (effluent quality/monitoring data) was determined to be available. Through sometimes extensive communications with regulatory/permitting staff, lists of systems were compiled having the applicable design/permitted flow and years of service that would qualify each for inclusion in the study. Since in many cases there were no electronic databases containing sufficient information about permitted systems to sort and select systems of interest, for some regions it was necessary to rely on regulators to compile lists of systems that they knew to be applicable to the study. Lists of systems were compiled that appeared, based on the information available about those systems, to be a representative cross-section of system types in the state/region.

In several states, team members were informed that systems information would only be available in paper format and located in state or county/local files. A strategy was then developed for the Phase 2 data gathering efforts, including assigning team members to obtain information from certain states based on their geographic proximity and familiarity with the regulatory staff and permitting procedures in those states.

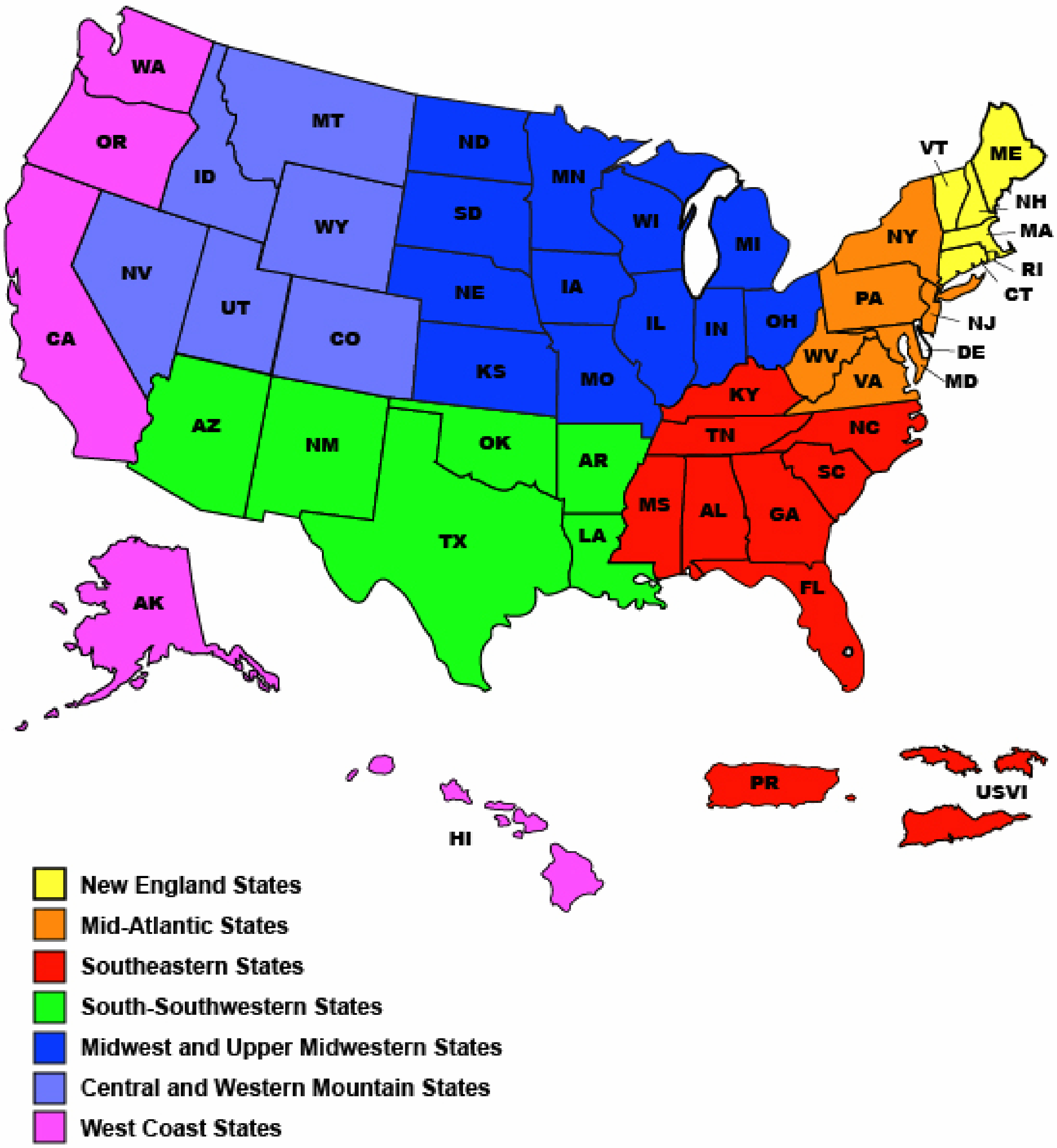


Figure 2-1. Seven Major Geographic Regions for Data Gathering.

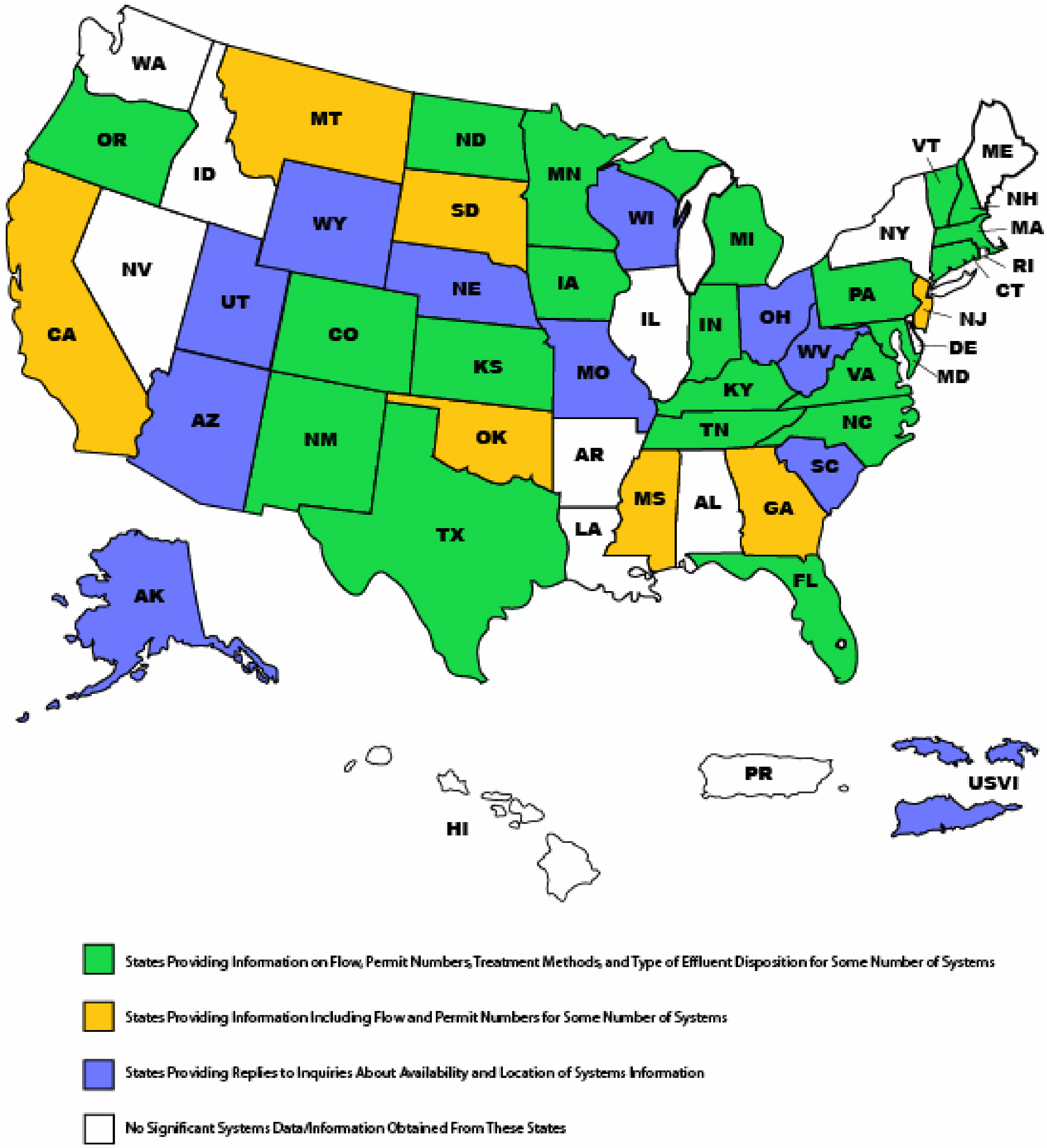


Figure 2-2. Level of Systems Data/Information Provided by State.

2.3 Systems Data Gathering Process

Phase 2 of the study commenced with the data gathering process in states across the U.S. for which sources of data/information had been identified in Phase 1. The steps taken for obtaining information for systems in each state tended to vary based upon the format and location of that data. Where effluent quality/monitoring data was found to be available in electronic format, the electronic data files were requested. In other states it was necessary for project team members to go in person to state offices where systems files were maintained, and arrange for records of interest to be copied. It was necessary in some cases for open records requests to be made in advance of these visits, and scheduled at times when staff could be present for the file searches. In some states, project team members were informed that data existed only in field offices located around the state, and the logistics of attempting to obtain that data exceeded the resources available to this study. The single biggest challenge for this study throughout the U.S. was the identification of representative sets of systems that were applicable to the study. Very few databases appear to exist nationwide which provide significant amounts of information on permitted systems in this size range, and that can be sorted and searched using criteria such as flows and method of treatment.

Along with systems monitoring data, capital and operating cost data was also sought for systems. Since regulatory files rarely contained this type of information, after obtaining contact information for systems of interest to the study, team members began contacting systems owners, designers and operators to inquire if this information was or could be made available. This effort proved to be very time consuming and often frustrating, in that it appeared that most private sector owners were disinclined to share this type of information. Obtaining systems cost data from public entities also proved very difficult, and in most cases essentially impossible due to the time and logistics needed to obtain such information. Many small communities were found to be too understaffed to be able to respond to such inquiries. In other cases, the administrative procedures and series of approvals required for sharing that information were found to make the process infeasible.

As a part of the information gathering processes, a number of telephone discussions were conducted with key regulatory staff in states across the U.S., and with some private entities involved with systems implementation and management. Because important observations and insights about systems performance may only reside in the minds of persons having long-term experience with the oversight of those systems and not found in regulatory files/records, these discussions were thought to be an important means of gathering valuable information on systems performance around the country.

2.4 Challenges and Obstacles with Data Gathering Process

While it would be impossible to fully describe the many challenges encountered with gathering detailed and meaningful data associated with large/community-scale decentralized wastewater systems during this study, some examples may be helpful for emphasizing some key issues surrounding these systems.

In contrast to many larger centralized wastewater systems, decentralized wastewater systems with flows up to 50,000 gallons per day are in a size range for which economies of scale don't typically afford the support and management staffing that accompanies most centralized systems. Very few systems for which information was obtained for this study had full-time operators, for example. For cluster or community systems of this size range, there are not enough users of the system billed at reasonable monthly rates to pay for many of the services better afforded for systems with many users, such as detailed system performance tracking and public information dissemination. Many of the small communities served by decentralized wastewater systems are also in rural areas with lower average incomes and overall economies, where it's all the more important to maintain low monthly user charges for systems.

These sorts of realities were encountered on a daily basis during the data gathering process. Other examples of the types of situations routinely encountered included:

- Most state regulatory staff around the U.S. responsible for reviewing and processing systems permit applications and follow-up compliance activities seemed to have little time available for developing and maintaining detailed systems databases.
- Converting files currently in paper format to electronic databases appeared often to be an overwhelming task for regulatory/permitting offices. In most cases, critical systems details and data are located in paper files located in county offices throughout the state, or in a state's district or regional offices.
- Most state and county/local permitting offices are reluctant to have persons not employed by those authorities going through files in their offices. Without knowing in advance what is included in permitting files, it is difficult to request specific information related to evaluating a system's performance from those files. Permitting staff were informed of the types of information team members were seeking, but for them to go through files and locate that information would have been well beyond their time limitations in most cases.
- For small communities operating these systems, city personnel often work part-time, and a town's office may only be open a few days each month. These persons usually have too much to deal with during these short operating hours to respond to inquiries about such things as power usage or sludge hauling costs associated with their wastewater system.
- These decentralized systems were most often managed by private operators even if publicly owned (with the exception of a few public entities which tended to operate their own systems). The private operators that could be reached to discuss systems were usually responsible for multiple systems often located at considerable distances apart. As a result, they seemed to have very little available time for detailed outside discussions about any given system.
- Owners of private systems often seemed reluctant to provide information or approve discussions about the details of their systems.
- The time, logistics and other factors associated with processing most public records requests needed to gain access to most information associated with publicly owned and operated systems well-exceeded the limitations of this study.

Despite these types of challenges, considerable generosity of time and energy from both public and private sector staff and industry practitioners contributed to some amount of data being compiled for several hundred systems located throughout the U.S. The following chapters describe that body of information and the analyses that were done to assess the performance of systems.

CHAPTER 3.0

DATA ACQUISITION RESULTS

3.1 Systems Monitoring Data

As discussed in the previous section, monitoring data was obtained from states in each of the seven major U.S. regions from either physical permitting file reviews, or in electronic databases provided from regulatory or private sector sources. Private sources maintaining electronic databases of compliance monitoring reports in a few cases provided such information in response to requests by team members. In those very few cases, the compliance monitoring data provided had been submitted to applicable county or state authorities, and was verifiable in those county or state program files. Most of the available monitoring data for systems was for final treated effluent, with some influent data reported for certain parameters such as biochemical oxygen demand (BOD) and total suspended solids (TSS). At least some amount of effluent quality data was obtained for a total of 341 systems nationwide, including both subsurface dispersal and surface discharging systems.

A minimum of three years of monitoring data (most recent period) were typically requested from regulatory authorities, unless it appeared this would exceed the capabilities of the office. As effluent quality data was obtained for systems it was organized into Excel spreadsheets to enable subsequent sorting and analysis. Where influent quality data was provided, that was also entered in the spreadsheets. In addition to reported quality parameters (e.g., BOD, TSS, forms of nitrogen, fecal coliform, etc.), fields were included in the spreadsheets for the following:

- Descriptions of treatment process(es) and method of final effluent disposition;
- Year the system went into service (included in the field describing the system);
- Type(s) of facilities served;
- Whether the system was managed by a public or private entity; and
- Permitted flow

These were considered important factors for subsequent systems performance evaluations to be done as a part of the study.

Some states for which data was obtained require monitoring of groundwater for systems using some method of subsurface effluent dispersal. Primarily nitrogen (typically nitrate and/or total nitrogen) was tracked for those systems, with results above a specific limit for the system triggering notice by the applicable compliance authority. Overall however, the ground water monitoring data and descriptive information found to be available for systems in regulatory files that might enable developing meaningful assessments of ground water quality impacts from subsurface dispersal systems was quite limited.

The map shown on Figure 3-1 shows the states from which effluent quality monitoring data was obtained for some number of systems. The number of systems for which effluent data was obtained is shown for each state. In some states, only information for surface discharging systems was found to be available in electronic file format (e.g. VA and KY), while in others, only data from systems using subsurface dispersal of effluent was obtained (e.g., MA). In cases where electronic databases of effluent quality data were found to be available, only a limited amount of descriptive data about the systems' unit processes and configurations was typically available in those databases. Where physical file reviews were needed, team members attempted to obtain as much descriptive information about the systems as possible, including sizing and types of unit processes, permitting history, design basis, and cost information.

Some amount of monitoring data was obtained for systems in 13 states, with one or more of those states being located in each of the seven major U.S. geographical regions shown on Figure 2-1. Below are descriptions of the information obtained from each of those states in alphabetical order. Because the intention of this study is to evaluate the performance of systems on a regional and nationwide basis so as to identify meaningful trends that may inform the industry, and is not intended to focus on the performance of specific systems, certain identifying information for systems has not been included in the summary spreadsheets and other data/information. Permit numbers, names of facilities served, and specific locations have not been included in the datasets, with systems' locations provided only by county in the particular state.

It should be noted that changes in regulatory authority and practices are currently in the process of changing for most of the state programs below from which compliance data was obtained. The U.S. EPA's Class V Underground Injection Control (UIC) Program has become increasingly involved in the permitting and regulatory oversight associated with large scale subsurface effluent dispersal systems. Many state regulatory programs are currently making adjustments to meet the requirements of UIC programs across the country, as well as watershed-based protection initiatives and other water quality control programs. The information provided below for various state programs in the U.S. is based on information provided to team members during Phase 1 of this study.

3.1.1 Colorado

In Colorado, systems with flows greater than 2,000 gallons per day are subject to both state and local permitting. The Water Quality Control Division of the Colorado Department of Health and Environment is responsible for the state's permitting of those systems. Communications with regulatory staff in that Division revealed the existence of an in-house database of existing or proposed wastewater systems for which permit applications had been submitted. This database was obtained and reviewed by CES to identify candidate systems for which to request data/information from the state. Approximately 80 systems of varying types, sizes and serving different types of facilities were identified as being of interest to the study. After reviewing the list, state regulatory staff explained that most of the types of information sought by the project team for those systems would be located in county files, with hard copies of certain information contained in state files located in Denver. Based on the limited information available about those systems in the permit applications database, it was not possible to determine with certainty such things as whether the system was ever constructed, or when it went into service. Again, much of that information would be located in county files.

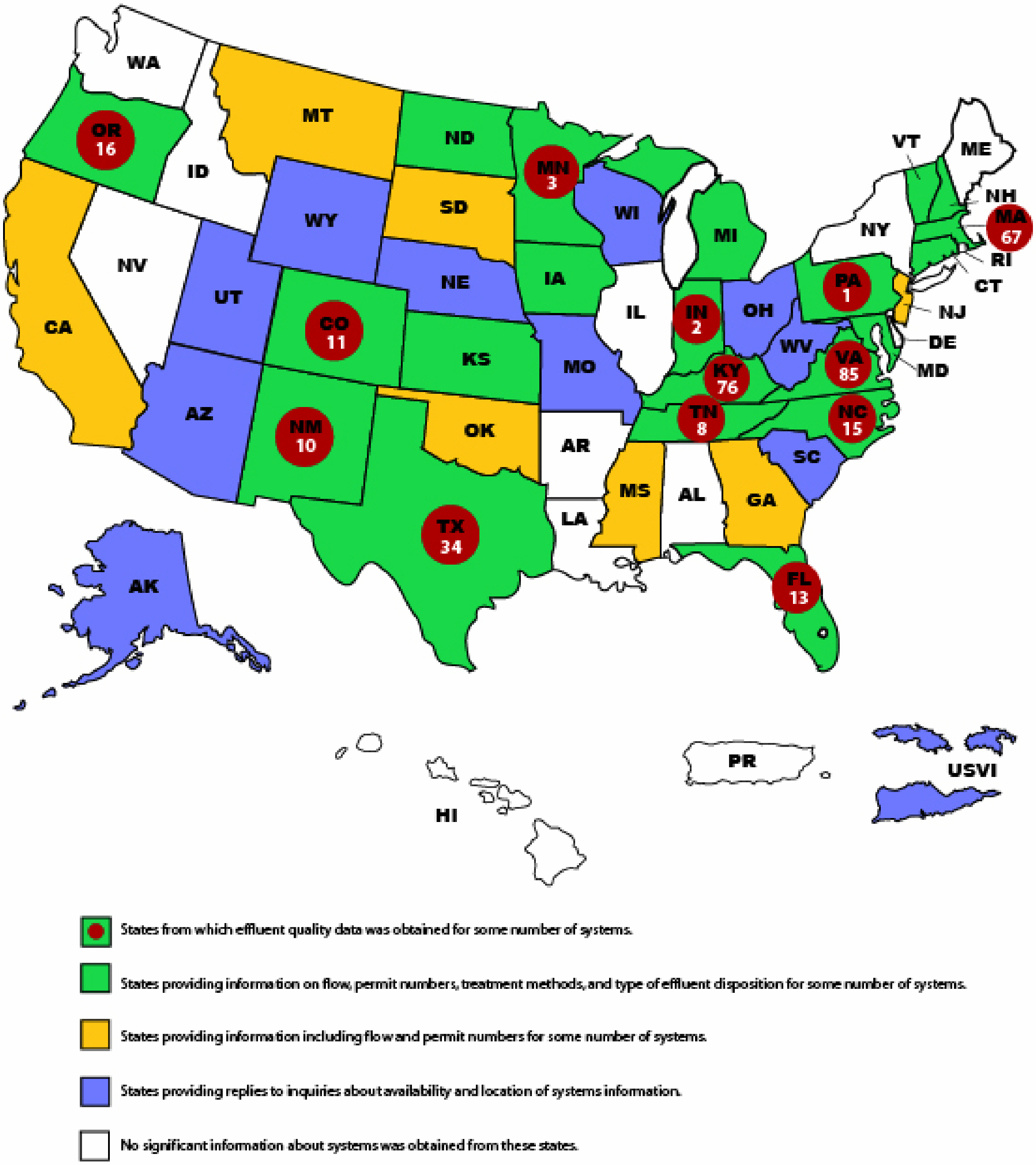


Figure 3-1. Level of Systems Data/Information Obtained by State.

An inquiry was then made about the possibility of state staff compiling a sub-list of systems (from the larger list of systems) they knew to be in service for at least several years, and which were of varying types and sizes, from the list of 80 systems. Staff agreed to do this, and subsequently provided that information to CES along with instructions for submitting a written request for a public records review. Upon receipt of authorization and instructions on conducting the state files review, this was performed by a project team member at the state's Denver offices.

All of these records were stored in paper format, and it was necessary to review each file to determine its contents, and select records of interest to have copied. The results of the file review yielded performance data and significant systems information of interest for only five of the systems for which a review of the files had been requested. Insufficient data/information was located in the state files for the other systems, or they were found to have only been in service for a short period of time, or had not been constructed.

Based on the limited number of systems for which data was obtained from the state files, follow-up efforts were then made to locate systems information from private sector sources. Those efforts produced contacts and systems information for another six systems, making a total of eleven systems of varying types and sizes for which at least a certain amount of data of interest was obtained.

Appendix 1.A shows the approximate locations of those eleven Colorado systems along with a listing of the system types and other basic information about those systems. Appendix 1.B. of this report provides the effluent quality data obtained for these Colorado systems.

3.1.2 Florida

In Florida, residential decentralized wastewater systems with flows greater than 10,000 gallons per day, and commercial systems with flows over 5,000 gallons per day are permitted at the state level (Department of Environmental Protection). CES obtained a list of the state's permitted wastewater systems from a Florida engineer. That list was stored in an electronic (Excel) database that could be sorted and searched to locate systems of the type and size applicable to this study. From that database, information was requested from DEP staff on a representative number of systems of varying types and sizes. CES was informed that systems information would be found at one of several district offices around the state. Inquiries were then sent to those district offices.

Information concerning NPDES discharge permits and their reported quantity and quality of effluent discharged is available through the U.S. EPA website/PCS database. Using the Excel database of systems obtained for Florida systems, the EPA's PCS database was searched to locate monitoring data for systems applicable to the study. Based on the contents of the systems (Excel) database, most systems in Florida having design/permitted flows in the range covered under this study appear to use some form of activated sludge treatment.

Monitoring data was ultimately obtained for a total of 13 Florida systems, including several systems overseen by one of the Florida district offices, and several systems included in the U.S. EPA's self-reporting database. Permitting documents and compliance monitoring data were provided by the Florida district office in electronic format for a total of four systems that were eligible for inclusion in the study, based on flows and years in service. Although an effort was made to obtain monitoring data for a variety of system types, compliance monitoring data was only obtained for systems relying on activated sludge processes for the principle method of secondary or advanced treatment. All but three of the thirteen systems use direct discharge (to surface waters) of treated effluent. All of the compliance monitoring data obtained for systems was compiled into a single Excel spreadsheet for subsequent review and analyses.

Appendix 2.A shows the approximate locations of systems in Florida for which effluent quality data was obtained, and their general descriptions. The effluent quality data obtained for those systems is provided in Appendix 2.B.

3.1.3 Indiana

During Phase 1 of the project, CES contacted the Indiana Department of Health to inquire about community/cluster or large scale individual decentralized wastewater systems of the size and age that would qualify for inclusion in the study. We were referred to the Indiana Department of Health, and in particular the Indiana Health Department's Plan Review Section for subdivisions and cluster systems. CES was provided the following information about cluster systems in Indiana:

"There are a total of 51 approved cluster systems, including both residential and commercial clustering, with one application pending. This includes a total of two gravity trench systems, four flood-dosed trench systems, nine pressure distribution trench systems, 25 elevated sand mounds, and 10 subsurface drip absorption field types. [Those numbers total 50, and it is not known what type of dispersal method is used by the 51st system.] Secondary treatment, either by subsurface constructed wetland (with or without recirculation) or recirculating media filter(s), is required for all subsurface drip absorption fields or for a downsizing factor of either 50 or 33% from the normal square footage in a trench or mound system for the absorption field. Each home or business has its own septic tank for the initial primary treatment of the generated wastewater."

A list of as many of these systems as possible was obtained, including the method of treatment used by each, to determine which would be applicable to this study. An Indiana Dept. of Health (IDH) Plan Review engineer described 15 of the cluster systems to CES through a series of telephone and email discussions. CES was informed that to date very little monitoring data has been required of and reported for these systems, with any amount of effluent quality data only available from the state for two of the systems. Paper copies of monitoring reports were obtained from the IDH office, and compiled into a single Excel spreadsheet.

CES was informed by IDH that a study on cluster systems had been done by a non-profit company in the state, and was referred to the results of that work for further information about Indiana cluster systems. The Indiana Capacity Center for Management of Onsite/Decentralized Systems, Inc. (ICCMODS) had previously researched and reported on community wastewater systems that used some type of innovative and alternative technology for wastewater collection and treatment. The wastewater systems that were studied had received funds from the U.S. EPA Construction Grants Program, which provided additional funding to communities that utilized innovative or alternative technologies as a part of the construction project. CES was referred to the ICCMODS website, which contained descriptions of each of the systems studied, along with photos and observations from site visits conducted by ICCMODS. No monitoring data was gathered as a part of the research performed for these systems, but photos and site visit reports were very informative on a variety of fronts, including general observations about performance, operational aspects, and costs where that information was available.

Appendix 3.A shows the approximate locations of systems in Indiana systems for which effluent quality data was obtained along with their general descriptions. The effluent quality data obtained for those systems is provided in Appendix 3.B, and the ICCMODS reports are referenced in Appendix 3.C.

3.1.4 Kentucky

During Phase 1 an inquiry was made with the Kentucky Division of Water (DOW) regarding available databases that would describe decentralized wastewater systems permitted in the state. CES was informed that such information could be compiled for surface-discharging systems (KPDES systems). In Kentucky, that includes both surface irrigation and point discharge systems. A request was then made for the state's database to be searched for all KPDES-permitted systems with flows in the 5,000 to 50,000 gallons per day range. These search results were then provided to CES in electronic Word document format, which included owner information, a limited description of the basic treatment unit processes for each, the type of wastewater flow category (domestic wastewater, wastewater residuals, industrial waste stream, etc.), the date the system was first permitted, and the flow. There were several hundred systems included in this list of systems, with a spreadsheet then compiled of applicable systems from the list.

A subset of this list containing only domestic wastewater systems was then submitted to DOW/KPDES staff, and a request made for compliance monitoring data available for those systems. Two very large Excel databases containing data for a total of 76 systems were compiled electronically by DOW staff, and transmitted to CES. This data was then reorganized and compiled into a single Excel spreadsheet, with the effluent monitoring data organized similarly to spreadsheets compiled for other states. All of these appeared to be surface-discharging systems, with a fairly wide range of treatment methods represented in the dataset.

Appendix 4.A shows the approximate locations of those systems in the state for which effluent quality data was obtained, and a short description of each. The effluent quality data obtained for those systems is provided in Appendix 4.B.

3.1.5 Massachusetts

In Massachusetts, facilities discharging wastewater effluent equal to or greater than 10,000 gallons per day (gpd) to the ground from a sewage treatment facility are subject to their groundwater program requirements. Systems with flows less than 10,000 gallons per day are subject to the MA Title 5 program requirements, although there may be situations (particularly in nitrogen sensitive areas) where a groundwater discharge permit will be required for flows less than 10,000 gpd. A request was sent to the Massachusetts Department of Environmental Protection's (DEP) groundwater program for information on domestic wastewater systems in the size range applicable to the study. A list of systems permitted through the groundwater program was provided to CES in Excel format, which was then sorted to identify those with flows between 5,000 and 50,000 gallons per day, and treating domestic wastewater.

An inquiry was then made to DEP staff regarding the availability of compliance tracking/monitoring information on each of those systems. DEP staff compiled a very large Access database containing a variety of permit file information on those systems, and provided this to CES. Using permit numbers for applicable systems, data/information was imported into an Excel spreadsheet for a total of 67 systems applicable to the study. A fairly wide range of treatment methods are represented in the dataset, with the most frequently occurring process used being rotating biological contactors (RBCs). A few of these systems have permitted flows between 5,000 and 10,000 gallons per day, though most are permitted for flows greater than 10,000 gallons per day.

Appendix 5.A shows the approximate locations by county in the state of systems for which data was obtained, and a short description of each. Slightly more descriptive information was obtained for the Bioclere systems from Aquapoint, Inc. for those systems and has been included. It should also be noted that in some cases, based on the monitoring data gathered, it appears that unit processes may be included for certain systems that were not noted in the regulatory information obtained electronically. A spreadsheet summarizing effluent quality data obtained for key parameters for those systems is provided in Appendix 5.B.

3.1.6 Minnesota

In Minnesota, the Minnesota Pollution Control Agency (MPCA) administers rules and state licensing programs, and reviews and approves decentralized wastewater systems designs with average design flows greater than 10,000 gallons per day. The Minnesota Department of Health (MDH) reviews and approves decentralized wastewater systems for facilities designed for less than 10,000 gallons per day, with these systems permitted at the county level.

A request was made to MPCA for information on permitted systems with flows between 10,000 and 50,000 gallons per day. At the time this request was made, there was a study underway by MPCA staff on large subsurface dispersal systems in Minnesota. Though the results of that study were not available at the time, a certain amount of descriptive information was provided to CES for a total of 24 systems. That information was transmitted in Excel electronic file format.

Minnesota is reportedly in the process of revising its monitoring and reporting requirements for large decentralized wastewater systems. For the purposes of this study, data was not available for a significant number of systems. Of those that were applicable to this study in terms of design flow and years in service, effluent quality data was available for three systems from MPCA. Appendix 6.A shows the approximate locations of those systems in the state along with a brief description. The effluent quality data obtained for those systems is provided in Appendix 6.B.

3.1.7 New Mexico

Decentralized wastewater systems in New Mexico with flows greater than 2,000 gallons per day are regulated at the state level in New Mexico through the NM Environment Department (NMED). In particular, soil-based dispersal systems with flows greater than 2,000 gallons per day are permitted through NMED's Ground Water Quality Bureau. Smaller systems are permitted at the county/local level.

During Phase 1 of this study, inquiries were made to the Ground Water Quality Bureau (GWQB) about systems applicable to this study, including any databases describing permitted systems. CES was referred to an on-line database of systems permitted through the Ground Water program. Although that Excel database contains certain helpful systems information including permitted flow, permit status and date, owner contact information and permit number, it does not specify the methods of treatment and effluent dispersal. From the full list of systems, a subset of systems with varying flows and types of facilities served were selected and submitted to the GWQB with a request that staff comment on the data available for each of those systems, along with any descriptive information they could readily provide about each system. Based on GWQB staff comments, a list of systems was compiled for which to request permit file information. A public records review request was submitted to the state, and following approval of that request, CES coordinated with GWQB staff to review the available files in Santa Fe.

All files reviewed were in paper format, and it was necessary to set aside documents in those files for subsequent copying by a state-authorized copy service. Information contained in the files tended to vary significantly, including the type and amounts of effluent quality data available for systems. Monitoring data from compliance reports was obtained for a total of ten systems from that file review. Appendix 7.A shows the approximate locations of those systems in New Mexico and their descriptions. The monitoring data obtained for those systems is summarized in Appendix 7.B.

3.1.8 North Carolina

A request for information on systems applicable to the study was made to the North Carolina Department of Environment and Natural Resources (NCDENR) for both subsurface and surface discharging systems. In North Carolina, all systems that discharge effluent to the subsurface are within the jurisdiction of the Onsite Wastewater Section, and systems that discharge effluent to the land surface or surface waters are under the jurisdiction of the Division of Water Quality (NPDES permitting process). No single up-to-date database was found to be available during Phase 1 to identify systems applicable to the study. It was therefore necessary to rely largely on state regulatory staff to identify large scale systems of interest.

It was found that much of the permitting and descriptive information associated with most large scale decentralized systems relying on subsurface effluent dispersal methods were located in county files. Some of this same information might be found in state files, but certainly not in all cases. Inquiries were made to counties about any available datasets on large scale systems in each county. Several counties provided lists of systems that could be included in the study, and team members communicated with each to determine how data/information might be obtained on those systems, and in what format it was stored.

With very few exceptions, compliance data and information was found to be stored by counties in paper file format. Compliance monitoring data and information was copied and forwarded by certain counties for a few systems, and ARCADIS arranged with other counties to conduct file reviews in person. Effluent quality data was obtained for a total of 15 systems, with these using a variety of treatment methods. Most of these systems use low pressure pipe (LPP) subsurface effluent dispersal. Appendix 8.A shows the approximate locations and descriptions of those systems by county, with the monitoring data obtained provided in Appendix 8.B.

3.1.9 Oregon

In Oregon, the Department of Environmental Quality (DEQ) has sole responsibility for large scale decentralized wastewater systems regulations and permitting. An NPDES permit is required if there is a point source discharge to navigable waters, with DEQ being the permitting agency. From inquiries to DEQ regarding the availability of data and information on large scale decentralized wastewater systems, it was found that systems records are maintained in regional offices based on geographic location in one of three Oregon regions: Eugene (northwest quadrant of state), Grants Pass (southwest quadrant) and Bend (eastern half of state).

Project Team members were referred to on-line databases maintained by DEQ for onsite systems, and systems listings from these were downloaded and sorted to identify systems of interest to the study. Using coordinate-based information from DEQ for large scale domestic wastewater systems, a map (Figure 3-2) was generated by Orenco Systems, Inc. for systems in the applicable flow range that were permitted at the time of the inquiry (Phase 1 of the study). The map shows that most of the large scale systems are located in the western half of the state, and in particular the northwest quadrant.

Using the DEQ on-line databases, systems were first sorted by flow to eliminate those outside the study's size range, and next by regional office. In recognition of the time limits for staff in each of the regional offices to pull records for systems of interest, listings of manageable numbers of systems were compiled by CES for which information was requested from the three regions. Although in many cases there was not sufficient information in the database about treatment processes used or final dispersal method, an effort was made to compile systems lists covering a variety of treatment methods, sizes, and types of facilities served. These lists were then submitted to the regional offices so that paper files could be pulled for subsequent review by team members (and copies made thereafter of relevant records).

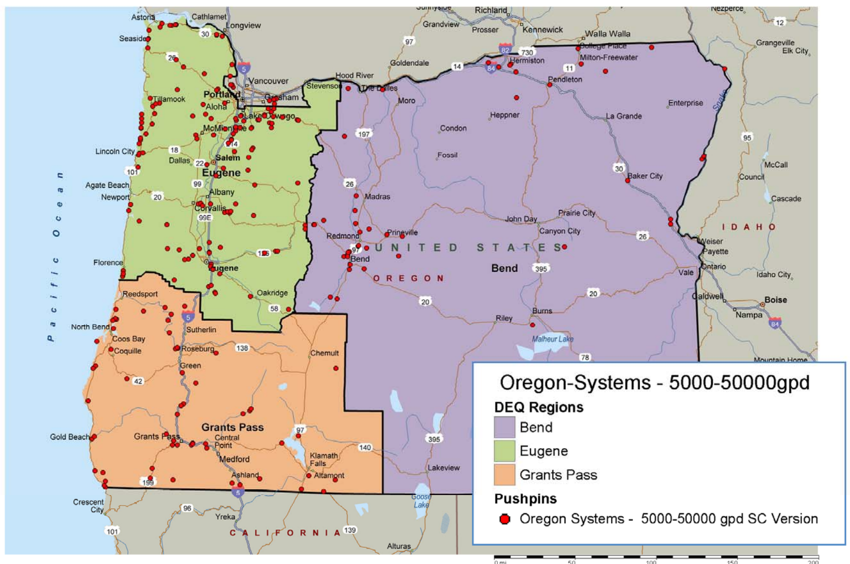


Figure 3-2. Locations of Oregon Decentralized Wastewater Systems with Flows From 5,000 to 50,000 Gallons per Day.

It was learned that there had recently been a fire in one of the regional offices, which eliminated those records from inclusion in the reviews requests. Systems information and monitoring data were requested for a total of approximately 50 systems from the two other regional offices (20-30 located in each of those two regions). Project team members then coordinated with the two DEQ offices to personally review the pulled files. Once information was reviewed in the files for those systems, it was determined that some of them had either not been in service for a long enough period to include, or were no longer in service. The majority of files contained very little if any monitoring data. Effluent quality data was obtained for a total of 16 Oregon systems, with the locations of those systems shown in Appendix 9.A along with basic descriptions of those systems including permitted flows, types of facilities served, and methods of treatment used. The monitoring data obtained for each is provided in Appendix 9.B.

3.1.10 Pennsylvania

In response to the nationwide inquiries about the availability of systems data/information during Phase 1 study activities, CES was contacted by the operator of several treatment facilities serving a small community in Pennsylvania. One of the treatment plants serving the town was of the size range and years in service that would qualify it for inclusion in this study. CES submitted a formal request for information to the town's administrator, and subsequently received reports, data and a variety of information about that system (an aerated lagoon treatment system). Appendix 10.A shows the approximate location of that system in the state and its basic descriptive information. The monitoring data obtained for the treatment system is presented in Appendix 10.B.

3.1.11 Tennessee

In the state of Tennessee, responsibility for decentralized wastewater regulations is split between the Division of Groundwater Protection (GWP) and the Division of Water Pollution Control (WPC). The GWP generally handles flows less than or equal to 10,000 gallons per day (domestic wastewater). WPC handles larger flows, and those that discharge to the surface.

Requests for information were submitted to both GWP and WPC for systems with flows between 5,000 and 10,000 gallons per day, and those with flows from 10,000 to 50,000 gallons per day, respectively. WPC was also asked for information about systems using surface discharge of treated effluent. In particular, GWP and WPC were asked about any statewide databases that were available to inform the project team about systems applicable to the study.

In response to those requests, CES was sent a large ACCESS database containing descriptive systems information, including treatment methods, in some cases type of collection system and/or final effluent disposition method. The database did not however contain compliance monitoring data. Information from the database was organized into a single Excel spreadsheet and sorted by permitted flows to exclude those outside the study range. Based on brief descriptions of treatment systems and types of facilities served in the database, a total of 69 systems were selected for which an inquiry was made regarding the availability and format for compliance monitoring/reporting data, and detailed permit information.

CES was informed that detailed information submitted for systems' permitting and compliance reporting data would typically be located in one of Tennessee's eight district field offices. The applicable district office was then identified and entered as a field in the Excel spreadsheet for each of the 69 systems of interest. The systems were sorted by field office, and a request sent to each office to request information for the systems located in their district. Systems data/information was copied for several systems by one of the field offices and sent to CES, with in-person file reviews needed to obtain systems information from each of the other district offices. CES therefore explored other sources of data/information from the state.

A private Tennessee engineering firm routinely dealing with decentralized systems was contacted regarding the availability of systems data/information through their firm. A significant amount of information was subsequently provided by that firm for several systems applicable to the study. Compliance monitoring data was provided along with basic descriptive information about those systems, including a variety of cost information.

Including information provided by both public and private sources, regulatory compliance data was obtained for a total of 8 Tennessee systems, with the locations of those shown on Appendix 11.A along with their basic descriptions. Monitoring data obtained for each is presented in Appendix 11.B. Six of these systems consist of effluent collection followed by recirculating sand/gravel filter treatment and subsurface drip dispersal, and two use Bioclere treatment systems along with effluent collection and subsurface drip dispersal. All are owned by the same public utility, and designed/built/managed by one of two companies.

3.1.12 Texas

In Texas, for systems treating and disposing of domestic wastewater off-site from one or more of the generators, and for systems with flows equal to or greater than 5,000 gallons per day, there are basically two types of permits; Texas Pollutant Discharge Elimination System or TPDES permits that authorize the discharge of treated effluent into waters in the state and Texas Land Application Permits (TLAPs) that authorize the disposal of treated effluent via land application (surface irrigation, subsurface dispersal beds and trenches, drip irrigation, evaporation, etc.). Several years ago, Texas' wastewater systems regulatory authority, the Texas Commission on Environmental Quality (TCEQ) revised its rules to require that cluster systems serving two or more properties must be permitted through the Municipal Wastewater Permitting Section of TCEQ, even though their flows may be much lower than 5,000 gallons per day.

Inquiries were made to permitting staff at TCEQ about databases that might be available by which to identify large scale decentralized wastewater systems in the state. It was learned that TCEQ does not require that TLAP permitted systems (surface or subsurface land application systems permitted in TX for cluster systems or flows > 5,000 gpd) submit monitoring records/reports (DMRs) to TCEQ. Therefore the focus was turned to "discharge" systems in terms of data to be identified and gathered through TCEQ. A records search was requested of TCEQ, for public & private permitted wastewater systems (TPDES permits). Two large files were provided to CES, with permit numbers identified for TPDES systems. The U.S. EPA self-monitoring database (http://www.epa.gov/enviro/html/pcs/pcs_query_java.html) was then used to search these records on-line to identify which systems 1) had permitted flows in the size range of interest to the study, and 2) had an original permit date at least five years ago. A list of public systems was then compiled from which to then obtain data from the reports. Those included community systems, schools, highway rest areas, public parks, correctional facilities, and other public systems. Public systems were considered more likely candidates for obtaining detailed information other than monitoring data, such as capital and operating costs. The data was manually recorded into a spreadsheet for subsequent organization, sorting and analyses.

CES also inquired directly with certain state agencies that own and operate relatively large numbers of decentralized wastewater systems throughout the state, given that TLAP systems records and monitoring data would need to be obtained directly from those owners. As systems were identified, owners were contacted directly to obtain detailed information, including comments from operators on systems performance and operational issues, repairs, and both capital and operating costs. Effluent quality data was often found to be available for TPDES permitted systems on the U.S. EPA's self-reporting database. TLAP systems owners were asked if they would be willing to provide at least three years of monitoring data along with other information being gathered. One of the state agencies contacted about systems' data/information was the Texas Parks and Wildlife Department (TPWD), which owns and manages lands throughout the state, most with water and wastewater facilities serving recreational areas, campgrounds and visitor centers. TPWD was exceptionally helpful in response to the request for data, and provided detailed information for a number of the Texas systems studied.

Effluent quality data was obtained for a total of 34 Texas systems, including 20 TPDES/discharge systems and 14 systems utilizing some method of surface or subsurface soil application of effluent. Most of the systems utilized some form of activated sludge treatment, and most of those that are permitted as TLAP systems use surface application of effluent. Appendix 12.A shows the locations and brief descriptions of the 34 systems in Texas, with monitoring data obtained for each presented in Appendix 12.B.

3.1.13 Virginia

In the state of Virginia the Department of Environmental Quality (DEQ) handles permitting of all systems with above ground discharge of treated effluent, and the Department of Environmental Health (VDH) handles permitting of all systems using subsurface effluent dispersal (regardless of flow). Both VDH and DEQ were therefore contacted regarding the availability of data/information for large scale decentralized systems. For subsurface dispersal systems permitted through VDH and/or counties, CES was informed that most records were maintained at district VDH offices, and in county files where those systems are located. A request was sent to district offices by the central/state VDH office requesting information on systems meeting the study criteria. A listing of permitted systems with flows between 5,000 and 50,000 gallons per day were provided to the central office by several district offices, and forwarded to CES.

CES was informed that project team members would need to coordinate with district and county permitting offices to review subsurface dispersal systems files to determine what information was contained in the files, and then arrange for copying of data/information relevant to the study. However, for systems using surface application or discharge of treated effluent, DEQ was found to maintain a relatively large database of systems. DEQ staff compiled a list of systems meeting the requested study criteria, and provided this list along with treatment codes and other information necessary to select systems for which to request compliance monitoring data.

As with most states from which data and information were requested, compiling information needed to determine that the system was first applicable to the study, and then to determine the method of treatment used and other basic information about the system was a multi-step process. To sort systems so that representative numbers could be selected using different methods of treatment, having varying flows, and serving different types of facilities for each of those treatment/flow categories, it was necessary to add data entries to a single spreadsheet manually for each system. A listing of systems was then compiled in this way and sent to DEQ for which compliance monitoring data was requested.

DEQ provided effluent quality data for a total of 85 systems, including those using either land/surface application of effluent or discharge to surface waters. The dataset covers a fairly wide range of treatment methods. Appendix 13.A shows the locations of those 85 systems in the state, and gives basic descriptions of each. Regulatory compliance monitoring data obtained for each is presented in Appendix 13.B.

Compliance monitoring data from each of the states was reviewed and analyzed separately (by state) to identify observable trends relative to systems performance. Those analyses are presented and discussed in Chapter 4.0 of this report.

3.2 Detailed Design, Operational History and Cost Data

For each of the seven major U.S. regions shown in Figure 2-1, approximately 12-20 systems were targeted for more detailed data gathering. Based on the types and quality of information found to typically exist in regulatory files and/or be available from systems owners and operators relevant to evaluating systems performance, a basic list of requested information was compiled. This information was intended to provide a representative sampling and overview of specific activities and conditions occurring with large scale systems that might offer valuable insights into their performance. In general, these systems represent a subset of the 341 total systems for which regulatory compliance data was obtained. However, there are a few systems for which some of the detailed information listed below was obtained, but for which there was no effluent quality monitoring data found to be available.

In an attempt to gather representative information for a range of system sizes and types, certain factors were used in selecting these systems. Those criteria included:

- Flow (some systems with flows between 5,000 and 20,000, and some between 20,000 and 50,000 gallons per day);
- Method of Treatment (at least 3-4 methods of treatment would be represented in the selected set of systems, and possibly more depending on the region);
- Dispersal/Discharge Method (attempted to cover systems using varying methods of final effluent disposition);
- Type(s) of Facilities Served (or "sector" served).

For this group of systems, in addition to the basic systems information listed in Section 2.2, the following types of information were sought from public and private sector sources:

Regulatory Information

- Regulatory authority and contact info;
- Effluent quality limits (regulatory performance standards/limits for system);
- Are there periodic regulatory inspections of the system?

Detailed Design Information

- Design basis and/or model and assumptions used in developing design. This includes the following:
  - Description of data or assumptions used for influent waste strength/characteristics;
  - Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.);
  - Loading rates to unit processes;
  - Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
  - Soil/land loading rate;
  - Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

Operation, Maintenance and Monitoring Information

Qualitative Information Requested

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers?
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system?
- What are the regularly scheduled operation and maintenance activities?
- How many man-hours per week or month are routinely committed to O&M activities;
- Are there repair and trouble call history/records available, including replacement of system components (e.g., pumps, fans/blowers, etc.);
- Are there inspection or other "walkover" photos of the system that may be available for review?

Quantitative Information Requested

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field.

Cost Information Requested
Design/Construction
- Initial construction costs for the system (including design and permitting costs if available);

- ***OM&M***
- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

- ***Fees***
- Connection fees (if applicable);
- Service fee structure and user fees charged

It was necessary to contact a variety of sources to obtain different types of information, with regulatory authority files seldom containing cost information (with the exception of a very few public projects). The information that could be obtained for systems targeted in each region for detailed data gathering and review tended to vary greatly, with all of the above information available for very few systems nationwide that were identified in Phase 1.

From systems permits and other documents in regulatory files, it was often possible to note loading rates to unit processes, and basic system sizing information. To the extent that operators had time and willingness to spend time listing operation and maintenance practices, repair incidents/histories, and comment on those aspects of the systems' performance, that information was gathered. However, what appeared to be relatively complete operational information was obtained for few systems. Detailed information gathered for each system is summarized in Appendix #.C-# of each of the 13 separate appendices organized by state (e.g., Appendix 12.C-32 for Texas system number 32) and the corresponding system number for the monitoring data obtained for that state (TX-32).

Given some of the constraints encountered with identifying systems eligible for inclusion in the study (based on size and years in service) and discussed previously, it frequently occurred that systems previously thought to be good candidates for detailed information gathering were later found to not be applicable to the study. After going through the steps to gain access to regulatory files for certain systems, review of the documents often revealed one or more of the following circumstances: 1) System no longer in service; 2) A single permit for a larger total combined flow was issued to multiple smaller systems, each of which had a flow well below 5,000 gallons per day; 3) System was permitted but never built; 4) No monitoring data was included in the system records; 5) Some portion(s) of the information sought for systems was not available from either public or private contacts; and 6) Once the system records were reviewed in detail, the system was found to have been in service for a period of time significantly less than five years (approximate years of service/operation for inclusion in the study).

While it may not be possible to draw conclusions about the performance of these systems based on the body of information gathered and presented here, it may be useful for making general comparisons and illuminating issues associated with certain treatment methods used in certain conditions. Where monitoring data tends to show certain patterns or periodic problems, the information provided herein may be helpful for evaluating those observations. The cost information that was obtained for systems is summarized and discussed in Chapter 5.0.

3.3 Discussions with Regulators and Operations/Management Entities

As a part of the data/information gathering process, a number of detailed telephone discussions were conducted with operations companies and regulators with long-term experience dealing with large scale decentralized wastewater systems. These exploratory discussions were thought to be an important means of gathering valuable information on systems performance around the country, beyond what might be gathered from permitting files and other documentation. In many cases, valuable insights and observations about systems performance and industry practices exist in the minds of those persons that have been involved with those systems for long periods of time.

A total of 13 such detailed discussions were held with experienced regulators and operations company representatives, in addition to the discussions with owners, engineers and systems operators when gathering system-specific information. Telephone discussions were conducted either by Susan M. Parten, P.E. of CES, or Victor D'Amato, P.E. of ARCADIS. Below is a summary of the observations communicated during those conversations.

3.3.1 Discussions with Regulators

Information discussed with regulators included a general description of the permitting and compliance framework in their respective states. That information can sometimes be helpful in providing a context for certain practices and observations. Since several of the regulators contacted work in permitting programs from which monitoring data was gathered for this study, an understanding of the regulatory climate and framework in those states may offer insights into effluent quality limits and monitoring requirements for those states (or lack thereof). Portions of the information provided by regulators about state programs in this section may have changed since these telephone discussions occurred.

Regulators were also invited to comment on the most common types of systems tending to be used in their states, and offer any observations or assessments they might have relative to the performance of systems in their state, and areas of concern or needs for change. In states where there may be insufficient amounts of data to reliably assess the performance of certain types of systems, or states from which no systems data was obtained at all, observations by regulators about systems in those states over time (based on inspections and compliance reporting) should offer meaningful added information about systems' performance. Persons interviewed with regulatory authorities were either managers of programs responsible for large scale decentralized systems, or very experienced program staff.

3.3.1.1 **Colorado** [ARCADIS]

<u>General Regulatory Program and Systems Management Considerations:</u>

- ♦ The Engineering Section of the Water Quality Control Division has responsibility for SDWA and CWA requirements, and water capacity development responsibilities.
- ♦ Statute requires approval of sites/designs for domestic wastewater treatment facilities over 2,000 gallons per day. The Engineering Section is responsible for onsite (ground water discharging) systems at the state level, with approximately four hours per week

allocated to oversight of those systems. This includes minimum guidance setting and interaction with 64 counties, most of which (but not all) have health departments.

- Currently there is no dedicated funding for onsite system at state level. There is an effort underway to get legislation passed to provide funding. Onsite systems over 2000 gallons per day require state review/approval. Primary enforcement responsibility is with counties, the local health department (LHD) or building inspector/commissioners/etc. if there is no LHD. The state approves the site location and design. Counties perform construction approval and permitting. In Colorado, groundwater discharges are permitted under the NPDES process, as well as systems with design flows over 2,000 gpd.
- With respect to ensuring compliance and quality control over systems installations, an engineering statement/certification is required. Counties do a final inspection typically before the system is covered up. After the system is operational, the NPDES operating permit specifies requirements including those for monitoring reports. Some older general permits had been issued for systems less than 10,000 gpd that only require best management practices (BMPs) and for the operator to report on BMPs every 5 years. These old permits are being revised to include monitoring and total nitrogen limits. For large subsurface dispersal systems, newer permits include nitrate limits and specific monitoring requirements. Some routine parameters require weekly or daily measurement while some, like nitrate, tend to be monthly.
- Performance monitoring by the state is done only on a complaint basis – it is unfunded at the state level. (Counties deal with performance issues, with not much handled at state level.)
- State training and certification are required for operators of large onsite systems.

<u>Systems Design Issues and Observations</u>

- With respect to the use of alternative collection systems in CO, there is at least one STEP, SDG and pressure sewer, but these connect to larger treatment systems (larger than covered in this study). There are no vacuum sewers. The state is open to alternatives.
- The NPDES permit issues preliminary effluent limits which drive designs. Recently (the past couple of years), limits have been 10 mg/l nitrate for ground water monitoring wells for most systems over 2,000 gpd. This tends to be driving designs
- Colorado has stringent setback requirements between soil absorption systems and wells, which can be as much as 1,500-2,000 feet. This sometimes precludes the use of cluster systems. The setback between soil absorption systems and wells is 100’ for the first 1,000 gpd + 8’ per additional 100 gpd.
- There have been problems with schools using a lot of ammonia in cleaning solutions.
- The most common type of large scale onsite wastewater treatment systems used are traditional septic tank and soil absorption systems. The state has begun to see RSFs and recirculating textile filters in the last 5-10 years, mostly in response to the new 10 mg/l nitrate limits. There are a few aerated tank treatment units which require higher level operators.
- The state is working with vendors of textile filters on setting hydraulic and organic loading limits. Vendors have submitted data which was reviewed and used as basis for loading decisions. The state is trying to keep these loadings consistent state-wide.

- The most common type of subsurface effluent dispersal system is the gravelless/chamber system. It is used almost exclusively rather than gravel and pipe. The state allows substantial areal reductions for chamber systems (up to 40%).
- Requests for approval of technologies are sent to the state level.
- There is not much drip irrigation used in CO.
- There is some low pressure pipe distribution in the state.
- Sometimes deep trench systems with sandy loam fill are used, and installed by over-excavating fast perking (gravelly) soil in mountains.
- Reuse for toilet flushing is discouraged. Greywater used in greenhouses is also not sanctioned by the state although there was a lot of discussion about greywater reuse during a severe drought in 2002.

<u>Public Complaints or Requested Changes</u>

- There have been complaints about setback requirements.
- There has been an effort to bypass the >2,000 gpd approval requirements by installing smaller subsystems, but the state also considers development density in establishing the 2,000 gpd threshold.

<u>Observed Regulatory Challenges and Suggested Changes</u>

- The lack of funding has prevented the development of a regulatory framework for decentralized systems at the state level in Colorado. Added funding of these state programs would help in that regard.

3.3.1.2 **Georgia** [ARCADIS]

<u>General Regulatory Program and Systems Management Considerations:</u>

- Local health departments, under rules promulgated by the Department of Human Resources, Division of Public Health, approve and permit residential and small scale subsurface systems (<10,000 gpd). The Environmental Protection Division (EPD), Watershed Protection Branch approves and permits subsurface systems over 10,000 gpd and all surface application systems. (The cut-off flowrate will probably will reportedly drop down to 2,000 gpd soon.)
- Most subsurface systems over 10,000 gpd are covered by the state's general permit. A general permit is a "one size fits all" type of permit and is issued for specific types of discharges and systems. An individual permit may be issued if the system falls outside the constraints of the general permit. For example, if the effluent limits are different or if the applicant or proposed system is "iffy".
- There is little local involvement in the state-administered large subsurface system program.
- DHR rules require all system designs with flows over 2,000 gpd to be certified/sealed by a licensed professional engineer for the systems they permit.
- EPD requires that professional engineers design/certify all systems which they permit.
- For systems between 2,000 and 10,000 gpd, local health departments issue a construction permit and approve construction/installation. Likewise, for systems over 10,000 gpd, under the state's general permit, the engineer has to certify (seal/sign off on) the installation. The state may do a final inspection. For systems on individual permits, the state usually does a final inspection.

- For systems permitted by EPD, a certified operator is required (minimum class 3), although the operations firm does not have to be certified. Owners must contract with an operations firm via a trust indenture.
- Monitoring requirements are generally established in the permit (i.e., in the general permit). The general permit requires effluent and groundwater monitoring. Groundwater monitoring includes at least one down-gradient well.

<u>Systems Design Issues and Observations</u>

- Large scale decentralized systems in Georgia tend to be concentrated in certain areas of the state. Roughly 60-70% of new systems are in a ring around Atlanta. There are also a large number along the coast. Basically, they are concentrated where the population is expanding and where there is little existing wastewater infrastructure in place.
- With respect to the types of collection systems most commonly used for large scale decentralized systems, for housing, probably 20% or less are served by conventional gravity sewers, with 80% or more served by pressure sewers. For other cluster type systems that are less spread out (like shopping centers), conventional collection systems are normally used.
- More STEP/STEG is used than grinder pump pressure sewer systems.
- The state recognizes the importance of collection systems being installed correctly, and watertight.
- With regard to the types of facilities served by large scale decentralized systems in Georgia, roughly 65% serve housing (primary or second homes), with roughly 25% serving commercial (shopping centers, hotels, etc,), and about 10% serving schools.
- At present, the most common types of systems used in Georgia for pretreatment (prior to soil dispersal) are mechanical treatment systems (e.g., FAST/Bio-Microbics, Nibbler, SBRs). There are still some large septic tanks being installed for pretreatment. Twenty years ago, large systems were mostly served by just septic tanks but now about 80% utilize some form of mechanical pretreatment.
- Engineering consultants generally decide/select the pretreatment system.
- The most common subsurface dispersal option today is drip, particularly since the general permit loading rates are based on aerial loading. After drip, there are some low pressure pipe systems and some dosed infiltrator/chamber systems. The general permit does not require pressure distribution. Some systems are siphon-dosed.
- For surface application systems, approximately 85% are spray and 15% surface drip. However, today at least 90% of the new systems going in are subsurface systems, since the general permit makes subsurface much easier and also because there are less stringent buffer and other requirements for subsurface versus surface systems.
- Surface application system approval requires an engineering report, plan review and an individual permit. The driver for the general permit was mostly an increase in applications and a lack of staff to process individual permit applications. There is a memorandum of understanding between the Environmental Protection Division (EPD), the consulting engineers' council, and the professional engineers licensing board that allows the EPD to refer engineers for disciplinary action if warranted. There is a general feeling that subsurface systems are better technologies, have less odor issues and that the U.S. EPA is encouraging the use of subsurface effluent dispersal.

- With regard to the reuse of effluent in the state, there is currently some reuse occurring, mostly through landscape irrigation, yards, and golf courses. There is none occurring for toilet flushing. There are some reuse land application sites (RLASs), where wastewater is treated to reuse quality standards and land applied to reduce buffer requirements.
- Reuse systems are not covered under the general permit.

Observations Relative to Systems Performance

- The state's general permit issued to large scale system has only been in existence for a few years, and has allowed many systems to go into service. As yet, there isn't a long record of operational information on most of the systems in operation to observe particular trends relative to the performance of different types of systems in different settings.
- Conventional gravity dispersal systems don't seem to distribute effluent well.

Public Complaints or Requested Changes

- There are sometimes complaints about failing systems for which effluent is surfacing or backing up, or that has pretreatment odors.
- Complaints also occur with development on a split system; that is, where some portion of the homes are on a community system and some are served by individual onsite systems, but the billing is the same for each category of system. The individual systems still need to be maintained by the homeowners. For these situations, the state has told the health departments that all residential development needs to be served either by community systems or individual onsite systems, and they can't be split.
- Problems can occur when residents pay their sewage bills to a private developer, since they are not regulated by the utilities/public services commission. The state gets complaints if the developer starts charging too much. If the developer doesn't charge enough, operation and maintenance will likely be insufficient for proper on-going care of the system.

Observed Regulatory Challenges and Suggested Changes

- With regard to the on-going management of collection systems leading to community scale decentralized systems, there's a need to make sure that the permittee is responsible for pump replacement and septic tank maintenance, not the homeowner. The state prefers that the RME be a city or county, but the RME is also sometimes the developer or homeowners association.
- There is insufficient funding for enforcement.
- The current rules state that a trust indenture *may* be required for community/cluster systems. They need to *require* trust indenture and also require public/local government ownership, which can then contract back out to the developer if desired.

3.3.1.3 **Idaho** [CES]

General Regulatory Program and Systems Management Considerations:

- While the rules covering large scale onsite systems are the Department of Environmental Quality's, (IDEQ), IDEQ does not have the funding nor the personnel to execute the program within their Department. Consequently, IDEQ solicited the seven independent health districts within Idaho to execute this program. They inspect the sites, approve construction, and write the permits. DEQ evaluates larger systems, called Large Soil Absorption Systems (LSAS), and the Clustered (decentralized) Systems (CS) in the state. If the design passes the engineering and hydrogeologic evaluation, IDEQ sends a letter to the appropriate health district informing them that the project meets state minimum requirements and authorizes them to issue permits. Smaller individual systems are left totally to the health districts to evaluate and permit.

Systems Design Issues and Observations

- The vast majority of older systems are simple septic tanks that either gravity flow or are low pressure dosed to drainfields. There have been increasingly more package treatment plants, predominantly Sequencing Batch Reactors (SBR). The numbers of Membrane Batch Reactors (MBRs) are increasing at a faster rate.
- New reuse rules govern cluster systems/centralized systems. If systems process/treat the wastewater sufficiently well and disinfect, spray irrigation can be used within very close proximity to houses
- All new LSAS (at least since 1993) have been required to use pressure dosing. There are probably a couple of dozen gravity-fed LSAS. The majority of these older systems are simple septic systems, but there has been a major increase in the number of packaged treatment plants submitted for approval due to the increased development encroaching on sensitive areas (i.e. adjacent to surface waters, areas of high ground water, shallow soils, fractured bedrock, high ground water nitrate areas, etc.).

3.3.1.4 **Indiana** [CES]

General Regulatory Program and Systems Management Considerations:

- In Indiana, the state health department reviews and permits subsurface soil dispersal systems other than those serving single family or two-family dwellings. That includes clustered residential and commercial systems. For publicly funded systems (funded through SRF, the Department of Commerce, etc.), the Indiana Department of Environmental Management (IDEM) permits the systems but frequently requests Health Department review. Any plans for a system reviewed by the state must be sealed by an engineer or architect (in a few cases designs are submitted by architects). Overland flow and surface irrigation (NPDES permits), are handled by IDEM.
- Operational permits are not currently issued by the State Health Department.
- The state Health Dept. does not have enough staff for inspections of commercial/cluster systems. Pre-construction conferences do occur, to try to address concerns and anticipate problems, and operation and maintenance issues. Local/county health departments may provide inspection services, but this is on a county-specific basis.
- The State Health Department asks that a contract be entered into between the owner of a system and a competent service provider. Currently there is no licensing or certification program for O&M service providers. IDEM has been interested in a certification program, but this is still not occurring.
- With respect to systems monitoring, the State Health Department asks that samples be collected on a monthly basis for one year, and quarterly thereafter. This is typically for BOD and TSS. Nitrogen would likely be monitored on a voluntary basis. IDEM's operational permits may require nitrate or ammonia monitoring, but mostly deal only with secondary limits. If the system is monitored then a report of the monitoring is sent to

both the Indiana State Department of Health and the local health department. If the system is considered experimental, then monitoring is required in all cases (with the report sent to the State and the local health department.) Recently the state has begun requiring monitoring of all cluster systems whether experimental or not, and whether above ground or subsurface effluent dispersal.

- The State recognizes that absolutely all systems need maintenance, including the simplest that use just septic tank pretreatment. However, the State currently doesn't issue any operational/maintenance permits for subsurface dispersal systems.

<u>Systems Design Issues and Observations</u>

- With regard to collection systems for large scale decentralized systems, approximately 5% use conventional gravity sewers and lift stations. Most systems use STEP and/or STEG. At least one system uses grinder pumps, going to septic tank(s) for primary treatment. No knowledge was reported of any vacuum sewers in the state.
- For STEP/STEG systems the state requires that at each connection, curb stops are equipped with a ball valve (on force main side of check) and a brass check valve (on house side), after the effluent pump station serving residence/building.
- With respect to the types of treatment and final dispersal methods that tend to be used in the state, it is a function of site-specific soils & conditions. Registered soil scientists in Indiana first do a site/soils survey, and provide a report (for all sizes of systems). The State follows up with an assessment of the type of final soil dispersal system(s) suitable for the site, and loading rate(s) based on flows. The State determines what flows would need to be.
- For subsurface drip dispersal, a 30/30 (BOD/TSS, mg/L) secondary quality effluent quality is required, with no reductions in sizing allowed.
- For low pressure pipe or low pressure dosing (LPP/LPD) there are reduced areal provisions for secondary treated effluent (higher allowed soil loading rates, with those rates based on soil type). Higher soil loading rates are allowed under certain conditions when secondary treatment is provided prior to pressure or flood dosing (field dosed by gravity from a flooded D-box dosed by a pump(s)), or for small gravity dispersal systems. If the total lineal footage of trench is 500 or more (of 3' wide trench), trenches must be dosed. If less than 500 LF, and the system can gravity flow, that is allowed. Trenches have to be at least 7.5' on center apart. Trenches must be at least 3' wide.
- The most common methods of pretreatment used tend to be septic tanks, recirculating media filters, subsurface wetlands, and subsurface wetlands with recirculation (chamber at the outlet of the wetland that pumps effluent back to head of the wetland, trickling through a few feet of gravel media before entering the wetland). There is not much extended aeration/activated sludge used for these systems. Currently there is a deep lagoon system under consideration.
- There are concerns about the use of strictly suspended growth/extended aeration treatment system for decentralized systems.
- During the past 10-20 years, there has been a transition from ordinary gravity subsurface dispersal to pressure distribution, and now to secondary treatment prior to final effluent soil dispersal. There has been a shift during the past few years away from pressure distribution, to flood-dosing. With that transition, cost tends to be more concentrated in controllers rather than pumps.

- The State discourages the use of subsurface dispersal areas as recreational or sports fields.
- With regard to reuse projects, there is a project on the east side of the state using a recirculating media filter, and for which the treated effluent was used for urinals & toilets after UV disinfection.

Observations Relative to Systems Performance

- There are no particular problems reported with STEP/STEG collection systems, as long as they're designed properly.
- Most systems appear to be operating satisfactorily if they're sized properly. Systems are to be sized for peak daily loads. Schools are unique in that most of flow occurs over about a 3-hour period, which can result in large doses to a field or treatment unit if timed dosing isn't used. Drip dispersal systems typically use timed dosing, which helps attenuate peaks. Unlike drip dispersal systems however, trench systems have effluent volume capacity in trenches which help with storage for peak flow periods.
- For some cluster systems when they were initially going into service, there were problems with some wetlands, and with diurnal flow surges (no equalization provided for those systems). The technologies and design enhancements have tended to address most of these problems.
- Most systems use effluent filters. Effluent filters have to be installed so that they're accessible and can be serviced. They also have to be installed so as to be able to pump and clean the tank. Filters have to be sized adequately for reasonable service intervals.
- Cigarette butts and condoms have been a problem for effluent filters installed in screened pump vaults.
- In general, there is a need for more on-going management/maintenance of systems, with a renewable operating permit, and with sufficiently trained/certified service providers.

Public Complaints or Requested Changes

- There have been complaints in the past from homeowners regarding a utility owner who was not doing adequate management and system maintenance. The private utility was later sold to another individual, and later resold. It is now being reportedly being properly managed.

Observed Regulatory Challenges and Suggested Changes

- Requiring on-going operational permits would help greatly, rather than just construction permits as is currently the case.
- For cluster systems, there needs to be operation, maintenance and monitoring. Unless there are the organizations out there to assure that (regulatory and otherwise), there will likely be more problems with these systems over time.
- The State would like to be involved in the planning process from the beginning for subdivisions, to better select the most appropriate wastewater service approaches, as well as being able to look at development densities, green space considerations, etc.

3.3.1.5 **Iowa** [CES]

General Regulatory Program and Systems Management Considerations:

- ♦ DNR permits systems with flows above 1500 gallons per day, and smaller systems are permitted at the county level.
- ♦ Older unsewered communities in Iowa (there are about 700 or so now) have mostly conventional onsite systems with septic systems and gravity subsurface drainfields. Most older communities having populations greater than 250 have been sewered, and those with lesser population typically have not been sewered. New subdivisions not served by centralized sewer systems also fall into this area of wastewater service.
- ♦ In Iowa the 10-State Standards have tended to govern/limit what technologies are used for larger systems, because permitting is so much longer & more difficult for technologies not in the 10-state standards. Iowa has been gathering data and developing standards for a variety of technologies believed to be appropriate for consideration in Iowa to supplement the 10-State Standards.
- ♦ Systems with design flows above 1,500 must be designed by a licensed professional engineer.
- ♦ Design plans are approved by the permitting authority, and the design engineer is relied on for overseeing and approving the quality of construction;
- ♦ There is only an operating permit requirement for NPDES systems (surface discharge systems) through the NPDES program, with monthly monitoring/reports (DMRs) for these systems. There is no clear requirement yet for an operating permit for large or small onsite wastewater systems. Recently there is a trend to, on a case-by-case basis require an operating permit for larger onsite/subsurface dispersal systems. This is in transition right now for subsurface systems > 1500 gpd.
- ♦ There is currently no monitoring requirement for subsurface soil dispersal systems.

Systems Design Issues and Observations

- ♦ With respect to the types of wastewater collection systems most commonly used in Iowa for small community systems, nothing "alternative" really predominates. Conventional gravity is the most common. A few STEP/STEG systems are used, but permitting is rigorous and so typically not done. There may be a few vacuum sewer systems, with the same constraint noted as for STEP/STEG systems.
- ♦ Regulators are reluctant to permit "alternative" systems (collection, treatment or dispersal methods) due to unknowns relative to long-term operation and maintenance concerns.
- ♦ Traditional small-community wastewater systems in Iowa have consisted of lagoons (anaerobic and/or aerated lagoons). Traditionally these have been a three-stage/cell lagoon, with "controlled discharge" (in spring/fall, when flows are up in the rivers, the lagoon discharges and is drained, and then stored for 180 days). There are some provisions for continuous discharge lagoons. Iowa doesn't have evaporation ponds as such because of "break-even" evaporation rates.
- ♦ In Iowa lagoons, followed by discharge is the most common scenario. Direct discharge is typically used if possible, and there are very few large scale subsurface dispersal systems.
- ♦ With regard to dispersal system selection and use, in northern Iowa soils are more conducive to absorption. In southern Iowa there are more clays. Other than that, the type of system is mainly dependent on population density and land usage (depending on what seems most cost-effective).

- With respect to types of treatment/pre-treatment systems most commonly used in Iowa, lagoons are predominantly used to serve older small communities. For newer small community systems, package plant (extended aeration) systems began to be used until it was found that small communities could not effectively operate/manage them. Currently, packed bed filters (sand/gravel) have been used to some extent. Recirculating open media filters are used. Peat filters have been used for some small communities. A few FAST systems have been used. Wetlands have been used. AdvanTex treatment units have been used for a couple of systems.
- Some sand mounds and straight septic tank/soil absorption systems are used for larger systems. However, there have been problems with sand mounds because of the infiltrative limitations of underlying soils (clays) and evaporation rates. Iowa is currently developing a sand mound design manual.
- Sand filters have been used for about 30 or so years even for larger systems. Larger sand filter systems exclusively use pressure dosing of the filter media, with a dosing rate of about 1 gpd/ft^2 (as contrasted to gravity dosing for smaller sand filters systems that could use 0.63 gpd/ft^2).
- With regard to soil dispersal methods used in Iowa, subsurface drip dispersal is really not used for larger systems in Iowa. Large subsurface absorption systems may use pressure distribution, but they use standard sized wider trenches, unlike "low pressure-dosed" systems. Surface irrigation is not used in Iowa.
- Nitrate is not limited for surface discharge systems, but it is for larger subsurface systems (< 10 mg/L NO_3 as N). NH_3 limits for surface discharge depend on the receiving streams.
- There is no real driver for reuse due to the availability of water in Iowa.

Observations Relative to Systems Performance

- Some means of equalizing flow is needed for systems (e.g., timed dosing, flow equalization/mixing, etc.).
- There is a need for recirculation and/or reserve storage capacity tanks for power outages;
- Flow control (e.g. timed dosing) and equalization is needed for essentially all systems using any type of mechanical or filtration process except for wetlands, including peat filters, fixed media (submerged or not).
- There are concerns about activated sludge processes used for individual systems up to small community systems, due to operational vulnerabilities/instabilities. In tandem with fixed media, timed dosing, etc. these systems may work better, but are still considered susceptible to problems.
- There are some concerns about plugging of packed media filters and wetlands ("bio-fouling"/biomat formation).
- All systems need on-going maintenance and checks (management).

Public Complaints or Requested Changes

- There are complaints from the public about spending large amounts of money on systems that don't work (this is mainly true for smaller systems). For small community systems, most of their complaints relate to the costs of service.

Observed Regulatory Challenges and Suggested Changes

- ♦ Nitrogen limits (ammonia for surface, and nitrate for subsurface dispersal) are presenting challenges for the types of treatment systems that can be used.
- ♦ Some means of equalizing and controlling flow is needed for systems (e.g., timed dosing, flow equalization/mixing, etc.).
- ♦ Subsurface dispersal operational, maintenance, and monitoring requirements are being discussed in Iowa.
- ♦ There could be better use of certain technologies that might be most appropriate for certain conditions. Iowa is currently developing standards for drip and mound systems that may help in this regard. There is currently a 50% reduction allowed for subsurface field areas for traditional trench systems (1998 rule) for systems providing "secondary" treatment. There needs to be further evaluation and development of these types of approaches to better match soil conditions and treatment processes.
- ♦ Iowa is currently developing a STEP/STEG manual because it's recognized that too much money is often spent on conventional gravity collection systems, and conventional systems have historically been used in cases where STEP/STEG may be more appropriate for a variety of reasons. Grinder pressure sewers will also be included in that manual. 10-State Standards require minimum 6-inch diameter sewers, with 8-inch above a certain number of connections, so STEP/STEG has been challenging, in terms of a non-standard approach.
- ♦ Regulators are reluctant to permit "alternative" systems (collection, treatment or dispersal methods) due to unknowns relative to long-term operation and maintenance concerns.
- ♦ Iowa is moving to require that small communities have their wastewater system managed by separate (from the community) licensed/authorized management entities. This might be a county, or a rural water association, or multi-county utility agencies/entities.
- ♦ Monitoring (where, for what, and how often) is an on-going concern, especially from a cost perspective, to really assure adequate performance.
- ♦ There are concerns about potential operational problems and vulnerabilities associated with activated sludge processes used for small community systems.
- ♦ There are some concerns about biomat formation and clogging/plugging of packed media filters and wetlands.
- ♦ All systems are viewed as needing on-going maintenance and operational and/or performance checks.
- ♦ A process or system of solving problems and providing sound wastewater service options is needed, and then develop standards and policies to adapt to those solutions -- not the other way around. The regulations are currently limiting the types of technologies used. Although, changing things can sometimes lead to other questions and problems, so regulators need to really understand the processes and their technical issues.

3.3.1.6 Massachusetts [ARCADIS]

[Note: This information was obtained from a Title V (< 10,000 gpd systems) program engineer, with some of the information less relevant to systems in the 10,000-50,000 gpd flow range.]

General Regulatory Program and Systems Management Considerations:

- ♦ The primary regulatory authority for decentralized wastewater systems in Massachusetts is the Department of Environmental Protection, Bureau of Resource Protection, Division of Watersheds. All systems 10,000 gpd or more are considered a "groundwater discharge" and must be approved by the Department. The Title 5 program is responsible for systems with flows under 10,000 gpd. For those systems, the Department approves the technologies and sometimes specific systems. Otherwise approval and permitting occur at local health departments. There is a lot of cross-over between the Title 5 and "groundwater discharge" programs.

- Local Health Departments (generally at the town, not the county level) permit all onsite systems. Certain categories of systems are approved by the state, mostly at the regional level. However, Boston (state central office) approves/permits the technologies also.
- For systems in the 2,000-10,000 gpd range, there is a three part form that includes sign-off by the installer, the engineer and the board of health. The result of this seems to be that no one tends to accept responsibility. For systems over 10,000 gpd, there is no similar sign off. However, the local health department is supposed to approve the installation before final permitting.
- With respect to on-going operation and maintenance (management), all systems are supposed to have service contracts for the life of system. In reality there is very little management oversight. Very few towns want to get involved. Barnstable County (Cape Cod) has a management district. The state and local health departments share responsibility for enforcement. It is implied but not specifically required that local health departments do periodic inspections of systems.
- Systems' monitoring requirements vary according to the specific system, but frequency is generally monthly or quarterly for advanced treatment systems. The state is leaning toward monthly or more often. The state does not allow surface discharges; only subsurface.
- A professional engineer is required for the design of all systems with flows over 2,000 gallons per day.

<u>Systems Design Issues and Observations</u>

- With regard to the geographic locations of most large scale decentralized systems, generally speaking, they tend to be concentrated in Cape Cod and the south and north coastal areas. The remainder are scattered throughout the state.
- There are relatively few STEP or grinder pressure collection systems used in MA.
- There is one vacuum sewer system serving a town-wide project
- With respect to the types of treatment systems that are most commonly used in MA: Trickling filters and submerged media processes are more common than recirculating sand filters. Other treatment systems used include AdvanTex, Bioclere Amphidrome, and SBRs. FAST/Bio-Microbics also has a relatively large market.
- N-removal systems are required primarily in nitrogen-sensitive areas (coastal areas, Zone 2 Public Water Supply Well areas, etc.).
- There is a trend toward nutrient (mostly nitrogen) removal. MBRs are starting to pop up, mostly for onsite reuse applications. Many technologies are having trouble consistently achieving less than 25 mg/l total nitrogen.
- The selection of treatment systems used for projects varies based on costs, and whether the site has a TN limit. The facilities footprint can be an issue, but more so for the dispersal system than the pretreatment system.
- The state has approved some phosphorus removal treatment systems around some lakes where towns have required it, but it is not widespread.

- Sufficient flow equalization is critical for school systems to function properly.
- There are a lot more gravelless and drip dispersal systems coming into use recently.
- All systems over 2,000 gpd have to use pressure distribution.
- Drip irrigation is preferentially used for landscape irrigation/reuse.
- More maintenance is required for drip systems (spin filters, etc.) than for more conventional systems (e.g., chambers/trenches).
- There is one toilet flush reuse project, using a MBR for pretreatment.

<u>Observations Relative to Systems Performance</u>

- There have been some problems observed with the operation of systems.
- The advanced treatment technologies need more motivated/proactive operation and maintenance than tends to be specified by vendors. O&M is currently driven mostly by regulations.
- Management is a major problem. Oversight is reportedly no happening, or it is happening slowly.
- School systems can be a disaster without equalization.
- There appears to often be inadequate O&M for facilities with food service; Grease trap pumping is often ignored.
- Incompetent installation is a big problem.
- Effluent filters are being used with good results as long as they're installed correctly.
- With regard to systems in the 5,000 to 10,000 gpd flow range: Not many problems have been reported with Septitech and Waterloo Biofilter systems; Some Bioclere, Bio-Microbics FAST and Amphidrome systems have had some problems, mostly traced back to installation.
- It would be beneficial if vendors/systems distributors spent more time overseeing projects.

<u>Public Complaints or Requested Changes</u>

- Most public response has been regarding systems costs, and that too much monitoring and testing are required.

<u>Observed Regulatory Challenges and Suggested Changes</u>

- Management is viewed as a major problem by the state.
- Better and more consistently applied operation and maintenance practices are needed for advanced treatment technologies.
- There is not enough designer responsibility or O&M oversight.
- There is not enough training for operators and installers. More training is needed that's specific to small/decentralized systems. Each town has its own certification for installers; There is no statewide certification program for installers.
- There is local primacy up to 10,000 gpd, which tends to make the standards and policies a "hodgepodge". Local health departments don't want to assume responsibility, claiming they don't have adequate funding, but they also don't have the training/expertise. Things tend to work a little better at the state level for systems with flows over 10,000 gpd, but the state also has enforcement/staffing issues. Management districts might help; Barnstable County is starting a program.

3.3.1.7 **North Carolina** [ARCADIS]

General Regulatory Program and Systems Management Considerations:

- In North Carolina, subsurface wastewater systems with design flows over 3,000 gallons per day must be approved by the OSWS. However, all subsurface systems are actually permitted by the local (typically counties) health departments (LHDs).
- All non-subsurface systems are permitted by the Division of Water Quality (DWQ). DWQ has an Aquifer Protection Section that has a Land Application Permits and Compliance Unit, Groundwater Investment Unit and a Groundwater Protection Unit. The DWQ-Land Application Unit permits large land application (surface application) systems. DWQ also has a Surface Water Protection Section which includes the Point Source Branch, which carries out the NPDES program and thus permits surface water discharges of all sizes.
- All subsurface dispersal systems over with design flows over 3,000 gpd must be designed by a licensed professional engineer.
- Large subsurface systems have a three-phased approval process. Site approval triggers the issuance of an "Improvement Permit" which allows land transfer and site work (e.g., clearing) to begin at the site; State-approval of engineering plans permits the LHD to issue an "Authorization-to-Construct", which allows construction of the wastewater system to proceed; Approval of the installation allows the LHD to issue an "Operation Permit" for the system and occupancy of the facility. A PE must certify installation in accordance with the approved plans and specifications. The LHD must also inspect and approve the installation. The OSWS requires drainfields to be laid out (staked) on-site prior to design approval.
- A bill to certify/license wastewater system installers recently passed the NC legislature.
- The State's onsite sewage rules establishes the minimum frequencies of operator visits, operator's reports, and LHD inspections of systems depending on complexity of system. Operating Permits must be renewed every 5 years. The OSWS has a "Quality Assurance Unit" with two staffers that audit LHD wastewater programs, including their large system programs.
- Systems with flows over 3,000 gpd must be visited by the Operator in Responsible Charge (ORC) at least monthly (more often depending on system complexity). Monitoring requirements are established in the Operation Permit on a project-by-project basis. A sub-set of the large systems in NC have groundwater monitoring requirements, based on a risk analysis (e.g., proximity of drinking water source or high-quality shellfish waters, etc. trigger GW monitoring). Advanced pretreatment systems (treatment beyond septic tanks/grease traps) generally require effluent monitoring. Spot monitoring data is usually required for leniency requests, such as "design flow reductions" (as allowed by the rules). Flow/elapsed time meter/cycle counter readings are generally required for all systems.
- In NC, all new subsurface systems require 100% repair area set-aside. For surface/land application systems, a repair area set-aside is not required. However, the land application areas for surface-applied systems are based on agronomic application rates and are generally larger than areas for subsurface systems. Surface land application systems also have an "express permitting" option. Subsurface systems may have such an option in the future. Applicants and LHDs have devised many ways to get "large" systems permitted without state approval by, for example, splitting large systems up into multiple

subsystems, etc. [This may explain why, during the files searches for systems data, some systems were found to be ineligible for inclusion in this study because it was learned from the file documents that the total flow indicated in a state database pertained to multiple smaller systems (each less than 5,000 gallons per day).]

- OSWS has been more proactive in drafting Operation Permits with/for LHDs. The LHD's copy OSWS for different types of systems if OSWS wants to see specific O&M and monitoring requirements.

Systems Design Issues and Observations

- With regard to the types of collection systems most commonly used to serve large/community scale decentralized systems, about one-third use STEP and about two-thirds use conventional gravity collection, along with a few grinder pump pressure sewers.
- Choices of collection method are usually driven by terrain issues.
- With respect to the geographic locations of most large scale decentralized wastewater systems in NC, the majority are located in the NC coastal areas, and in particular the barrier islands. Dare and Carteret Counties have the largest number of active systems.
- With respect to the occurrence of large scale systems serving particular types of facilities: In the mountains most large scale systems serve new housing, summer camps, retirement housing, resorts; All over the state, large systems serve churches, schools, nursing homes, parks/visitors centers, RV parks/campgrounds, shopping centers, restaurants, some industrial process; Along the coast, these systems serve mostly housing (condos, subdivisions/vacation homes, hotels), restaurants, shopping centers, campgrounds/RV park, others. Low pressure pipe (LPP) subsurface dispersal is not used for restaurants unless good pretreatment is provided ahead of the dispersal system. There are many existing/old RSFs serving schools.
- The most common types of pretreatment processes used in the state for large scale decentralized systems are standard septic tank treatment, package extended aeration plants, Bioclere recirculating trickling filter units, some AdvanTex recirculating textile media systems, and recirculating sand filters (RSFs). Earthtek is promoting treatment at the building(s) served with Envirofilter treatment units, from which the treated effluent then collected/transported to a central area where there may be further treatment or just enter the dispersal system.
- With regard to the use of certain subsurface effluent dispersal methods as related to geographic location: Along the coast one finds predominantly some method of pretreatment to LPP (not much drip dispersal); The Piedmont/mountain areas have started to see more "deep trench" systems (i.e., disposing into higher conductivity material) following some method of pretreatment (for example, septic tank to RSF to pressure manifold/conventional deep trench). Pressure manifold/conventional trench final treatment/dispersal is still very common everywhere except the coastal areas, particularly for sloped sites. Along the coast, LPP is still overwhelmingly the most common method of dispersal used.
- Almost all large subsurface drip dispersal systems in NC include treatment beyond a traditional septic tank. In most cases, this has been with an RSF.
- With regard to observed trends with systems designs in the past ten to twenty years, there is much greater use of secondary or advanced treatment following septic tank primary

treatment in recent years. Probably more than half of the new large systems use added treatment.

- The use of RSFs is decreasing because they have a relatively large footprint, collect rainwater, have to be built-in-place and because there is only one source of good filter sand in the state.
- Many more package plants are being designed/operated for nitrogen reduction in the past five years (N reduction reduces or precludes the requirement for nitrogen transport analyses). These include extended air with denitrification filters (methanol), package plants with alternating aerobic/anoxic (including SBRs).
- Bioclere treatment systems probably represent half the large systems pretreatment market. They can be designed for high-strength wastewater and nitrogen reduction and are space efficient.
- AdvanTex treatment systems are competing for large systems subdivided into several smaller subsystems.
- There is a trend toward package systems, with close interactions between design engineers and vendor. More vendors now have technical staff in-state to assist with designs.
- With respect to effluent reuse, OSWS doesn't see many applications for this because it would have to include subsurface effluent dispersal. There was a recent application for irrigation reuse on a ball field for a school using drip dispersal 8" below grade. Car washes (mostly under 5,000 gpd) often have reuse systems. Establishment of new OSWS treatment standards in the rules may make reuse applications more attractive. Surface land application rules allow quite a bit of leniency for effluent that has been treated to reuse standards.
- In NC, dealing with trees in the site layout is a big issue.
- Drip irrigation (and especially surface drip) seems to be effective for use in shallow soils and overcoming certain site constraints (e.g. heavily wooded areas and tree protection, etc.).
- The use of LPP dispersal is becoming less common on sloping sites.
- The state monitors/tracks: delivery rates for LPPs and pressure manifold systems; and flushing pressures and flow rates for drip systems.

Observations Relative to Systems Performance

- With respect to any performance problems observed with systems serving seasonal use facilities, sufficient equalization, seems to take care of most problems. However, seasonal issues are an important consideration for the biology in package plants in resort areas (e.g., feast/famine effect).
- There have been problems with high nitrates in the effluent of RSFs serving schools (lots of urea/NH_3, and low solids/feces/BOD). Effluent nitrate levels of 50-60 ppm are common. The use of coarse versus fine sand in RSFs, and rainwater entering RSFs tend to exacerbate performance problems.
- For package plants, particularly along the coast (salt), corrosion is a never-ending problem. This includes structural corrosion as well as components, particularly for vigorously aerated systems (e.g., extended aeration).
- Flow equalization is important for hotels (diurnal as well as weekly/seasonal issues).

- With regard to any operational or performance problems with certain treatment processes that may be tied to specific things, such as lack of equalization; sufficient primary settling capacity; use of effluent filters of screens, etc.: Generally, there has been an ability to address such specific problems with evolving technology-specific requirements or guidelines over the years. Examples of these include flow equalization and effluent filters. Coarse screening and static screens present an issue for package plants, because of the solid waste disposal issue. Alternatively, grinder pumps and comminuters have their own issues.
- Lift stations in conventional collection systems are often a weak link, especially along the coast. Over-wash can flood lift stations, and corrosion is a major issue (similarly to package plants in coastal areas).
- There were some observed issues with Nibbler systems, but they appear to have been addressed (there are only six to seven such systems in the state)
- Bioclere treatment systems serving large scale systems seem to demonstrate good performance.
- Extended aeration/activated sludge package plant maintenance and cost management presents challenges.
- Septic tank longevity (concrete corrosion) is a concern.
- LPP "hole shadowing" and clogging have been a concern in the past, though guidelines and requirements incorporated over the years of experience have helped a lot.

<u>Public Complaints or Requested Changes</u>

- Public input on subsurface systems is more or less on an informal basis (no public hearings are specifically required for systems).
- There is a movement in Carteret County for a moratorium on large package plants. North State Utilities/Harrco Utilities management failures seemed to put a stigma on community systems in the Piedmont area. The utility structure doesn't really address management effectively.
- Length of permitting process an issue for many in development community.

<u>Observed Regulatory Challenges and Suggested Changes</u>

- There appears to be very little research basis that has gone into the "real-world" operation of large onsite treatment (or "pre-treatment", prior to final soil treatment) systems.
- There is still not a lot known about what is happening once the effluent enters the subsurface. The definition of a "working" system is mostly limited to superficial/easily monitored systems aspects.
- Design standardization/package systems (pretreatment + discharge/disposal technology) are increasing trends.
- A stronger federal/EPA presence is needed with onsite/decentralized systems.
- There are no systematic means and drivers for LHDs to keep up with systems.
- Financial incentives (e.g., construction grants) are needed for management.
- Need standards for keeping systems managed properly when property changes hands.
- The differences in NC between DWQ and OSWS rules and policies are an issue (procedures/requirements are very different).
- How should the state best process/use groundwater monitoring results?

- There's a need to improve operator training and compliance (this is all done by DWQ, even for OSWS systems) and to hold operators accountable for compliance in addition to the owner. Installer certification is coming and this should help.
- Utilities' structures are an issue relative to management (e.g., utility can't assess customers for preventative maintenance; they also could insure subsurface system components). The experience in NC's Public Water Supply section may be transferable here.
- Some projects are high profile for random, usually misinformed reasons (this can't really be generalized.)
- There have been some problems with schools doing wastewater systems related work without having the necessary permits in place.

3.3.1.8 **Pennsylvania** [CES]

General Regulatory Program and Systems Management Considerations:

- The planning section of DEP reviews and permits all systems with flows > 10,000 gpd, as well as smaller systems for which there is a nitrogen permit limit. For other systems less than 10,000 gpd, DEP may still review the application, but they would be permitted locally by the applicable permitting/enforcement authority.
- All systems permitted by DEP must be designed by a licensed professional engineer (PE). Local discretion is exercised by local permitting authorities on who may design non-DEP permitted systems.
- PE inspections are relied upon for verifying proper installation of DEP-permitted systems. The PE sends a "form of completion" to DEP, stating that installation was completed in accordance with the design and permitting requirements. No official DEP inspection occurs during construction.
- If DEP is involved in issuing the permit, it specifies the O&M requirements. For locally permitted systems, maintenance contracts tend to be relied up, however this might be required under the permit.
- Weekly or monthly monitoring of conventional parameters (e.g., BOD, TSS, and NH_3) is typically required. For subsurface dispersal systems, permits may specify total nitrogen (TN) limits and monitoring requirements (commonly on a monthly basis). [TN limits are applied to only a few small individual onsite system permits, in areas with high groundwater nitrate levels.]
- For surface discharge systems, conventional parameters are typically monitored on a weekly basis, and this might include NH_3 (rather than TN). Surface discharge systems tend to be permitted on a watershed basis, with limits based on applicable water quality conditions for the watershed.

Systems Design Issues and Observations

- There tend to be more large scale decentralized systems in central and eastern PA, with mostly subdivisions and schools served by those systems.
- DEP reviews designs for soundness of basic approach and details of the design, but does not dictate approach or specific method/type of treatment process or system used.
- With regard to the type(s) of collection systems most commonly used to serve large/community scale decentralized systems, typically conventional gravity collection systems are used.

- PA currently has a Technology Verification Protocol (TVP) program underway. AdvanTex units are currently being tested under this NSF-type testing program for individual residences. A system utilizing recirculating sand filters with wetland polishing is being tested for a community system of about 100 homes. This community system has just recently gone into service. The TVP program is expected to help guide design approaches and system selection over time in the state.
- Currently, for large scale systems, SBRs and MBRs (activated sludge processes) tend to be used more than other treatment processes prior to subsurface dispersal. A few Bioclere units are also used prior to subsurface dispersal.
- Effluent filters are tending to be specified increasingly for larger scale primary treatment tanks.
- Drip irrigation systems tend to be used increasingly for systems > 10,000 gpd, while trench/bed subsurface dispersal systems tend to be used for smaller scale systems. Previously, either gravity fed or pressure dosed trench/bed systems were used for larger scale systems.

Observations Relative to Systems Performance

- For gravity fed subsurface dispersal systems, there have historically been problems with very uneven distribution, and surfacing of effluent has been observed.
- For pressure dosed trench/bed systems, some pump problems were observed in the past, but these have been corrected by tightening pump specifications/standards.
- For drip irrigation systems, there have been some problems with freezing of lines in distribution boxes that were not adequately insulated. Also, in forested areas where there can be substantial soil moisture, there have been some problems with trees/limbs falling and damaging drip system lines/components. There are installation problems with drip lines where soils are very rocky.

Public Complaints or Requested Changes

- There is often significant public opposition to the use and DEP approval of surface irrigation systems. Concerns are expressed about spray “drift”.

Observed Regulatory Challenges and Suggested Policy Changes

- For larger systems (DEP permitted), there are not specific design criteria or requirements for unit processes such as primary treatment. Therefore, the design depends on the particular engineer’s approach.
- There is a need for more engineer/designer, installer, and operator training specific to decentralized wastewater systems (large and small).
- There’s a need to establish the upper limits for soil loading rates for drip irrigation systems, as driven by pressures by applicants to continually push for higher limits. A rational and well-founded scientific basis for establishing upper limits is needed.
- Within the regulatory/permitting segment of the decentralized wastewater industry, there appears to be a widespread lack of understanding of “what success is”. There is observably not enough flexibility or rational approach used for setting permitting requirements for all sizes of systems. Parameters should be set forth in the permit that will establish and verify true “success”, however that is defined for the specific setting/conditions.

- Municipalities are challenged politically with implementing management practices for decentralized wastewater systems, and particularly small scale systems. For larger scale systems, locating and contracting with responsible/reliable, well-trained and experienced operators can be challenging. In general, municipal/public management of larger scale or clustered decentralized systems seems to offer benefits that may be less easily achieved by private management approaches (e.g., quality and cost controls).
- There are concerns about the management of decentralized wastewater systems in general, both small and large. The larger the system, the more funding there is typically available for the on-going care/management of the system.
- High quality training/certification is badly needed for designers, operators and installers of systems.
- Installer/installation oversight and quality control is a huge issue and concern.

3.3.1.9 **Tennessee** [ARCADIS]

General Regulatory Program and Systems Management Considerations:

- Regulatory authority for large scale decentralized wastewater systems in Tennessee has historically been broken up by depth of dispersal and complexity of system. The Groundwater Protection Program (GWP) has handled conventional (septic tank pretreatment) systems and more complex systems if 7” or deeper. The Division of Water Pollution Control (WPC) handled more complex systems installed at less than 7” depth.
- Divisions of WPC and GWP are in the process of trying to delineate responsibilities and draft a Memorandum of Agreement (MOA). In the future, it is most likely that all "subsurface" projects will be reviewed by GWP and surface spray projects will be reviewed by WPC. The question that still has to be resolved is where the line will be drawn on what size project above the single unit that will be required to have as SOP. The 4,500 GPD is probably close to where this line will be drawn. It may be in terms of units (10 to 15) or design flow (3,000 to 4,500 GPD).
- In all cases, WPC will issue state operation permits (SOP) for these projects (surface or subsurface applications, with flows greater than the designated break point). GWP will deal with individual homes; no SOP will be required for those.
- The GWP has state employees in each county; some still officing in county health departments. Some counties contract with the state to administer the program; their requirements must be as or more stringent than the state rules. GWP field staff help with inspections.
- A professional engineer’s (PE) design is required for WPC-permitted systems with advanced treatment. The GWP requires engineered plans for large system (cluster residential) approval.
- WPC requires PE certification of systems installations; field staff do some inspections. There are 8 field offices with different levels of interest in decentralized systems. The GWP does intensive inspection; largely for single-family systems.
- Soil/site evaluations are done by GWP staff or approved consultants. Engineered systems/complex systems require a soil/site consultant and report.
- The WPC issues a state operating permit similar to an NPDES permit (five year, reapplication, monitoring requirements, operator certification) with state inspections on an as-needed basis.

- The GWP requires a maintenance entity for systems with treatment (beyond septic tank treatment).
- WPC program: For drip systems, there are requirements for quarterly monitoring for BOD, ammonia (needs to be reported to assess secondary treatment unit performance ahead of drip, but there is no permit limit), nitrates (in some situations), and *E. Coli* if the drip system area is not fenced. Disinfection/*E. Coli* monitoring is required for spray irrigation systems.
- The state does not issue operating permits to homeowners' associations or private individuals; only to public utilities, water/wastewater authority, municipal authority, and privately-owned utilities (these are regulated by the Tennessee Regulatory Authority).

<u>Systems Design Issues and Observations</u>

- The majority of large/community scale decentralized systems in the state are located around the major metro areas: counties surrounding Knoxville and Nashville and near the Great Smoky Mountains/Gatlinburg (Sevier Co.).
- With regard to the types of collection systems serving large scale systems, only about 1% are purely conventional gravity systems; STEP and grinder pump are the most common, with about 75-80% being STEP systems.
- The state has design criteria/guidance for these various types of collection systems.
- The predominant types of facilities served by these systems are subdivisions (homes on one-half to one-third acre lots), recreational areas, rest stops, campgrounds, schools, and some commercial developments (shopping centers). Of those, GWP mostly deals with residential facilities.
- With respect to the most commonly used methods of treatment in the state: Initial treatment with a septic tank is typically used for all systems (STEP or STEG collection provides this for clusters), followed by secondary/biological treatment, with ~90% being recirculating sand filters (RSF). There are some other attached growth systems using in the state, like AdvanTex and Bioclere. These are usually only used if the site is space-limited. Otherwise, RSF is typically used.
- Pretreatment via one of the above methods is usually followed by spin/disc filter before drip dispersal systems. RSF to drip is the most common combination of treatment and dispersal methods, although the choice of technology varies somewhat with size.
- For drip, some level of disinfection is required (the vast majority employ UV disinfection). For reclaimed water, chlorine disinfection is used for achieving the necessary residual chloride.
- The state does not support the use of plastic septic tanks in situations requiring water-tightness. The fill/draw sequence stresses the seams and causes leakage after time. In these situations, the use of one-piece concrete or fiberglass tanks is preferred (although fiberglass tanks are twice as expensive as a conventional concrete tank).
- There appear to be trends away from effluent discharges, and toward the use of land application systems. Communities with discharges are often unable to grow because of limits on assimilative capacity of the receiving water. Some large cities that are maxed out on their discharge are going to land application with conventional treatment. Virtually all systems in the 5,000-50,000 gpd range utilize drip irrigation, although some golf courses use spray irrigation. GWP permits some LPP systems, although it is not commonly used for large systems in TN.

- ♦ Drip is used in areas with limited suitability for conventional dispersal (e.g., most of central TN).WPC requires an extra high intensity soil map (borings to 4 ft or refusal on 50’ grid and 1-2 pits or more per soil type).The hydraulic loading rate is determined from MPI/percolation rate tables based on soil characteristics. Additionally at least 2 feet of soil depth is needed.
- ♦ The use of spin/disc filters is required for drip systems. Both hydraulic and nutrient loading (uptake of cover crop) calculations are required for determining application rates. Plant available nitrogen (PAN) is very significant for these types of systems and nutrient loading controls most sites. When high uptake crops are specified, they include a permit condition requiring that the vegetation be cut and exported to manage nutrients. The default approach is to use a “U” value of 50 lbs/acre and nitrate < 20 mg/l NOx which yields an LTAR of 0.2 gpd per square foot. The nitrogen concentration used in the calculations becomes a permit limit that has to be met.
- ♦ Wastewater reuse is being employed for several golf courses around the state. For golf courses, a dedicated disposal area is needed – or at least a backup drip area – unless there is a permanent right of disposal on the golf course property. The state is just getting into the application of reuse for landscaping. There is at least one municipal-scale reuse system.
- ♦ With respect to reuse systems, there is a need for dedicated disposal areas or storage for winter conditions.
- ♦ For a long time, the GWP saw large tracts of land that could only accommodate a few lots because the occurrence of good soil conditions was so limited on those sites. The cluster systems approach has facilitated much better site utilization, and the utilization of the best soils on sites.
- ♦ GWP requires a duplicate dispersal field area (100% reserve) for all systems.

<u>Observations Relative to Systems Performance</u>

- ♦ For schools – fixed media systems appear to function better than systems using suspended growth processes. Existing schools are retrofitting/replacing existing suspended growth systems during expansions and when there are major compliance problems.
- ♦ Biological treatment units (especially attached growth) seem to be fairly “forgiving”.
- ♦ UV disinfection unit maintenance is inadequate. They are maintained every couple of months just before taking compliance samples, and sometimes the analyses still are not able to comply with applicable requirements.
- ♦ There are concerns about the reliability of telemetry systems.
- ♦ The state regulators interviewed are less comfortable with suspended growth treatment systems than with attached growth/fixed film systems. Old extended aeration treatment plants are out of favor: For <30,000 gpd, they will not be approved; For up to 100,000 gpd, they need specific approval. [Suspended growth/ATUs are not used for single residential applications anymore in the state.]

<u>Public Complaints or Requested Changes</u>

- ♦ Clustering and new technologies are allowing growth in areas which haven’t experienced growth before. There have been permit objections by the public driven by overall objections to growth, rather than the wastewater system per se.

- There was one complaint from a neighbor about a contractor not putting drip lines deep enough, which was causing surfacing of effluent, but this was an isolated installation issue.

<u>Observed Regulatory Challenges and Suggested Policy Changes</u>

- The state is headed toward doing more in-depth soil/site evaluations. The GWP has soil scientists, so WPC is working with them on site evaluations. The Tennessee regulators interviewed observe that there is a “disconnect” between soil scientists and engineers/designers. They don’t feel that a hydro-geological assessment is a good way to determine loading rates due to site heterogeneity, but it can be used to supplement a soil evaluation.
- A big question the regulators see as needing to be answered is: How well and how long will systems operate when loaded at design capacity?
- The regulators participating in this discussion have concerns about the long-term viability of privately owned public utilities. In particular, they wonder how these private utilities will ensure that they will be there to serve the homes for many years. The utilities appear to have sufficient revenue flow for now; they charge developers for design, construction and administration, but are required to operate at a rate that protects the customer and will probably not be making as much money over time on operations as systems age and require more infusion of monetary resources. If a company goes out of business, could another step in and be profitable/viable?

3.3.1.10 Vermont [ARCADIS]

<u>General Regulatory Program and Systems Management Considerations:</u>

- The Vermont Department of Environmental Conservation, Wastewater Management Division, Indirect Discharge Permits Section has responsibility for large scale decentralized systems relying on land/soil disposition of treated effluent (non-NPDES systems). The Small Scale Rules regulate systems less than 6,500 gpd, and the Indirect Discharge Rules regulate systems greater than 6,500 gpd.
- Professional engineers (PEs) must be responsible for all designs submitted to the Indirect Discharge Permits Section.
- The permit issued contains construction inspection requirements which require the permittee to contract with a Vermont registered PE to oversee construction and certify that the construction of the system was in accordance with the approved engineering plans.
- The permit contains requirements for annual inspection of these systems by a VT registered PE who submits a report to the State as to the condition of the system permit.
- Systems which involve pretreatment are required to have an operator and usually also have system effluent quality monitoring and reporting requirements.
- Monitoring requirements depend on several factors, including when the system was installed. New requirements began in May, 1986. Subsurface systems installed before that date have minimal monitoring requirements (occasional septic tank effluent sampling and monthly flow measurements). However, surface discharging systems installed before that date have monitoring requirements for effluent treatment, groundwater quality and stream water quality. All systems installed after that date have these monitoring requirements because of water quality standards which the system must meet.

- For systems built after May, 1986, a stream biological standard applies as the effluent from the system will eventually reach the stream via groundwater flow (hence the terminology "indirect discharge"). Therefore, the effluent, groundwater and stream monitoring requirements for these systems are greater than for the pre-1986 systems which were essentially grandfathered.
- At this juncture the state has developed a permitting program which provides data on stream water quality through permittee self-monitoring, as well as considerable amounts of data for effluent and groundwater quality

Systems Design Issues and Observations

- The locations of most large scale decentralized systems in Vermont are pretty well distributed around the state, but generally are in connection with ski area development. Ski areas are located in mountainous terrain which lends itself to spray irrigation systems rather than subsurface disposal. Many ski areas have treatment facilities followed by spray irrigation in forested areas.
- Most systems serve resorts, condos, vacation homes and second homes.
- With regard to the types of collection systems most commonly used in Vermont to serve large/community scale decentralized systems, primarily conventional gravity with lift stations is used, with a few (10%) STEP systems.
- With respect to the types of treatment systems most commonly used, there has been an increase in Sequencing Batch Reactors (SBRs) in the past 10 years. There may be an increase in Zenon treatment facilities, but this trend is too new to be certain.
- For the largest systems, spray irrigation is utilized for final effluent disposition. The treatment process must meet 30/30 mg/L BOD_5/TSS on a max daily basis. The treatment technology doesn't appear to vary with effluent disposition type or geographical location in the state.
- Regulators have noticed a trend towards increasing telemetry for reporting alarm condition to operators, but those systems may have their own sets of problems.
- Tertiary treated effluent is required for subsurface disposal for systems >50,000 gpd. When UV disinfection is added to the treatment process, this essentially reduces the effluent disposition issues to hydrogeologic (water loading and construction) constraints.
- With respect to trends in final effluent dispersal during the past 10-20 years, Vermont went through a phase in the 1970s to early 1990s of permitting spray irrigation disposal in forested environs. Some of the earlier approvals were allowed in areas the state would not allow today due to soil types. It is difficult locating a spray field today due to the land area requirements (allowable disposal rate of two inches per week over the wetted area of secondary treated effluent) as well as locating a stream which can assimilate the treated effluent after passage through the shallow soils without causing alterations of the stream chemistry and aquatic biota therein. The trend now may be towards tertiary treatment and UV disinfection which, under the current rules, allows for up to 4.5 gpd/ft^2 in a subsurface drain field that can be located near a major stream or river. However, some areas in western Vermont contain clay soils and do not lend themselves to large subsurface drain fields.
- Reuse is sometimes used in conjunction with large scale decentralized systems in Vermont, but it is not common. At the Killington Ski Area it is used for urinal and toilet flushing; but this has not caught on as a trend.

Observations Relative to Systems Performance

- For some resort systems (summer usage facilities) there are start-up problems in early summer when the system begins to see loading again after a long dormant period. The state has recommended preloading these systems to develop the bacterial populations necessary for effective treatment (preload with dog biscuits for example).

Public Complaints or Requested Changes

- The only concerns expressed by the public about larger decentralized systems appear to be regarding environmental (water quality) impacts of some of the largest spray disposal systems.

Observed Regulatory Challenges and Suggested Policy Changes

- Out of necessity, the state has essentially placed the responsibility for management and performance issues on the backs of the permittees by requiring the annual inspection of these systems. The state's field personnel presence is extremely limited, as there are only two persons tracking about 200 or so systems across the state. Therefore, staffing and resources tend to be a limiting factor.

3.3.1.11 **West Virginia** [ARCADIS]

General Regulatory Program and Systems Management Considerations:

- For decentralized wastewater systems in West Virginia, the UIC program deals with all residential (excluding single family homes) and non-residential systems with subsurface effluent disposition. Systems with a design flow of 3,000 gpd or more require state approval and permitting, and the facilities have to meet waste load limits. Systems with a design of 40,000 gallons per day or more are required to have in-ground monitoring.
- Systems with design flows of 3,000 gpd and larger are approved by the West Virginia Department of Health and Human Resources, Office of Environmental Health Services (OEHS) for plan review and approval and issuance of a construction permit. After a construction permit is issued, the application goes to the Department of Environmental Protection/Groundwater/UIC Program for review and approval. The UIC Program issues a five-year renewable operation permit. The state does not regulate single-family systems; these are permitted at the county health department level.
- The system design is approved before it goes to the UIC Program for permitting the operation of the system. Operation and maintenance and monitoring requirements are placed on the plant by permit conditions. The plant is monitored at start up and continues for the life of the permit.
- A professional engineer (PE) is required to design all systems with flows greater than 3,000 gallons per day.
- These systems must be installed by a state-certified installer.
- For Level 4 or Level 5 systems management models (management levels for which there is a responsible management entity (RME), as described in EPA's Voluntary Guidelines), a state-certified operator is required. The owner's contract with the RME must be for five-year permit duration.

- All large system permits include O&M requirements.
- With regard to systems monitoring requirements, the state requires that permittees monitor discharge (effluent) total nitrogen, TSS, total phosphorus, BOD, Oil &Grease, temperature, fecal coliform, pH, dissolved oxygen and flow. RV campgrounds have additional monitoring parameters, such as formaldehyde, propylene glycol, ethylene glycol, and dichlorobenzene. Surface irrigation monitoring requirements are dealt with by the NPDES program.
- The UIC Program has adopted the use of a mass balance calculating spreadsheet that was developed by Anish R. Jantrania and used by the state of Virginia. The hydrologic model (Excel spreadsheet) is used to determine if the plant can meet the permit conditions, and suggests larger drain fields or lowering the design flow in order to be able to meet set the permit conditions if needed.

Systems Design Issues and Observations

- There tend to be more large scale decentralized systems located in the eastern panhandle, because of growth trends (Martinsburg, Jefferson, Berkeley, and Morgan County). There are some in resort-type areas like those around the New River Gorge, for second homes, etc.
- Large scale systems in West Virginia mainly serve residential subdivisions, campgrounds, and associated facilities (e.g., some schools, shopping centers, etc.).
- With regard to the types of collection systems that are most commonly used to serve large/community scale decentralized systems, (STEP/STEG) is the most common for residential subdivisions.
- The most common treatment systems used are recirculating sand filters, with some peat and other media filters. Some membrane filters are also used. These large systems must also include disinfection, such as UV disinfection or chlorination. The treatment method used varies based on characteristics of the site and type of system.
- With respect to the most common types of dispersal methods used for large systems, drip irrigation is most common because it seems to work better in the WV terrain It can be used in most places because of shallow line placement. Some Infiltrator units and gravelless pipe systems are used, and LPP on occasion. Drip irrigation seems to be the most common method at used currently. In general however, the method of dispersal used depends on the site conditions.

Observations Relative to Systems Performance

- For larger systems, the state does not yet have much data because the UIC Program has only been putting monitoring conditions in their permits for about two years. Therefore, operating problems are not known at this time. Data collection will be forthcoming over time.

Public Complaints or Requested Changes

- In Jefferson and Berkeley Counties there has been opposition from locals who oppose growth, so they complain about the permits. WV DEP grants public hearings, if even one person asks for a public hearing.
- Capital costs are turning out to be a lot higher than anticipated, especially for retrofitting an existing community system. In southern, more rural communities it was hoped that

retrofit costs would be about $10,000/house, but situations have been encountered where a community system costs approximately $28,000 per house.

Observed Regulatory Challenges and Suggested Policy Changes

- The programs need more money for oversight/enforcement. There are two UIC inspectors who look at new and existing systems and try to find systems that are not properly permitted and get them permitted. These could be very old systems or ones for which the proper process was not followed. District inspectors (DEP people in regional offices) also inspect all types of systems and take complaints. County sanitarians are very important to the permitting of the new systems, as well as assisting in locational data and information collection.
- Very few engineers in the state are able and willing to design these types of systems – Rather, they tend to stick to the types of things that they know. This is especially the case in rural areas where alternative approaches are resisted.
- A few public service districts (PSDs) are beginning to provide O&M for decentralized systems. The state is encouraging them to take on this activity. One PSD is the RME for a subdivision system in Jefferson County. Others have expressed an interest in doing the same. (At least a Level 4 or 5 Management Model RME is required for all large systems.) The system owner can contract a certified operator/individual as their Level 4 Operator for the life of the permit.

3.3.2 Discussions with Systems Managers/Operators

As a part of the detailed data gathering process, there was an opportunity to invite observations and comments from systems operators regarding the performance of various types of systems. A detailed telephone discussion was also conducted with an engineer working with a relatively large New England design/build/operate company. The observations and comments provided to CES by those persons are summarized below.

3.3.2.1 New England Design/Build/Operate Company

Description of Company and Activities

- Applied Water Management (AWM) operates/manages approximately 200 systems in New Jersey, Pennsylvania, Delaware, Connecticut, Massachusetts, Nevada and Rhode Island, and employs about 200 persons. These systems tend to be larger than 5,000 gpd, with flows up to approximately 300,000 gpd.
- The company contracts directly with property owners for commercial properties. For single family systems, the contract is with the resident of the property. In general, contracts are with those who pay the utility bill for the wastewater services. AWM also owns several regulated community on-site systems through its sister company Applied Wastewater Management, Inc (AWWM).
- AWM typically serves as the RME. Typical user charges are flat rate charges of $75-$80/month for residential properties. Applying charges through flow metering is pending, but currently not occurring. The monthly user charges include design/construction, operation and maintenance, repairs, and replacement(s) over time. Given there is a fixed uniform rate for all customers and not all systems are the same, the equity investment (how much is paid up front for the customer) varies. Ultimately, once AWM owns the system, it then owns all responsibility for repair, replacement and upgrades. If the system

is large enough, the developer gets all of his costs back and AWM essentially builds the system for them. If the system is very small, the developer contributes the asset to the utility at no charge, therefore the developer pays for all the initial capital costs. Each system is evaluated on its own merits and economics and that establishes how much the firm pays for the initial asset.

- At the time of this discussion AWM was not certified as an operator for specific proprietary systems. The company does not wish to be confined to using or working with any particular type of system or manufacturer, and instead selects the technology based on the performance needs/requirements and specific conditions.
- AWM maintains all records required by regulatory authorities, but mostly in paper format (hard copies). NPDES reporting is typically required for the systems managed by the company.
- AWM does web-based controls and monitoring for unit processes. However, in that NPDES compliance monitoring requires that the samples go to a certified laboratory for testing, the company doesn't do remote monitoring for regulatory compliance purposes.

Collection, Treatment and Dispersal Systems Issues and Observations

- With respect to the types of collection systems most commonly employed by AWM for the systems it manages, approximately 75% of these systems use conventional gravity collection systems with lift stations as needed, and most of the remaining collection systems are variable grade effluent sewers. There is one grinder pressure sewer system. VGS and STEP systems are the most common alternative collection systems in each state where AWM operates.
- With regard to types of treatment systems used/managed by AWM, approximately 60-70% of the systems use membrane bioreactors (MBRs), and about 20-30% use sequencing batch reactors (SBRs). There are a few extended aeration treatment plants, making up the remaining 5% or so.
- The type of treatment system used is based on the permit requirements and the performance needs.
- MBRs are often used because "they offer safety and reliability in that they provide a positive barrier against breakthrough of solids, they can be run at a high solids level which makes them less vulnerable to changes in influent concentrations, and they're relatively easy to operate and control remotely (the controls are easy to automate)".
- With respect to the most commonly used dispersal methods used by AWM for systems, primarily land application systems including groundwater recharge subsurface dispersal systems are used following treatment for AWM-managed systems. Those include low pressure dosing and infiltration ponds. Spray irrigation, drip irrigation, and other reuse strategies such as industrial reuse and reuse for cooling water and laundry are incorporated and employed in systems.
- The final effluent dispersal method used is based on each site's soil and geology, so the designs vary from site to site. Infiltration ponds work very well wherever they can be used. They can be drained and cleaned if needed.

Observations Relative to Systems Performance

- The grinder pressure sewer system has had significantly more problems than either of the other two types of collection systems (conventional gravity or effluent collection) used by

AWM in their systems. Those problems have included pipe breakage and plugged/jammed grinders/pumps.

- Issues related to ownership of the on-site portion of the system must be considered and taken into account. AWM has found that system management of repair and maintenance of equipment on homeowner's properties must be addressed. One successful strategy has been to have AWM be on call for repair, with responsibility for the repair (homeowner v. utility) being determined as the repair is made, with the priority on bringing the system on-line. This type of arrangement must be planned, communicated and managed in advance.
- STEP systems are often preferred by AWM from an O&M standpoint. AWM has it own vacuum truck, which helps in coordinating tank pump-outs. Having cast-iron frames and covers set at grade has also helped prevent problems. They are easy to locate, don't get broken and kids usually can't open them and possibly fall in. Having access lids at grade is very important to cost-effective and efficient O&M. AWM works with developers/builders to lay out systems with the wastewater components needing periodic servicing located next to the road (with an easement for access).
- Having "cradle to grave" responsibility for a system tends to improve its performance. AWM designs, constructs, operates and usually owns the systems it manages. Ownership, and financial responsibility for a system tends to create a different (higher) level of interest and concern with a system than non-ownership.
- No particular problems have been observed in monitoring results for systems. Effluent total nitrogen levels around 5 mg/L can be achieved, and no adverse groundwater impacts have been observed at sites.
- A number of AWM-managed systems incorporate effluent reuse, and in some cases effluent recycle. Those include irrigation systems for golf courses and landscaping, and recycled water for toilets, cooling towers and laundry.

<u>Public Complaints or Requested Changes</u>

- There have not tended to be complaints from the public about service or function of STEP systems. As compared with traditional/conventional collection systems, when effluent sewers are used residents tend to have more knowledge about the overall wastewater system because they see more things going on and often talk directly with service personnel. In general though, they don't experience the system differently than with a conventional collection and treatment system.
- "System charges and rates are a regular subject of discussion. AWM works with customers to provide education regarding system operation costs and resulting system charges."

<u>Observations Relative to Regulations, Policies, and Systems' Performance and Management</u>

- Good, consistent enforcement makes for good quality performance. In New Jersey, for example, when violations of enforcement were changed to be a criminal rather than a civil matter, systems owners/managers became much more compliant with regulatory requirements.
- Rolling averages on system performance (as opposed to instantaneous maximum values for effluent limit requirements) would enable the use of more passive treatment processes that consume significantly less energy/power.

- The public tends to be afraid of cluster system zoning because they don't want higher density, but they fail to recognize the benefits of preserving significant open spaces.
- Direct reuse is great from a monitoring standpoint because there's no public tolerance for odors or lesser effluent quality when people are directly exposed to or using the water.
- Better enforcement brings about better performance.
- It would be helpful if the regulatory authorities and structure would let the technologies meet the performance requirements, and regulators have less involvement in driving which particular technologies are used.
- As an operations-driven company, AWM's focus has been on long-term operational efficiencies and minimizing labor requirements.
- To run a small plant in way that rate payers can afford is challenging. To do so, AWM operates multiple plants in a region with a team of operators, maintenance technicians and managers. An operator may be able to cover several plants with visits of a few hours per day on intermittent days when procedures and practices are defined and standardized and automation is provided. Those operators must be trained in safety practices as well as monitoring and maintaining plants. Managers hire and train staff as well as monitor reporting to glean any trends that may offer an opportunity for improving practices. Maintenance technicians who do scheduled maintenance and address mechanical malfunction can require different skill sets than operators. AWM's structure provides for maintenance crews that support multiple operators and answer to the same management.
- Small plants can be particularly challenging to start up. Early on AWM learned that combining facilities by storing initial low flow in equalization then hauling to an established plant not yet at capacity had benefits and enabled us to stage an installation. Adding more equalization in front of the plant generally proved to have significant benefit. It enabled the company to have measured response in the event of plant equipment or process upset.
- AWM also learned to add automation and refined that automation to run warnings at various levels of urgency back to our central location. Locally deployed operators and maintenance crews that are centrally managed work well when automation is provided. In some ways this would be analogous to many decentralized plants being managed as one larger plant.
- In smaller plants, economical residuals management is a challenge. The complexities and space requirements of screw presses and anaerobic treatment just don't make sense for a small plant. AWM learned to network plants by having the local decentralized plant be a storage and aeration location with larger central or dedicated plants used for residuals management. Part of this strategy was to learn to properly size sludge holding, decanting and transport facilities so as not to disturb bucolic neighborhoods with more than one or two truck runs per month.
- Odor and noise control is often a challenge that needs to be met. There are many ways to deal with noise and odor control for smaller plants. AWM learned that a barn-type enclosure is both cost effective and attractive way to deal with it. Inside the plant AWM uses dedicated scrubbers with activated carbon to keep odors isolated and down. Moisture control becomes an issue indoors, so the company's designs now incorporate adequate seasonally and indoor humidity based variable ventilation.

- With regard to choice of technology for smaller plants particularly with land application or reuse, AWM found that membrane treatment offered the flexibility and reliability of running at a higher mixed liquor suspended solids and a positive barrier at the end of the plant, and properly designed and operated required less operator attention than other technologies. With plants over 1 mgd, this starts to become marginal because of energy and membrane replacement costs, but as AWM gets better at taking care of the membranes the replacement costs go down.
- Energy costs has become an emerging area of operations focus for AWM in the past few years, and the company is committed to finding ways in the water business as well as the wastewater business to recover energy and to use locally renewable sources. There are many strategies available, but one example at a larger plant that applies to smaller plants is the use of solar cells. The Canal Road water treatment facility in Somerset, NJ has acres of cells that are being used to evaluate this option. Smaller plants have roof area and with underground land application bed area that can be employed when the economics work out.
- A subject of research in AWM's parent company (American Water) involves disinfection practices. AWM is finding that, as already required in several states, a small residual of disinfectant at the end for reclaimed water is very effective in eliminating "re-growth". This is combined with UV and ozone for economic and effective disinfection. For land application and some reclaimed water uses, the disinfectant residual is not necessary and perhaps not desirable.
- Fine screens at the head of the plant "make all the difference in membrane life and maintenance costs". Through experimentation at plants, AWM has found a very efficient technology to accomplish that. They use them at all new plants and have retrofitted most of those the company owns. AWM is still having an internal debate as to whether 1 mm or 2 mm openings are needed to prevent fiber reformation. Over the years, AWM has learned about "membrane scour, CIP, startup, flux rates, filamentous bacteria control, blower selection and application and numerous other refinements."

3.3.2.2 Southeastern U.S. Design/Build/Operate Company

<u>Description of Company and Activities</u>

- Adenus Utilities Group operates/manages approximately 100 systems in Kentucky, Tennessee, Alabama and Georgia, and employs about 75 persons. Flows for these systems tend to range from single home units up to approximately 2 MGD.
- The Adenus family of companies describes itself as "vertically integrated" to provide design, build and own/operate for the general public, including residential, industrial and commercial. For single family systems, the contract is with the resident of the property. In general, contracts are with those who pay the utility bill for the wastewater services. Most customers are served as an U.S. EPA Level V program (i.e., the utility owns and operates all components of the system).
- Typical user charges are flat rate charges of $40 to $50 per month for residential properties. Charges are generally flat rate for residential and commercial customers. The monthly user charges cover operation and maintenance, repairs, and replacement(s) over time. Escrow accounts are established for replacement of system components. All billing and administration is handled through the Adenus home office.

- The company has many certified collection and treatment operators. Adenus designs, build and operates many different technologies from fixed film (media filters), to lagoons to activated sludge with membrane filtration. The company's goal is to match the most cost effective, best long term wastewater treatment solution to a (customer) /community need.
- The firm maintains all records required by regulatory authorities, mostly in electronic format. Adenus has established a QA/QC program that it believes is effective for environmental and financial performance.
- Adenus operates an in-house web-based telemetry monitoring and operating system for unit processes, and verification/implementation of QA/QC program.

Collection, Treatment and Dispersal Systems Issues and Observations

- With respect to the types of collection systems most commonly employed by Adenus for the systems it manages, approximately 75 of these systems use septic tank effluent gravity collection systems with lift stations as needed (STEG collection with effluent lift stations), and most of the remaining collection systems are septic tank effluent pump systems (STEP).
- With regard to types of treatment systems used/managed by Adenus, approximately 70% of the systems use fixed film (sand filters, geotextile filters, RBCs, trickling filters, wetlands etc.) and about 25% use Deep Cell Lagoons (ranging from 50,000 GPD to over 2 MGD capacities.
- Regional "distributed" systems are being designed and built using membrane technology. Typically these are larger plants (with build out to 5 MGD or more). There are a few high strength waste plants using aeration and attached growth/moving bed technology. These treatment plants, while contributing a large percent of the treatment capacity, only account for less than 5% or so of the total number of systems.
- The selection of treatment technology is generally based on a 40-year life cycle operating-replacement analysis.
- Proprietary treatment systems are not favored, due to lack of control over replacement parts (and related costs).
- Generally, simple, easy to operate and maintain "natural systems" provide the lowest 40-year life cycle cost.
- With respect to the most commonly used dispersal methods used by Adenus for systems, primarily pressure compensating drip dispersal systems are used.
- Careful planning and soil analysis has resulted in very few problems with drip dispersal systems. Adenus has adopted a conservative maximum loading rate, and used the best soils available for it land application systems.

Observations Relative to Systems Performance

- Effluent collection systems have been the exclusive choice. Adenus has consistently built watertight collection systems, and has maintained them in that same condition.
- Adenus reports there have been very few treatment issues for any of the multitude of different technologies. Having a consistent quantity and strength of wastewater entering the treatment process has eliminated the normal problems associated with treatment system. All technologies have generally performed as designed.

- With respect to methods of treatment used for Adenus-managed systems for varying flow and waste strength, the company strongly prefers the use of fixed film systems (e.g. sand filters, geotextile, Bioclere, and peat filter media). They have consistently found that fixed film systems provide superior treatment reliability.
- Drip dispersal has been a huge success. Other than an occasional broken pipe or bad connection, Adenus has a rigorous operation and maintenance program that eliminates the normal issues of neglect associated with many drip systems.

Public Complaints or Requested Changes

- Adenus has had practically no wastewater service complaints.
- There has been significant political discussion and community interest in the increased development areas that their wastewater systems have enabled.
- Adenus has had to develop and/or participate in the development of regulations and programs. Prior to the Adenus program, no other company had attempted to develop a similar business model and platform in their markets.
- Creating new law and regulation is a painfully slow process. Adenus reports that most everyone involved in the developing of the program (from Adenus to Public Service Commissions to environmental regulators) is very proud of the accomplishments.
- The political portion is more diverse, as the "nimby's" generally create a lot of political interest, and politicians tend to listen to those who complain.
- Adenus reports that the largest obstacle to success has been the slow pace and general lack of competence of the environmental regulators to be able to decipher and accept a new paradigm for wastewater service. Environmental regulators tend to be skeptical (and probably with good reason), even when the technology is well established.
- Very few wastewater service proposals have come with a "non-governmental vertically integrated solution", and have said "we want to do it right", and have the ability to "charge the customer the appropriate amount to honestly operate a wastewater system consistently in compliance with the permit conditions". Adenus likes to think they are that type of company

3.3.2.3 Other Specific Engineer, Regulator and Operator Comments and Observations from Various States

- An experienced county regulator in Virginia commented that a major concern for decentralized systems in the size range studied is adequate flow equalization for systems to attenuate hydraulic and pollutant loading. He specifically mentioned schools, for which they have found this to be a problem and of great importance to achieving acceptable performance.
- Lagoon/pond systems on average tended to have the least daily maintenance requirements for treatment systems. However, for several lined pond systems, such problems as tears/holes in liners were reported.
- Reported maintenance and service activities and needs for recirculating packed media filters and other attached growth systems were much less frequent as compared with suspended growth/activated sludge systems, and mostly consisted of routine "checks" and sample collection activities. Service activities reported for packed media filters tended to be for relatively infrequent items such as pump replacement, broken pipe repair, removal of vegetation from surfaces of sand/gravel filters, and floats or control

settings/problems. Routine activities associated with managing activated sludge plants tended to be much more numerous and time consuming (where they were performed as recommended by the manufacturer).

- ♦ In Texas where detailed operator information was obtained from a number of state park facilities using grinder pressure sewers, severe corrosion problems were often reported for grinder lift stations (for guide rail systems, discharge piping, brackets, and valves. Very few problems were reported for effluent collection systems (used very little at present in Texas, but used significantly elsewhere in the U.S.).
- ♦ The following comments were provided by a public park system operator in Texas, regarding operational problems/challenges with an extended aeration plant designed for a maximum design capacity of 50,000 gpd:
  - "Original design was for the influent to come straight into plant; this caused inconsistent flow patterns and shock loading of plant due to the high strength of the sewage coming in. [Owner] Converted 1st aeration chamber into a pre-treatment basin which had pumps installed in it. This allowed us to control the flow going into plant and allowing the influent to aerate and dilute before entering the plant. The main issue has been the clarifiers, which are setup with a baffle wall at the entrance, 3 hoppers and air eductors to remove the sludge. Original design was to hydraulically force the sludge down once it entered the clarifiers instead of it gradually settling on its own. This causes floc shear and blanket wash out. So we positioned the baffle walls two feet further away from the entrance, we were trying to decrease the impact on the floc once it entered the clarifiers. The air eductors in the clarifiers will not draw thick sludge. So we must maintain our MLSS in the aeration at low levels or the clarifiers will load up with sludge and eventually wash over into the weirs. There are 12 lift stations that feed into the plant which sit at idle during the week holding septic wastewater in them. A pre-treatment system was added at our dump station, which has a holding tank and two aerated zones. This was installed to help reduce the impact of the high strength sewage coming into the plant when the RVs were dumping."
- ♦ A private Colorado operator responsible for operation/maintenance for several AdvanTex and recirculating gravel filters reported that during cold weather/winter months, ammonia limits were sometimes difficult to meet for the AdvanTex systems he manages.
- ♦ An engineer with long-term experience with operations companies commented that denitrification filters are often used with SBRs, and filter clogging can be a "weak link" in the system. If a very good decanter is used, there tend to be far less filter clogging problems. In general, the robustness of a design tends to dictate the reliability and consistency of a system's performance (including fewer operational problems).
- ♦ At least one operator reported being instructed to do "pre-sampling" of regulated treatment plant effluent parameters, prior to sending samples to a laboratory for analyses and reporting.
- ♦ The operator/manager of a 40,000 gpd (peak seasonal capacity) publicly owned and operated park system SBR treatment system reported the following for the treatment plant:

  > "This SBR plant was new five years ago. It was improperly designed in that the surface loading and the biological loading were not matched & the plant

has had a severe TSS problem. The permanent solution to this problem is currently under an engineering review by an engineering company specializing in water & wastewater. Pre-report estimates for reconfiguration of the plant are between $200,000 and $400,000. This would include resizing the main basin by placement of a dividing wall & some sort of filtration system between the post basin & the UV disinfection lights. The cost of construction of this plant was 1.2 million which was over the projected estimate of $800,000. Prior to the construction of the SBR plant above this park had a "extended air" plant rated at .01 MGD which was completely rebuilt while awaiting the construction and design of the above SBR. All pumps and pump control panels were replaced; the air lift Waste Activated Sludge system was rebuilt. Air compressor motors and control panel were replaced and a wood frame building for process control tests was built. Chlorine disinfection systems and pumps were rebuilt and replaced several times. Costs for these improvements were not stored electronically and accurate numbers may be available but would take time to recover. Park staff estimate a cost of $150,000 for those improvements (pre-SBR system)."

3.3.2.4 General Operations/Management Observations from Discussions with Operators

- Consistently throughout the U.S., it was reported that significantly more operation and maintenance time were required on average for those treatment facilities using activated sludge processes, as compared with fixed film/attached growth processes such as recirculating sand/gravel filters, or textile media filters.
- While there were definite trends in amount of time spent operating/maintaining specific types of systems, overall, the amount of time spent by operators on operation and maintenance activities did not appear to be consistently based on a clear set of criteria and management activities associated with that specific type of treatment facility. There appeared to be a need in many cases for further training and management guidelines.
- Based on discussions with and information provided by operators, time spent on routine operation/maintenance for public treatment facilities staffed by operators employed by the public entity tended to be significantly greater in a number of cases as compared with either private or public entities operated by private operators. The publicly employed operators seemed no less "busy" than private operators, so it appeared that there might be a tendency toward more thoroughness by publicly employed operators as compared with private operators who might be operating/maintaining several systems.
- Sludge wasting/pumping practices at treatment plants and from septic tanks were often based on either arbitrary frequencies (and thus possibly occurring more frequently than needed) or on the occurrence of visual problems from excess sludge (not occurring frequently enough).
- In general, where operators reported problems meeting effluent quality limits, the problems tended to be associated with meeting levels for either ammonia or total nitrogen.
- Many of the substantial and premature repair costs reported by operators and systems owners/managers appeared to be a result of inadequate/substandard systems installations.

Detailed descriptions of routine maintenance activities and repairs, where that information was reported by systems operators/managers is provided as an appendix for the state where that information was obtained, and is organized by category of treatment type/process.

CHAPTER 4.0

COMPLIANCE MONITORING DATA ANALYSES AND DISCUSSION

4.1 Discussion of Reported Data by State

Compliance reporting data for performance as related to BOD_5/$CBOD_5$ and TSS treatment are discussed below for the states of Colorado, Florida and New Mexico, North Carolina, Oregon, and Tennessee in Section 4.1.1. Detailed data gathering was conducted for systems in each of those states, with data obtained for between 8 and 15 systems in each. Secondary treatment performance results for states from which treatment data was found to be available either in databases or from file searches for larger numbers of systems are discussed in Section 4.2 of this chapter. For those states (KY, MA, TX and VA), monitoring data from systems using more methods of treatment and served by a wider variety of facility types tended to be included in the databases, thus offering more opportunities to compare performance under differing conditions.

Data for five-day biochemical oxygen demand (BOD_5) and carbonaceous five-day chemical oxygen demand ($CBOD_5$) have been combined where both were reported in the datasets for systems. $CBOD_5$ is the same as BOD_5 except that in laboratory testing procedures the nitrogenous demand as been prevented by addition of a nitrification inhibitor to the sample where results are reported as $CBOD_5$. Due to changes in laboratory practices over time in that respect, data for some systems studied changed at some point in the sampling period from reporting as BOD_5 to $CBOD_5$.

To the extent either ammonia or TKN data were required and reported for the systems in each state, those results are also discussed in Section 4.1.1 and in Section 4.2. Where either TN or both TKN and nitrate are reported for systems in CO, FL, NM, NC, OR, and TN, those results are discussed in Section 4.1.2. Only those systems for which results from at least 12 sampling events are included in a dataset for a particular parameter are discussed.

Fully evaluating the performance of systems requires consideration of a significant amount of information that was in many cases not available for systems included in this study. Those factors vary by specific permit requirements and method(s) of treatment used, and would include such things as design criteria used and unit process sizing; final method of effluent disposition (and assumptions relative to final soil treatment to be achieved for subsurface dispersal systems); flow equalization (whether included and if so, the capacity provided); redundancy of unit processes (for servicing and operational flexibilities); etc. Those types of considerations are considered and discussed for certain systems on a case by case basis where that detailed information was available, though for the most part systems performance is discussed generally by state and basic treatment category.

4.1.1 Secondary Treatment Performance (BOD and TSS), and TKN/NH_3-N

Secondary treatment and nitrification performance results observed from the systems datasets from several states are discussed below.

4.1.1.1 Colorado

All but three of the 11 Colorado systems listed in Appendix 1.A reported treatment results for the period reviewed with average BOD_5/$CBOD_5$ of less than 10 mg/L. Of those averaging above 10.0 mg/L , only two had more than 12 sampling events reported in the data obtained, and included:

- System 1 (RBC): 10.02 mg/L (51 sample events); and
- System 6 (AdvanTex) 11.24 mg/L (38 sample events).

In general, most of the Colorado systems reviewed appeared to perform relatively well with respect to BOD_5/$CBOD_5$ reduction, regardless of treatment method(s) used.

No Colorado systems for which data was obtained reported 12 or more monitoring results for TSS in the datasets.

Ammonia data was available for three Colorado systems for which at least a dozen data points were included in the datasets obtained. Those included:

- System 2, a 30,000 gpd SBR system serving a school, averaging 2.2 mg/L NH_3-N for 98 sampling events reported;
- System 6, a 5,300 gpd AdvanTex (recirculating textile media filter) system serving a lodge and café and averaging 2.5 mg/L NH_3-N for 14 reported sampling events; and
- System 9, a 27,000 gpd RSF/RGF system reporting an average of 0.50 mg/L NH_3-N for 20 sample results.

[Note: Recirculating “sand” filters and recirculating “gravel” filters (RSF/RGFs, or RGF/RSFs) to the extent those two are defined and/or referred to differently by industry practitioners and/or regulatory programs across the U.S., are consistently referred to in this document as one category of treatment system. To the extent those are defined differently based on media gradation differences in the filters, insufficient detailed descriptive information was available for the vast majority of systems studied in this project to offer meaningful segregation of those systems in the datasets.]

4.1.1.2 Florida

All of the systems for which data could be obtained in the applicable size and age range for this study used some type of activated sludge treatment process. More than 12 data points were available for review for all but one Florida system (#6, with eleven $CBOD_5$ results obtained). Ten of the 13 Florida systems studied and listed in Appendix 2.A reported $CBOD_5$ results that averaged less than 10 mg/L for the sampling periods reviewed. The three systems showing $CBOD_5$ averages above 10 mg/L were:

- System 1 (extended aeration with filtration, serving a community), 12.5 mg/L
- System 9 (extended aeration, possibly including filtration, serving a truck plaza), 11.2 mg/L; and

- System 11 (extended aeration with anoxic zone, and sand filtration, serving residential apartments), 10.3 mg/L.

CBOD$_5$ for five of the 13 Florida systems averaged less than 5 mg/L for the period reviewed (all of these with more than 12 data points).

Five of the 13 Florida systems also reported less than 5.0 mg/L TSS on average for the period reviewed (with two of these also reporting less than 5.0 mg/L BOD). Only one system exceeded 20 mg/L on average for TSS (20,000 gpd extended aeration system serving a truck stop, reporting 20.86 mg/L), with most systems at or below about 10 mg/L on average.

Only six of the 13 Florida systems reported ammonia and/or TKN data for the period reviewed. Of those, four reported ammonia and/or TKN monitoring results averaging less than 2.0 mg/L. The two with higher averages were:

- System 1 (community system), 4.0 mg/L TKN; and
- System 9 (truck plaza) 10.4 mg/L TKN.

The waste stream characteristics of the truck stop/plaza would be suspected as contributors to the lesser performance of that system relative to two of the above three effluent parameters.

4.1.1.3 New Mexico

Data from several different types of treatment systems serving varying types of facilities was reviewed from New Mexico.

The were only two systems in New Mexico for which data was gathered for BOD$_5$/CBOD$_5$, and for which there were at least 12 data points/sampling events in the monitoring period reviewed. Those included:

- Mobile home park with a design/permitted flow of 9,000 gpd served by a FAST/subsurface flow wetland treatment system (average BOD$_5$ of 16.9 mg/L, 76 data points); and
- Middle school with permitted flow currently of 30,000 gpd served by a recirculating sand/gravel filter (1.95 mg/L, 23 data points).

Monthly or weekly data was reported for the mobile home park and monthly data for the middle school. As noted in Table 4-1 in Section 4.1.2, the manufacturer of the FAST unit serving the mobile home park (Bio-Microbics) was contacted for comments about that system's overall performance, and reported that an evaluation of the system had showed performance issues needing to be addressed with design (including waste flow and characterization), installation, and operation.

Only one of the NM systems reported more than 12 measurements for TSS for the period of time reviewed – the 30,000 gpd middle school served by an RSF. TSS measurements averaged 2.96 mg/L for those 23 sampling events.

TKN and/or ammonia data was available from five New Mexico systems for which at least 12 sample events were reviewed, as summarized below:

- System 2 (10,000 gpd research/visitor center served by trickling filter system): 21.7 mg/L average TKN for 19 sample events;

- System 7 (9,000 gpd mobile home park served by FAST/Wetland system): 14.4 mg/L average TKN for 32 monthly or weekly sample events;
- System 8 (5,802 gpd shopping center served by a trickling filter system): 9.0 mg/L average TKN for 17 monthly or quarterly sample events;
- System 9 (30,000 gpd RSF serving the middle school): 1.3 mg/L average TKN for 45 monthly samples; and
- System 10 (8,000 gpd, later changed to 5,220 gpd SBR serving an RV park): Average TKN of 64.5 mg/L for 17 samples (approximately monthly reporting).

A larger SBR (30,000 gpd) system serving a college showed significantly better performance relative to TKN, though only 11 sample events were available from the records obtained (5.9 mg/L average for that period, with TKN reporting on a quarterly basis).

Of the New Mexico systems reviewed, the RSF demonstrated the best secondary treatment performance. Flow through that system for the period reviewed averaged about 43% of design flow. For the only two New Mexico systems reporting at least 12 sample results for BOD_5 for the period reviewed, the standard deviation calculated for the RSF system was significantly lower (2.2) as compared with the FAST/wetland system (22.6). The lowest standard deviation was also reported for the RSF system relative to TKN treatment performance (0.87 as compared with the next lowest value of 5.9 for those systems reporting at least 12 sample results for TKN).

4.1.1.4 North Carolina

The North Carolina systems studied all used one of three principal methods of treatment: Recirculating sand/gravel filters (4 systems), Bioclere treatment systems (4 systems), extended aeration systems with “tertiary” filters (7 systems).

All but one of the 15 North Carolina systems reviewed (System 1 in Appendix 8.A) had at least 12 BOD_5/$CBOD_5$ data points for the monitoring periods evaluated. Of those 14 systems, only one (System 9, a restaurant served by a 9,600 gpd Bioclere treatment system) averaged higher than 10 mg/L for monthly BOD_5/$CBOD_5$ monitoring records reviewed. That system averaged 16.4 mg/L for 28 sampling events reviewed. Ten of the North Carolina systems averaged less than 5.0 mg/L for the monitoring periods reviewed (all of those with at least 12 data points).

With the exception of a coastal area school served by a 27,600 gpd RSF system, average effluent TSS levels for the systems reviewed were mostly below 10 mg/L (11 of the 14 systems with over 12 sample events reviewed), with two other systems just under 11 mg/L. There were two periods during which that RSF system exhibited very high effluent TSS levels, causing overall averages to be high (just under 100 mg/L). If those monitoring periods with very high TSS levels are not included in the data, effluent levels averaged just over 10 mg/L. Seven systems averaged less than 5.0 mg/L TSS for the monitoring periods reviewed.

TKN or ammonia (NH_3-N) data were reported for at least 12 sample events for 13 of the 15 North Carolina systems studied, and nitrate (or nitrate + nitrite) data was reported for 10 systems for which there were at least 12 sample events during the monitoring period reviewed. All but three systems reporting either TKN or NH_3-N averaged less than 2.0 mg/L for the period reviewed. One of the systems (System 5 – coastal area PUD served by an extended aeration system with tertiary filtration) studied reported a number of ammonia results that were below detection limits. Those laboratory limits were not available, so the lowest reported result (0.05

mg/L) was used for calculating averages and other statistical values for that system. The three systems with averaged TKN or NH_3-N reported measurements higher than 2.0 mg/L included:

- A 9,600 gpd coastal area restaurant served by a Bioclere system (17.1 mg/L TKN for 17 sampling events);
- A 10,232 gpd coastal area shopping center served by a Bioclere system (3.15 mg/L TKN for 21 sampling events); and
- An 11,400 gpd elementary school (central NC) served by a recirculating sand/gravel system (16.6 mg/L TKN for 20 samples).

The elementary school and restaurant systems showed by far the least performance relative to NH_3-N /TKN reduction. Based on data elsewhere from systems serving restaurants and elementary schools and comments from regulators, the waste streams from these two systems would be expected to challenge secondary treatment and NH_3-N /TKN performance.

4.1.1.5 Oregon

All but one of the Oregon treatment systems studied that had secondary treatment limits used a recirculating sand/gravel filter, with that other one facility using a rotating biological contactor (RBC) to meet treatment limits. Of those systems for which at least 12 data points were included in datasets reviewed, only four (all RSFs) averaged less than 10 mg/L for BOD_5. No systems studied averaged less than 5 mg/L for the monitoring periods reviewed. Overall the reported RSF secondary treatment results were highly variable, although most were meeting the prescribed limit of 20 mg/L for BOD_5. The only RSF system for which at least a dozen data points were available for reviewed that reported average BOD_5 effluent higher than 20 mg/L was a 16,000 gpd coastal inn/resort that averaged 23.4 mg/L for 19 sample events. However, secondary effluent limits were not found in the records obtained for that system, so it may have been meeting its permit limits for BOD. The RBC system (a 19,500 gpd mobile home park) has effluent limits of 30 mg/L (monthly grab) for BOD_5, and averaged 24.6 mg/L over 56 sample events.

All nine systems reporting at least 12 sample events for TSS during the monitoring period reviewed averaged less than 20 mg/L TSS. Most systems were permitted for limits of 20 mg/L (where limits were identified), with the mobile home park served by the RBC permitted for 30 mg/L TSS. Four RSF systems averaged less than 10 mg/L TSS for the period reviewed, with no systems reporting less than 5.0 mg/L on average.

All of the systems required to meet secondary treatment limits prior to subsurface effluent dispersals also reported TKN and/or NH_3-N quality data, although only eight systems reported more than 12 sample events during the monitoring period reviewed. Of those eight systems:

- One system (16, a 5,750 gpd RSF serving a mobile home park) averaged less than 5.0 mg/L for TKN and NH_3-N for the period reviewed (3.7 and 2.7 mg/L for TKN and NH_3-N respectively, for 24 samples each);
- Five RSF systems averaged between 5.0 and 10.0 mg/L NH_3-N; Three RSF systems averaged between 5.0 and 10.0 mg/L TKN for the periods reviewed;
- Two systems (one RSF and the RBC) averaged between 10.0 and 20.0 mg/L for TKN; and

- An RSF (19,750 gpd) system serving a mobile home park (14) reported an average of 30.2 mg/L TKN for 15 sample events.

The 19,750 gpd RSF serving the mobile home park is in a non-coastal area, and reported average flows of about 62% of the design flow during the monitoring period reviewed. The other mobile home park in the dataset served by an RSF and showing much better performance relative to TKN and NH_3-N is permitted for 5,750 gpd, with flows averaging only about 31% of design flows.

4.1.1.6 Tennessee

All eight of the Tennessee systems studied use some type of fixed film treatment process (RSFs (six) or Bioclere (two) treatment systems), with all using subsurface drip dispersal of treated effluent. Five of the eight systems (Systems 1 through 5) were designed and are managed by the same firm, with the other three designed and managed by another firm. All eight of the Tennessee systems are owned by the same public utility. That circumstance offers an opportunity among the data gathered in states around the U.S. to greatly reduce possible certain variables associated with the use of different methods and materials for design, construction and operation in evaluating the performance of the Tennessee systems. That is especially the case given that all eight systems employ one of two types of recirculating fixed film/attached growth treatment processes (trickling filters and recirculating sand/gravel filters).

The RSFs reported better overall secondary treatment performance as compared with the Bioclere treatment systems, with only one RSF (System 7, serving a subdivision) averaging greater than 5 mg/L BOD_5 for the period reviewed (8.6 mg/L for 15 sample events). Reported results for the two Bioclere systems were:

- System 1: 19.6 mg/L BOD_5 for 12 quarterly sample events (30,000 gpd serving resort/rental cabins); and
- System 4: 13.0 mg/L BOD_5 for 15 quarterly sampling events (also 30,000 gpd system serving resort/rental cabins).

Neither TSS nor TKN data was available for the eight Tennessee systems.

Effluent ammonia-nitrogen data for at least 12 sampling events was available for seven of the eight systems. The RSFs also reported better overall performance than the two Bioclere systems relative to NH_3-N reduction. Of those:

- Four RSFs reported average NH_3-N measurements of less than 4.0 mg/L (one rental cabins, two residential subdivisions and a church); Two of those systems averaged less than 2.0 mg/L over the monitoring periods reviewed (both residential subdivisions);
- The only RSF averaging more than 4.0 mg/L NH_3-N for which there were at least 12 sampling results was one of the resort/rental cabin systems (10.4 mg/L for 24 quarterly sampling events).

Average reported NH_3-N results for the two 30,000 gpd Bioclere systems serving rental cabins were:

- System 1: 22.1 mg/L for 12 quarterly sampling events; and
- System 4: 20.4 mg/L for 15 quarterly sampling events.

Average effluent nitrate data (3.6 and 6.6 mg/L averages) reported for the two Bioclere units was relatively low as compared with effluent NH_3 levels, indicating that nitrification was occurring less efficiently than for the RSFs. BOD_5 levels tended to be higher for the two Bioclere systems, which would be consistent with the reduced nitrification observed.

Two of the three RSFs with 12 or more sampling events for nitrate and ammonia had average effluent NO_3-N levels of three to seven times their reported averages for NH_3-N. One RSF had average effluent NO_3-N results that were approximately equal to its averaged NH_3-N measurements. Although the highest averages for BOD_5 were reported for the Bioclere systems, three of the RSFs reported maximum values that were above 20 mg/L for the monitoring periods reviewed (two of those values were above 30 mg/L). Both Bioclere systems were reported to experience maximum BOD_5 levels above 30 mg/L, along with the two highest standard deviations calculated for those two systems as related to BOD_5 treatment performance for the Tennessee systems.

4.1.2 Total Nitrogen

Groundwater programs in several states from which effluent quality data was obtained, limit and require monitoring of either nitrate (NO_3-N) or total nitrogen (TN) from systems from at least certain areas of those states, with some states specifying NO_3-N and others TN limits in permits. Effluent quality data from treatment facilities in those states was reviewed to evaluate the ability of those systems to meet applicable TN or NO_3-N levels.

Massachusetts offered by far the best opportunity to review the performance of systems relying on subsurface dispersal methods for their nitrogen removal capabilities. The large Access database of systems data maintained by the state made this possible.

Most systems in Massachusetts and elsewhere for which total nitrogen limits are specified are permitted for TN levels of 10 mg/L or higher. Some systems appeared capable of meeting effluent TN limits of 10 mg/L on a relatively consistent basis for the periods during which data was obtained for each. Massachusetts has a few systems that are permitted with a limit of 5 mg/L. One of those systems has only been in service since 2005 and so was not included in this study, but data was reviewed for a 12-month period to consider treatment system capabilities for achieving lower TN levels. The system was exceeding 5 mg/L on average (just over 7 mg/L TN), even when not including the first six months of monitored operation to allow for a significant start-up period.

Of a total of 57 Massachusetts systems qualifying for inclusion in this study for which TN data was obtained, 41 (72%) were reportedly able to meet average TN effluent limits of 10 mg/L. Of these for which there were at least 20 reported sample events (and that had been in service for at least about five years), 12 systems did not exceed 10 mg/L for their monthly reported TN results. That constitutes 21% of the total systems for which TN was limited to at least 10 mg/L, and over a quarter of those that were able to maintain average TN levels of 10 mg/L or less for the data reported and obtained for this study. Of those 12 systems:

- ♦ Five (45.5%) had flows less than 20,000 gpd, with the remainder having flows between 20,000 gpd and 50,000 gpd.
- ♦ According to the MA DEP database, of the treatment systems used for these facilities:
    - o Seven (63.6%) used RBC treatment units; Four of these operate in conjunction with denitrification filters and two operate in conjunction with an anoxic RBC unit. One appeared to have no added denitrification process.

- Two used Amphidrome treatment systems, one of these in conjunction with a denitrification filter.
    - One used a Bioclere treatment system with a denitrification filter; and
    - One system was reported to be an activated sludge plant in conjunction with a denitrification filter
    - One system was reportedly an activated sludge plant *without* a further anoxic/denitrification process. However, it seems most likely there is a denitrification process associated with this system.
- Of the facilities serving these 12 systems, there were: two hotels; two retail stores; four residential housing units or developments; three elderly housing facilities; and one school.
- All but two of these systems were operating with average reported flows of at least about 50% of the design flow; One of the RBC + denitrification filter systems serving residential units was operating on average at about one-third of the design flow, and another RBC (no separate denitrification process) serving a retail store was operating on average at about 20% of its design flow.

Several other states offered an opportunity to review systems performance relative to total nitrogen reduction for a limited number of systems. For this size range of systems (5,000 to 50,000 gpd), in most cases monthly or quarterly "grab" samples were analyzed and reported for the required regulatory reporting period. The data obtained was reviewed and is summarized in Table 4-1 for systems from various states across the U.S., and of varying types and sizes, for which at least 12 sample events were reported for the period of time data was reviewed for this study.

Where information was obtained from regulatory files that seemed to offer possible insights for systems showing performance that seemed outside of normal or limited ranges, that information was noted for those systems at the end of the table. Most of the systems had total nitrogen performance requirements, although several Oregon recirculating gravel filter systems were included that have no total nitrogen limits. Those recirculating sand/gravel filters were designed for BOD/TSS reduction and loading, and not for total nitrogen. Where data was available for NH_3-N, TKN or NO_x-N for each of the systems in Table 4-1, that data was included to better enable evaluation of the overall performance of the systems.

Of the systems included in Table 4-1, two activated sludge systems were the only ones that produced average total nitrogen levels of less than 10 mg/L, based on reported compliance monitoring results for the period reviewed. Those were:

- A Florida extended aeration system with anoxic zone with recirculation and filtration, serving residential condos; and
- A New Mexico sequencing batch reactor system serving a college.

The Florida extended aeration system was designed to meet very low TN limits (3.75 mg/L, monthly grab) and reported values below that limit approximately 50% of the period for which data was obtained (the limit was exceeded 12 of 23 months). Flow for that system averaged about 60% of design flow for the period reviewed. The New Mexico system averaged 9.6 mg/L over the 13 monitoring results evaluated for TN performance.

Effluent nitrogen data from Colorado systems was fairly limited, with few systems having more than a dozen data/sample events to review for any form of nitrogen. Total nitrogen was not reported for any of the systems for which data could be obtained. The New Mexico, North Carolina and Oregon system however offer an opportunity to compare the performance of several types of fixed film treatment systems, including RSF/RGFs, Bioclere (recirculating trickling filter) systems, and an RBC.

The Oregon RBC was the only system for which nitrogen data was obtained from that state that had some type of total nitrogen limit specified in the permit files reviewed. That system did not appear to be consistently meeting its 45% total nitrogen reduction requirements, and based on the TKN and NOx data seemed to be limited with respect to nitrification. The two Bioclere systems in Table 4-1 showed variable performance relative to nitrification and TN reduction. The New Mexico Bioclere system serving a shopping center performed better in both respects, with an average TKN of 3.2 mg/L and average TN of 14.5 reported. The North Carolina Bioclere system serving a restaurant reported average TKN results of 17.2 mg/L and TN of 23.6, suggesting problems with nitrification. As a general trend, the relatively large number of recirculating sand/gravel filters in Table 4-1 showed very good nitrification, though typically limited with respect to TN reduction.

Of the Oregon recirculating sand/gravel filters designed for secondary treatment, the K-12 school system had the highest effluent nitrogen levels. A number of regulators have commented during the study about the performance challenges of public schools, and in particular elementary schools for which there tends to be less flow from gym showers, and higher concentrations of regulated wastewater constituents. Of these systems for which influent total nitrogen data was available for the sampling period reviewed, TN reduction ranged from about 19-69% (based on average influent and effluent TN values for the entire period reviewed). Orenco Systems, Inc. reports that RSF/RGFs designed and built properly to meet secondary treatment standards should on average be able to achieve about 45% total nitrogen reduction, which would be about in the middle of the observed range.

In reviewing these systems for total nitrogen performance, compliance with applicable nitrogen limits was variable. Based on the ability of certain types of treatment processes to meet applicable nitrogen limits, it appeared that poor performance by those same types of systems in other cases might be a result of design, installation or operational issues, or a combination of those factors.

4.1.3 Nitrate-Nitrogen

Groundwater programs in some states from which systems data was obtained specify nitrate-nitrogen limits in permits rather than total nitrogen for at least some systems.

Nitrate-nitrogen treatment results from systems for which at least 12 NO_3-N data points were reported are summarized below for the states of Colorado, Florida, North Carolina, and Tennessee, with the reported results discussed in the context of system performance relative to nitrification and total nitrogen reduction.

- Of the Colorado systems, 12 or more NO_3-N monitoring results were available for only one system; a 30,000 gpd SBR system serving a school averaged 3.6 mg/L NO_3-N average for 104 sampling events. That system also had low average results for NH_3-N (2.2 mg/L).
- All six Florida systems reporting more than 12 sample events averaged less than 10 mg/L NO_3-N. However, two of those systems averaged *over* 10 mg/L for total nitrogen, with one of those two systems serving a truck plaza (7.1 mg/L average NO_3-N and 17.9 average TN) and the other a community system (6.9 mg/L average NO_3-N and 10.3 average TN). All six Florida systems used some type of activated sludge process, typically in conjunction with a tertiary or anoxic filter process;
- Ten of the 15 North Carolina systems for which data was obtained reported at least 12 results for NO_3-N. Of those, the two with the highest effluent NO_3-N levels on average were schools served by RSF/RGFs (59.8 mg/L and 36.5 mg/L). Only two systems averaged less than 10 mg/L NO_3-N, both also reporting low effluent TKN and/or NH_3-N levels (RSF/RGF serving a rest home, and an extended aeration/tertiary filter system serving a residential subdivision).
- The only Tennessee systems with at least 12 data points for NO_3-N reporting relatively low averages for NO_3-N (11 mg/L or less) while also reporting a low average for NH_3 or TKN were two RSF/RGF systems: An RSF/RGF serving a residential subdivision (9.5 mg/L NO_3-N and 1.3 mg/L NH_3-N for 24 sample events) and an RSF/RGF serving rental cabins (10.75 mg/L NO_3-N and 2.86 mg/L NH_3-N). The other RSF/RGF systems showed significantly better average nitrification results than the two Bioclere systems.

4.1.4 Disinfection

All of the systems requiring disinfection for which monitoring data was obtained for this study appeared to use either ultraviolet irradiation (UV) or some form of chlorination. In some cases, the method of disinfection could not be determined from the information gathered from regulatory files.

Average performance for the monitoring periods evaluated was reviewed for trends in each state. For those states having a sufficient number and types of systems reporting at least 12 sampling events for disinfection by either UV or chlorination, no particular patterns were observed relative to disinfection method used. Both UV and various forms of chlorination appeared to be effective for certain systems while experiencing a greater number of excursions for others.

UV disinfection performance was also reviewed relative to TSS performance for specific systems to observe whether reported coliform “excursions” appeared to be associated with higher

TSS values for those sampling events. On some occasions for some systems, there appeared to be a certain amount of correlation, though not with sufficient consistency or degree to illuminate any definite trends. On some occasions, there might be a slightly elevated TSS level for days reporting a substantially higher coliform level, while on other days TSS levels might be even higher with low coliform levels. Lesser UV disinfection performance for some of those occasions may also have to do with maintenance practices for those disinfection units.

As just one factor that might affect disinfection efficiency for those systems using some method of chlorination, systems data was reviewed relative to reported NH_3-N levels for those sampling dates on which significantly higher coliform counts were recorded. Some systems (e.g., Florida systems 1 and 8) reported higher than average NH_3-N measurements on some dates for which coliform levels were high. However, as with UV disinfection and TSS levels, there did not appear to be any consistency observed for that pattern for systems in any of the states.

4.2 Monitoring Data Trending/Charting Results

Compliance monitoring data was obtained from several states for a sufficient number of systems using different methods of treatment and serving different types of facilities such that graphical analyses of certain types of data were possible in an effort to elucidate trends with systems' performance. Those states included Kentucky, Massachusetts, Texas, and Virginia. For other states from which data was obtained for a lesser number of systems, charting was done for certain categories of systems information to identify trends as possible.

Of the data/information that could be obtained about specific systems, certain factors were considered important to their overall performance. Those factors include:

- System design flow/size
- Type of facilities served (e.g., church, youth/recreational camp, subdivision/homes, restaurant, grocery store, etc.)
- Geographic location/region
- Method of collection
- Method(s) of treatment used
- Sizing/design variations for same treatment processes
- Method of final effluent disposition (discharge, surface application, or some method of subsurface dispersal)
- Public versus private ownership and operation
- System age (years in service)
- Regulatory performance/effluent quality requirements (design relative to performance)

The types of questions that were attempted to be answered as data was reviewed included:

- How did the type of facility served impact performance, if at all? For example, were schools more subject to performance variations than community or residential systems?

And, within the school category of facilities served, was performance observably different for schools of different aged children (such as elementary schools)?

- Does a certain type of treatment process perform better for lower or higher flows in the study flow range, for a certain type of facility served? A flow breakpoint of 20,000 gallons per day was used for certain systems analyses.
- Are trends observed in the performance data, including more or less data “scatter” (higher standard deviation values) for systems of lesser or greater size/flow or which use certain methods of treatment?
- Are there any observed differences in performance for a particular process where there was private vs. public ownership/operation?

The trending analyses performed and presented in this section are not intended to provide a definitive evaluation of the performance of systems in each state, but rather may offer insights into certain performance patterns that would invite further detailed investigations. Based on the amount and detail of the data gathered, there are insufficient numbers of systems with verifiably similar enough conditions to comprise well-defined populations of datasets. Even though regulatory/permitting file records may suggest that some systems are of the same type, the details of each system would need to be investigated further to verify a number of factors that would tend to significantly affect performance. Such detailed analysis is beyond the scope of this nationwide study, and would be more suited to studies focusing on systems in specific geographic areas/regions.

Because of the greater numbers of systems and accompanying dataset “populations” associated with data/information obtained from the states of Kentucky, Massachusetts, Texas, and Virginia, more graphical analyses were possible for data from those states in attempting to identify performance trends. There were enough systems using the same broad treatment categories, and serving the same or similar types of facilities to allow grouping of datasets for trending analyses. For other states from which data was gathered for at least a certain number of systems, a small amount of charting was possible to compare treatment performances for those systems. Those states include Colorado, Florida, New Mexico, North Carolina, Oregon and Tennessee. Due to variations in sampling methods, reporting requirements, data quality and geographic/climatic characteristics between states, systems data has been organized and charted separately for each state.

4.2.1 Massachusetts

A database of Massachusetts’ permitted wastewater systems was sorted and reviewed to identify those facilities matching the flow/size and age of systems to be included in this study (5,000 to 50,000 gallons per day, and with at least approximately five years in service). Using identifying information for each system, data for the selected permitted wastewater plants was extracted from the overall Massachusetts database. The extracted data included most of the more common parameters measured for effluent discharges. Each permit had its own unique parameter set so that not all parameters were measured for all discharges. All data was grouped for each wastewater plant. This data was then analyzed for each flow parameter for its average value and standard deviation. Observations from that data are presented below.

4.2.1.1 Massachusetts Performance Comparisons by Method of Treatment and Key Parameters

Massachusetts systems data was combined by treatment method and key measured effluent quality parameters included in compliance monitoring data obtained for those systems. Those results are provided below as combined averages for categories of treatment processes, with general observations and trends then described.

4.2.1.1.1 Massachusetts Performance Averages for Key Parameters

Systems were first segregated based on the method of treatment noted in the regulatory file information. In some cases, unit processes may be included in the system configuration that are not noted, though without further investigation into each system there was no way to know with certainty the details of each system's treatment train. Treatment performance for several basic wastewater parameters was averaged for each group of systems using the same method of treatment as noted in the database. Below are the effluent quality averages for BOD_5, TSS, NH_3-N, TKN, NO_3-N and Total Nitrogen where at least one system's average data was available for that parameter. Averages for each individual system were used over the monitoring period reviewed, which was typically about two-three years. The numbers of systems included for each treatment category is noted.

Of the Massachusetts systems studied, there were only three RBCs for which no effluent nitrogen limits were noted. Those RBCs were segregated from others in averaging the performance results. Permit files indicated some systems required disinfection and others not, but those two categories were combined in developing the averages described below.

It appears that some systems may in fact include some type of denitrification process, even though it was not noted in the permit files. In the case of RBC systems, there were a number for which nitrogen limits were indicated, but for which no denitrification process was noted in the treatment descriptor in the database. That was also the case for some of the Bioclere systems, although Aquapoint, Inc. was contacted to inquire further about the treatment processes used for each of the Bioclere systems, and the data herein was corrected based on that information. Therefore, and particularly in the case of RBCs, it is important to note that RBCs for which no "anoxic" or "denitrification" processes were noted in the databases may indeed be equipped with added treatment processes for total nitrogen reduction. In that (as seen below under averages for Total Nitrogen) RBCs which were supposedly without added denitrification processes actually performed slightly better on average with total nitrogen removal, it seems somewhat implausible that many (if not all) of those may indeed have had additional treatment processes.

<u>Average BOD_5:</u>

Treatment Category	mg/L	# Systems
RBC (No Nitrogen Limits Specified)	10.25	3
RBC (Nitrogen limits specified, but no Denitrification method noted)	12.68	22
RBC Plus Anoxic/Denitrification	20.39	13
BIOCLERE Plus Denitrification	19.20	7
FAST	24.18	3

ZENON (MBRs)	7.45	3
ACTIVATED SLUDGE	11.74	2
ACTIVATED SLUDGE Plus Denitrification	18.12	2
[1]AMPHIDROME (No further Denitrification method noted)	13.51	4
AMPHIDROME Plus Denitrification	20.96	3
RBC + FAST	16.03	1
RBC + RSF (Recirculating Sand/Gravel Filter)	7.85	1
SBR	29.00	1
Solar Aquatic	10.60	1

[1]Note: Amphidrome is a fixed film SBR package treatment system.

Average TSS:

Treatment Category	mg/L	# Systems
RBC (No Nitrogen Limits Specified)	11.13	3
RBC (Nitrogen limits specified, but no Denitrification method noted)	13.56	22
RBC Plus Anoxic/Denitrification	11.28	13
BIOCLERE Plus Denitrification	10.58	7
FAST	11.00	3
ZENON (MBRs)	6.63	3
ACTIVATED SLUDGE	7.59	2
ACTIVATED SLUDGE Plus Denitrification	8.33	2
AMPHIDROME (No further Denitrification method noted)	18.46	4
AMPHIDROME Plus Denitrification	16.79	3
RBC + FAST	8.51	1
RBC + RSF (Recirculating Sand/Gravel Filter)	8.69	1
SBR	6.14	1
Solar Aquatic	10.42	1

Average NH_3-N:

Treatment Category	mg/L	# Systems
RBC (Nitrogen limits specified, but no Denitrification method noted)	1.54	10
RBC Plus Anoxic/Denitrification	1.52	5
FAST	3.53	2
ACTIVATED SLUDGE (No Denitrification process noted)	10.91	1
AMPHIDROME (No further Denitrification method noted)	0.48	2
AMPHIDROME Plus Denitrification	3.81	1

Average TKN:

Treatment Category	mg/L	# Systems
RBC (Nitrogen limits specified, but no Denitrification method noted)	4.73	4
RBC Plus Anoxic/Denitrification	5.68	3

FAST	1.68	1
AMPHIDROME (No further Denitrification method noted)	3.54	2
AMPHIDROME Plus Denitrification	7.17	1

Average NO_3-N:

Treatment Category	mg/L	# Systems
RBC (Nitrogen limits specified, but no Denitrification method noted)	4.82	21
RBC Plus Anoxic/Denitrification	4.75	13
BIOCLERE Plus Denitrification	3.33	7
FAST	7.66	3
ZENON (MBRs)	3.31	3
ACTIVATED SLUDGE	14.07	2
ACTIVATED SLUDGE Plus Denitrification	3.58	2
AMPHIDROME (No further Denitrification method noted)	4.11	4
AMPHIDROME Plus Denitrification	2.46	3
RBC + FAST	2.50	1
RBC + RSF (Recirculating Sand/Gravel Filter)	10.00	1
SBR	34.82	1
Solar Aquatic	4.44	1

Average Total Nitrogen:

Treatment Category	mg/L	# Systems
RBC (Nitrogen limits specified, but no Denitrification method noted)	8.02	20
RBC Plus Anoxic/Denitrification	8.44	11
BIOCLERE Plus Denitrification	7.74	7
FAST	12.70	3
ZENON (MBRs)	6.05	3
*ACTIVATED SLUDGE (no Anoxic/Denitrification process indicated)	2.97	1
ACTIVATED SLUDGE Plus Denitrification	3.87	2
AMPHIDROME (No further Denitrification method noted)	9.19	4
AMPHIDROME Plus Denitrification	8.12	3
RBC + FAST	10.04	1
RBC + RSF (Recirculating Sand/Gravel Filter)	12.50	1
SBR	36.11	1
Solar Aquatic	8.38	1

* It appears from the data and permit limits specified for this system that there may actually be some type of anoxic or dentrification process associated with this system.

4.2.1.1.2 Observations Relative to Performance for Massachusetts Treatment Categories

When all of the RBC with or without denitrification processes, and including the FAST and RSF combinations, are combined and averaged to consider secondary treatment performance and ammonia reduction, those systems averaged 14.97 mg/L, 12.39 mg/L and 1.54 mg/L for BOD_5, TSS and NH_3-N, respectively. Of the treatment methods for which there were sufficient numbers of systems and data for those parameters to consider, RBCs appeared to perform relatively well for secondary treatment. The Zenon and Amphidrome/no denitrification process noted systems also performed relatively well with respect to secondary treatment. It is not at all clear why BOD_5 treatment performance averaged better for Amphidrome systems not noted as being equipped with denitrification processes, while performing approximately the same for total nitrogen removal as those for which a denitrification process was noted in the database. That could be an indication of inconsistencies with the manner in which information was recorded for systems in the database.

RBCs using some configuration of unit processes also appeared capable of meeting total nitrogen levels of 10 mg/L or less. Although BOD_5 averages were somewhat higher for the Bioclere systems, they also appeared capable of meeting total nitrogen levels of 10 mg/L or less, along with the Zenon, Amphidrome and activated sludge systems equipped with denitrification processes. Several singular systems using some of the other treatment methods also averaged less than 10 mg/L total nitrogen for the period reviewed. The FAST systems appeared more challenged with respect to total nitrogen reduction.

For the four "activated sludge" systems in the Massachusetts dataset, electronic permitting information indicated some type of additional denitrification process for two of those, and no further process for the two others. The data seemed to support the need for the additional process(es) to achieve average total nitrogen limits of less than 10 mg/L. One of the two systems for which no denitrification process was reported in the permitting file seems likely to indeed have such a process, since it was operating close to its design flows and still achieving effluent nitrate and total nitrogen levels that were very low and close to those of the two activated sludge systems that reportedly did use some type of further "anoxic" or denitrification unit process. The school served by a 30,000 gpd activated sludge system for which no anoxic/denitification process was indicated in the permit files averaged approximately 25 mg/L for NO_3-N, which was above its permitted limits of 10 mg/L. That school system's effluent NH_3-N levels also averaged relatively high (about 11 mg/L).

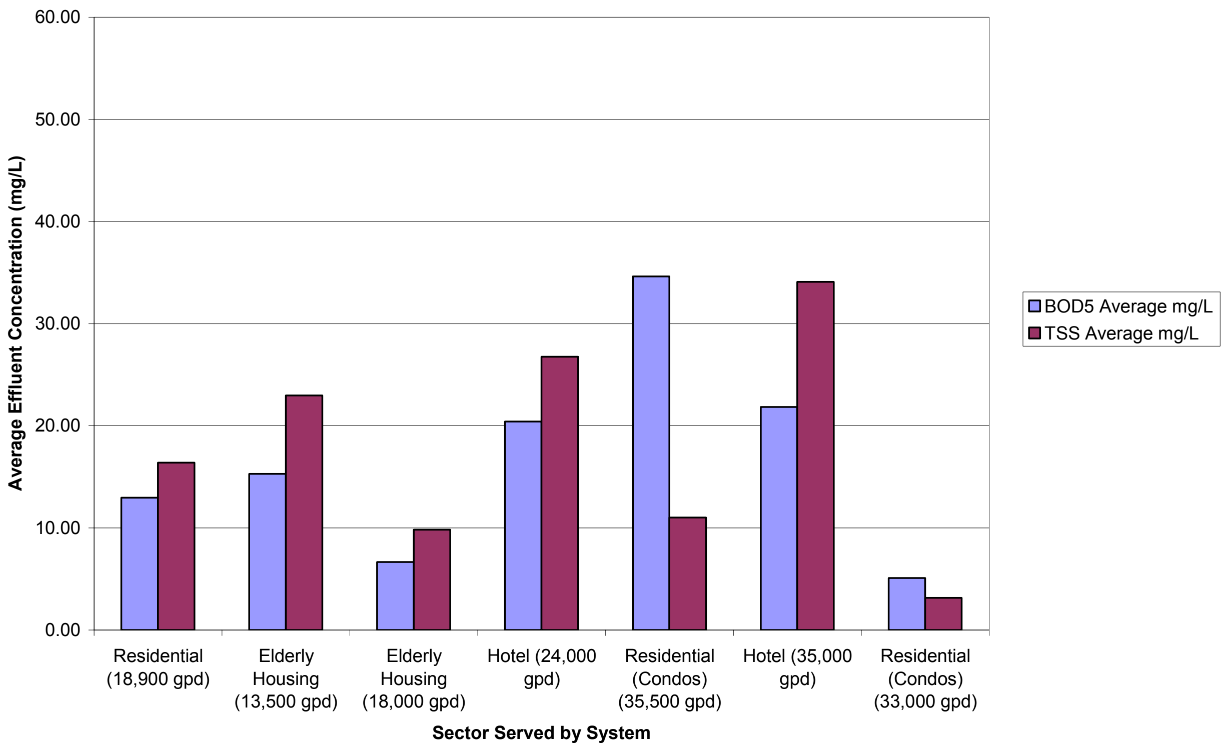
Standard deviations for total nitrogen removal were reviewed for three treatment categories for which there were at least six systems to observe "scatter" in the performance data: Amphidrome; Bioclere and RBCs. All systems using the Amphidrome process were combined, and those using an RBC with some configuration of unit processes were also combined into one dataset. Averaged standard deviations for systems in each of the three categories were very similar, with all being between 3.0 and 4.0. Amphidrome's was the lowest at 3.22, followed by the Bioclere systems at 3.39 and RBCs at 3.91.

4.2.1.2 Massachusetts Performance Comparisons by Facility/Sector Type

Below are several charts generated to identify potential trends associated with the performance of the Massachusetts systems, with respect to the types of facilities served and the method of treatment, as well as flows. Due to the greater numbers and types of facilities served by Amphidrome (some configuration), Bioclere and RBCs with or without some additional unit process for denitrification, data is graphed for those three categories of treatment systems.

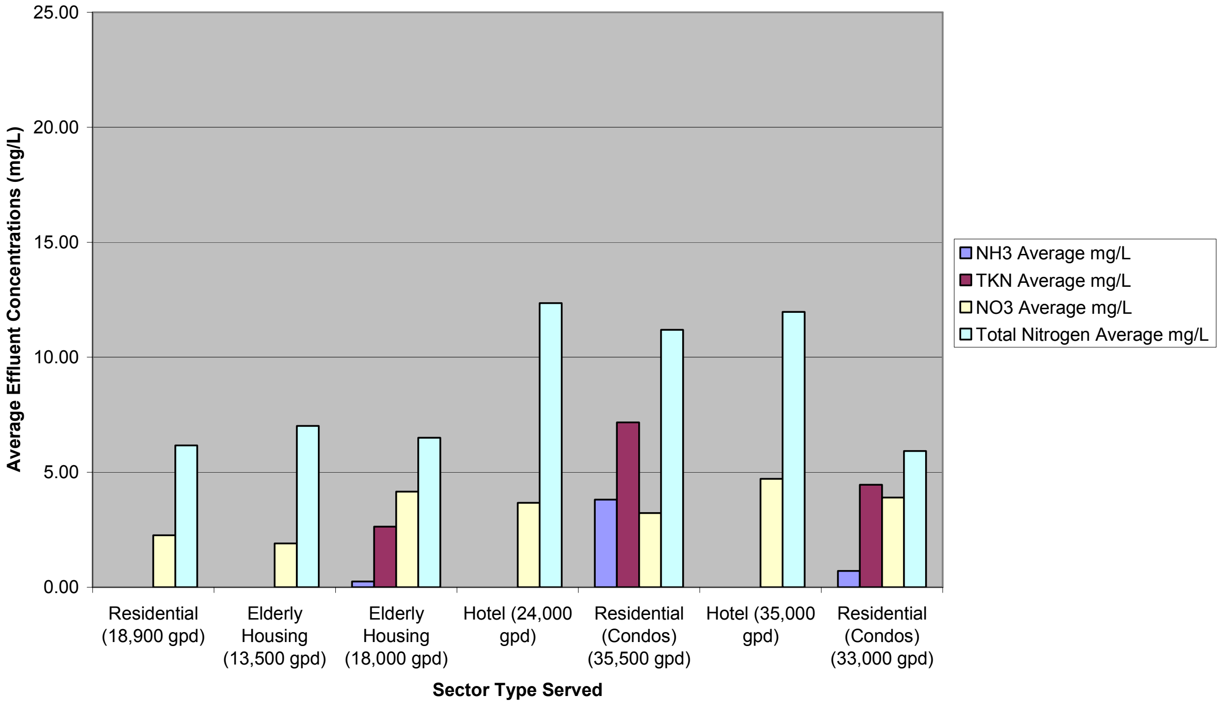
The following groupings of data were considered for permitted flow ranges: ≤20,000 gpd; and >20,000 gpd but ≤ 50,000 gpd. For RBCs, flows were broken into those two categories to identify possible variations in performance relative to system size/flow (5,000 to 20,000 gpd; and > 20,000 to 50,000 gpd). Due to the lesser number of systems served by different sectors for both the Amphidrome and Bioclere systems, those charts were not broken out by flows. Flows however are noted for each of the systems graphed. In Figure 4-1, average performance for secondary treatment parameters (BOD_5 and TSS) in addition to TKN and NH_3-N (where that data was available) were plotted by sector/facility type served for the Amphidrome treatment systems.

Figure 4-1. Amphidrome Systems Secondary Treatment Performance by Sector Type.



Performance by sector for treatment relative to nitrogen species for those systems is plotted in Figure 4-2.

Figure 4-2. Amphidrome Systems Performance By Sector for Ammonia, TKN, Nitrate and Total Nitrogen



The same three systems (the two hotels and the 35,500 gpd residential condos) had the highest effluent levels on average for both BOD_5 and total nitrogen. Those three systems all averaged over 20 mg/L for BOD_5, and were the only systems averaging over 10 mg/L for total nitrogen. Effluent total nitrogen levels for the other four systems were very comparable regardless of sector type served.

The same types of charts were generated for the Bioclere systems as for the Amphidrome systems, with performance tracked by sector served first for secondary treatment parameters, and then by performance relative to nitrogen parameters. Those results are presented in Figure 4-3 and Figure 4-4, respectively. For the Bioclere systems, no data was reported for either NH_3-N or TKN for the monitoring period in the database.

Figure 4-3. Bioclere Systems Secondary Treatment Performance By Sector.

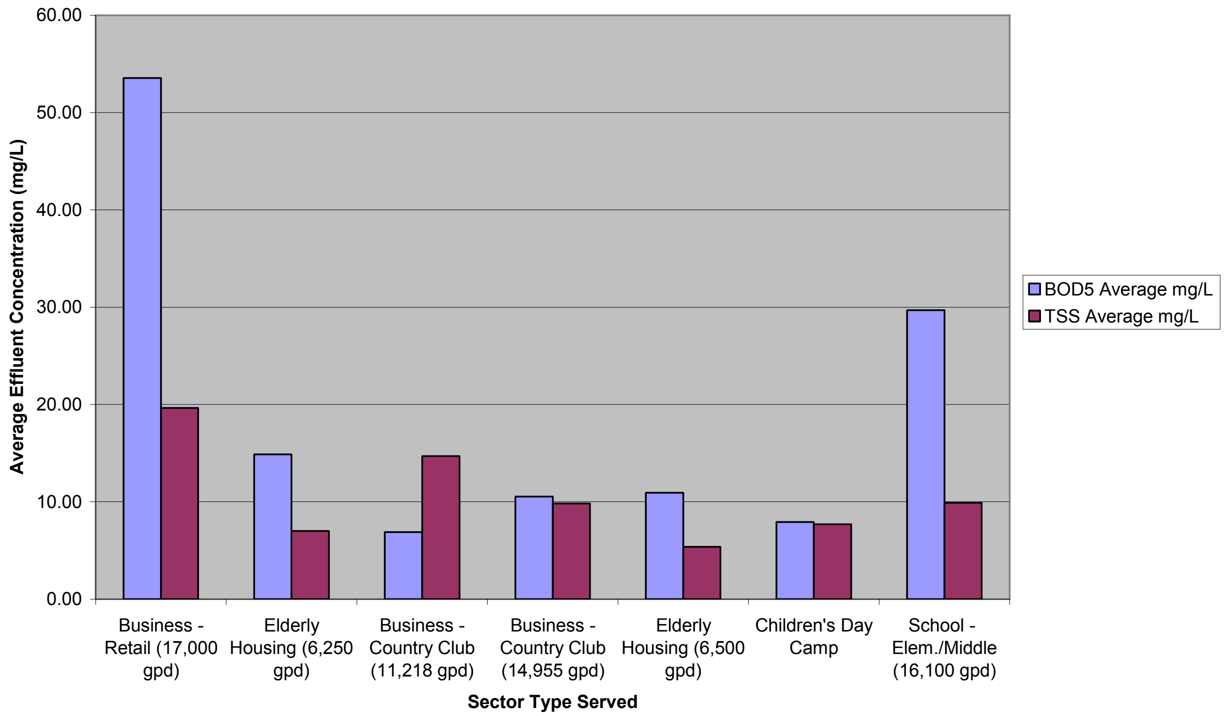
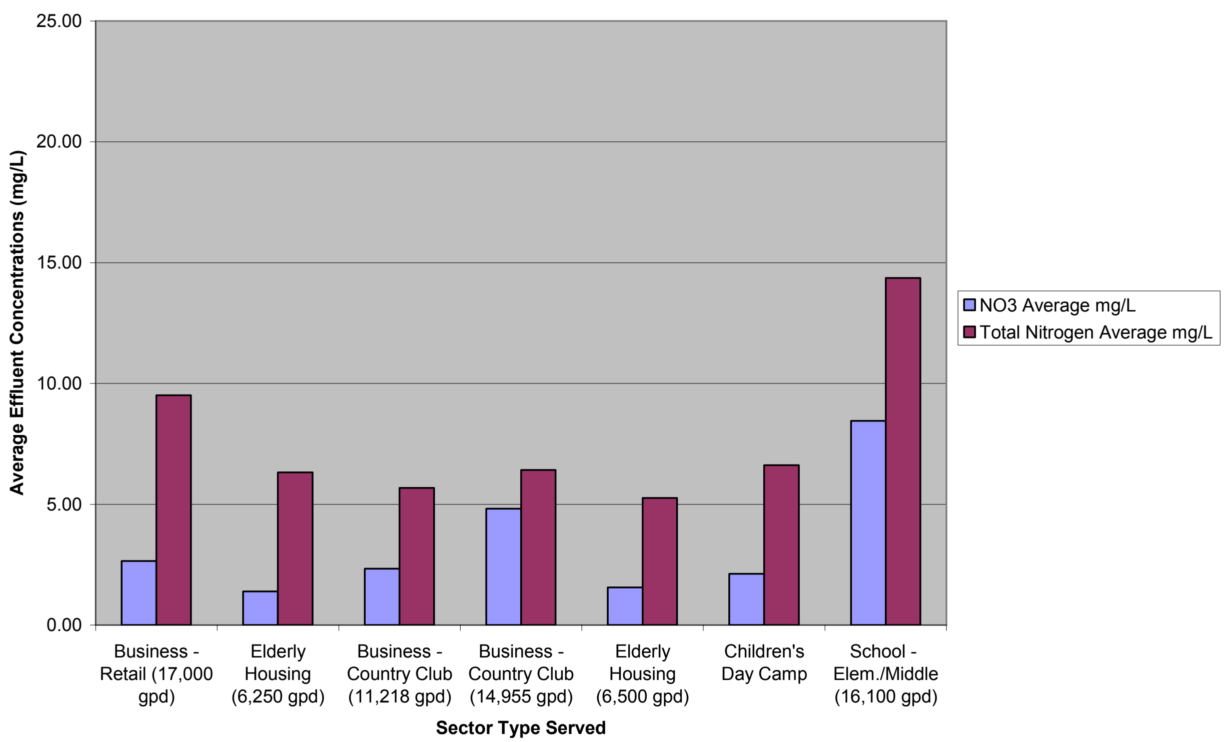


Figure 4-4. Bioclere Systems Performance By Sector for Nitrate and Total Nitrogen.



Of the Bioclere treatment systems, those serving the elementary/middle school and retail business performed the least well of the seven systems with respect to both BOD_5 and total nitrogen levels. Other sector types served by the Bioclere systems appeared to perform comparably, on average.

For the RBC systems charts, because the business sector needed reasonably to be subdivided further based on types of facilities served to the extent that information was available, and due to the numbers of systems with flows greater than 20,000 gpd, charts showing performance for RBCs sector were combined based on flows and whether the sector was "overnight use/activity" (e.g., hotels, camps, etc.), or none (e.g., shopping centers, restaurants, etc.). A total of six charts are presented in Figures 4-5 through 4-10, with the first two pertaining to flows 20,000 gpd or less, and the remaining for flows greater than 20,000 gpd. The same vertical scales were used to allow for better side-by-side comparison of those charts for secondary treatment parameters and nitrogen species, respectively for the two flow categories.

Figure 4-5. RBC Systems Secondary Treatment Performance By Sector (5,000 to 20,000 GPD).

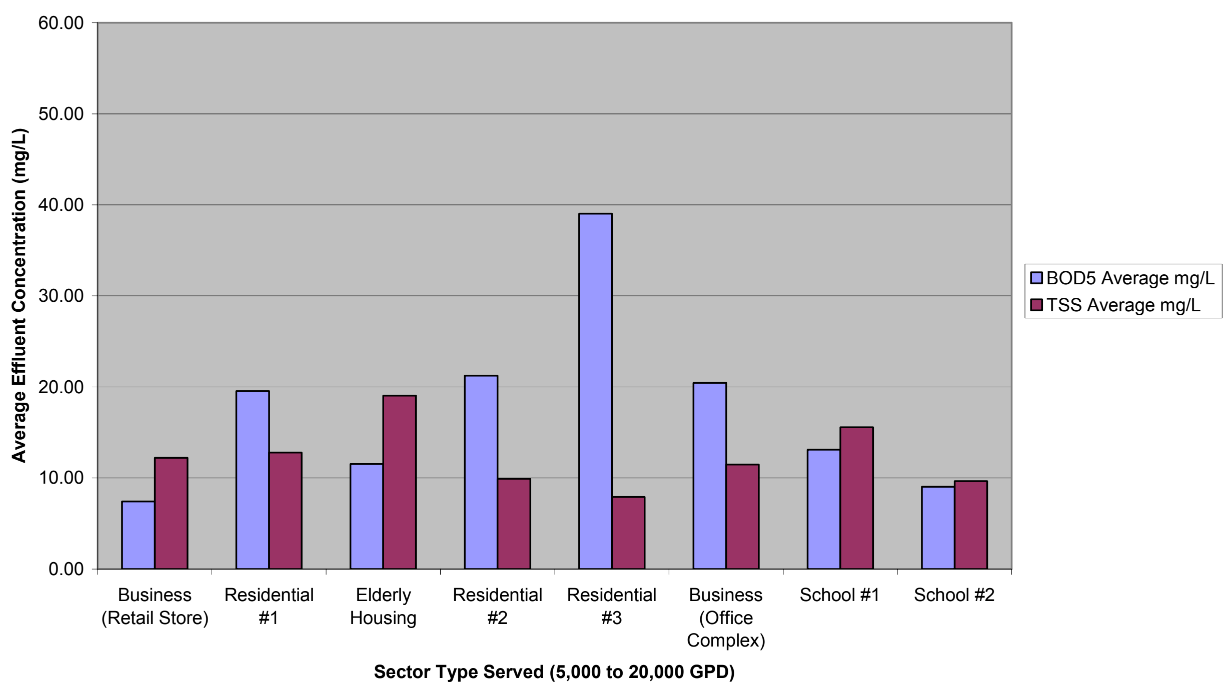


Figure 4-6. RBC Systems Performance By Sector for Ammonia, TKN, Nitrate and Total Nitrogen (5,000 to 20,000 GPD).

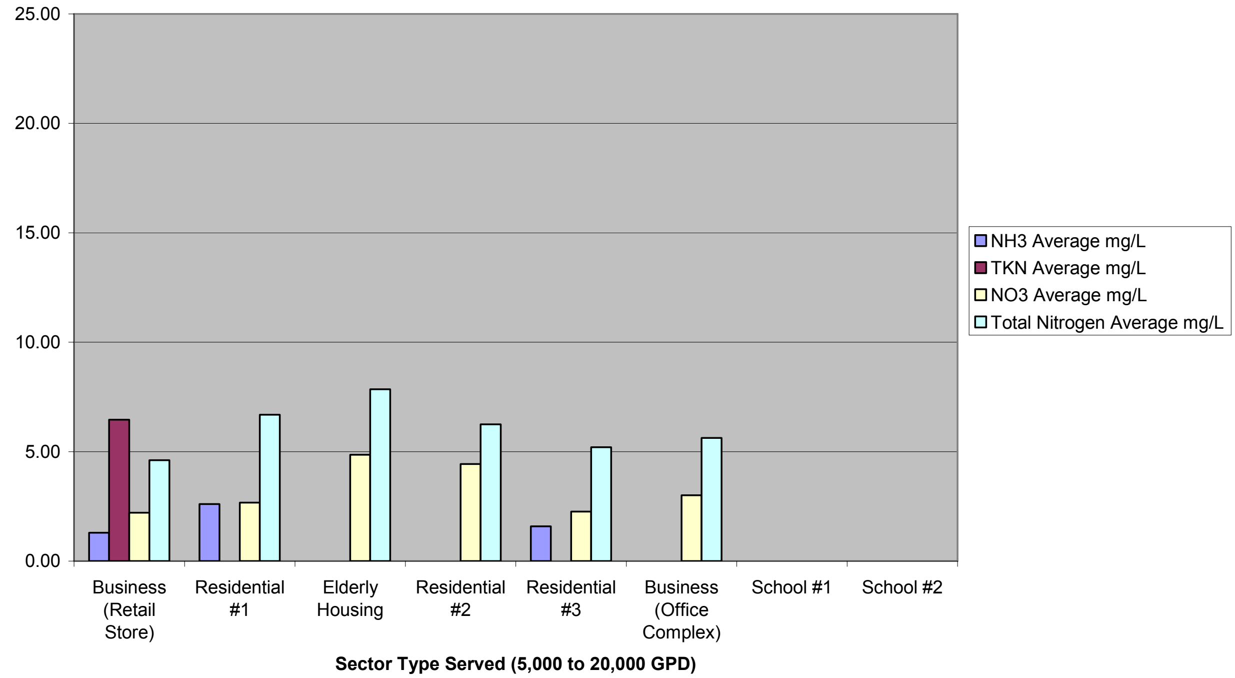


Figure 4-7. RBC Systems Secondary Treatment Performance by Day Use Sector (>20,000 to 50,000 GPD).

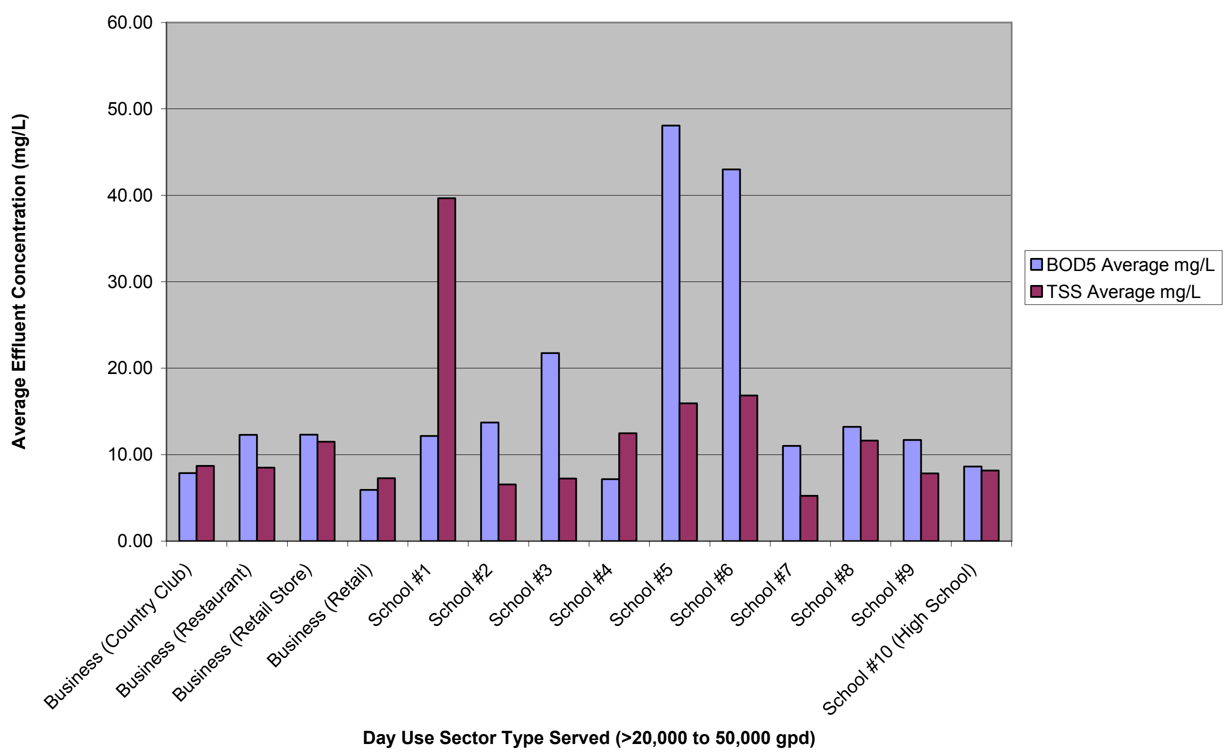


Figure 4-8. RBC Systems Performance By Day Use Sector for Ammonia, TKN, NO_3-N and Total Nitrogen (>20,000 - 50,000 GPD).

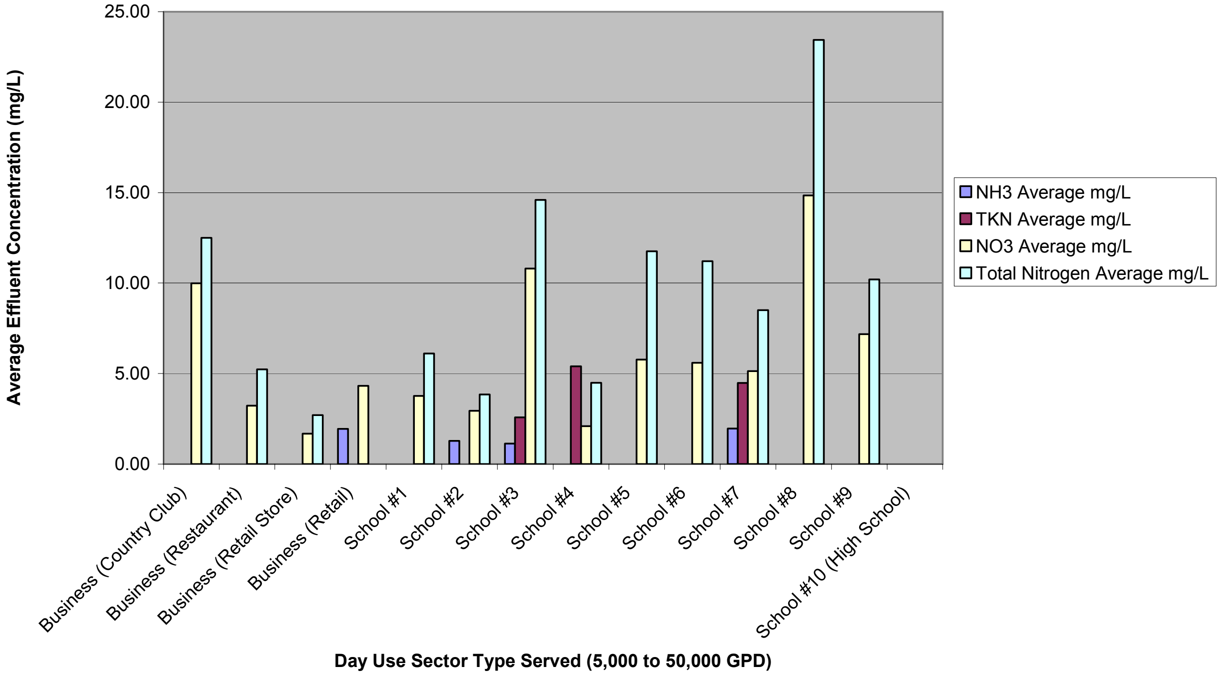


Figure 4-9. RBC Systems Secondary Treatment Performance by Overnight Use Sector (>20,000 - 50,000 GPD).

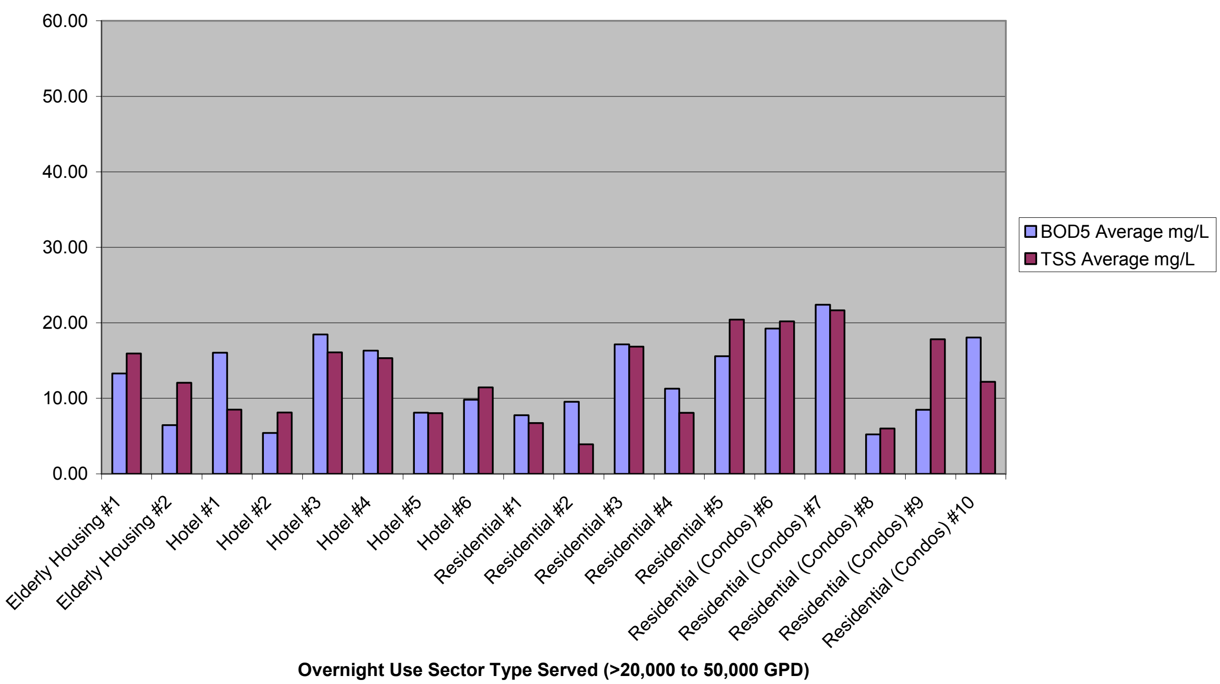
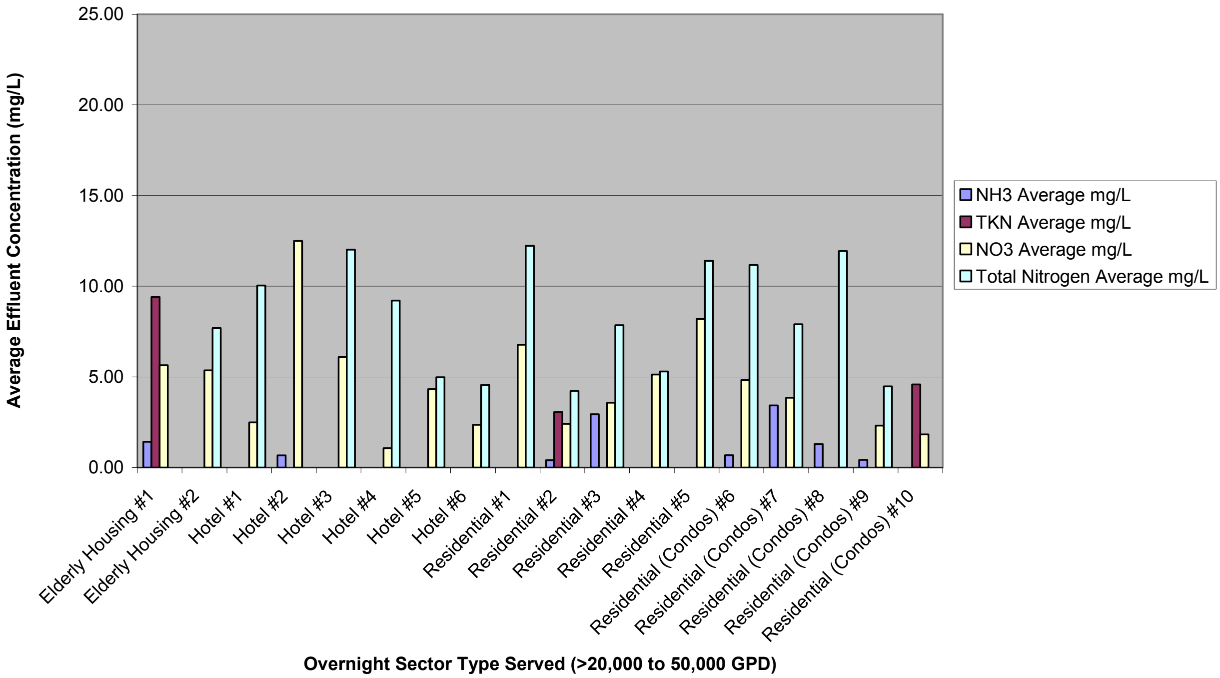


Figure 4-10. RBC Systems Performance By Overnight Use Sector for NH_3-N, TKN, NO_3-N and Total Nitrogen (>20,000 - 50,000 GPD).



All of the RBC systems with permitted flows in the 5,000 - 20,000 gpd range performed comparably relative to total nitrogen levels, although three of the systems averaged above 20 mg/L for BOD_5. Those three systems included two residential systems (2 and 3 on the chart) and an office complex. Despite reporting averages of above 20 mg/L for BOD_5, residential system 3 still averaged approximately 5 mg/L for total effluent nitrogen.

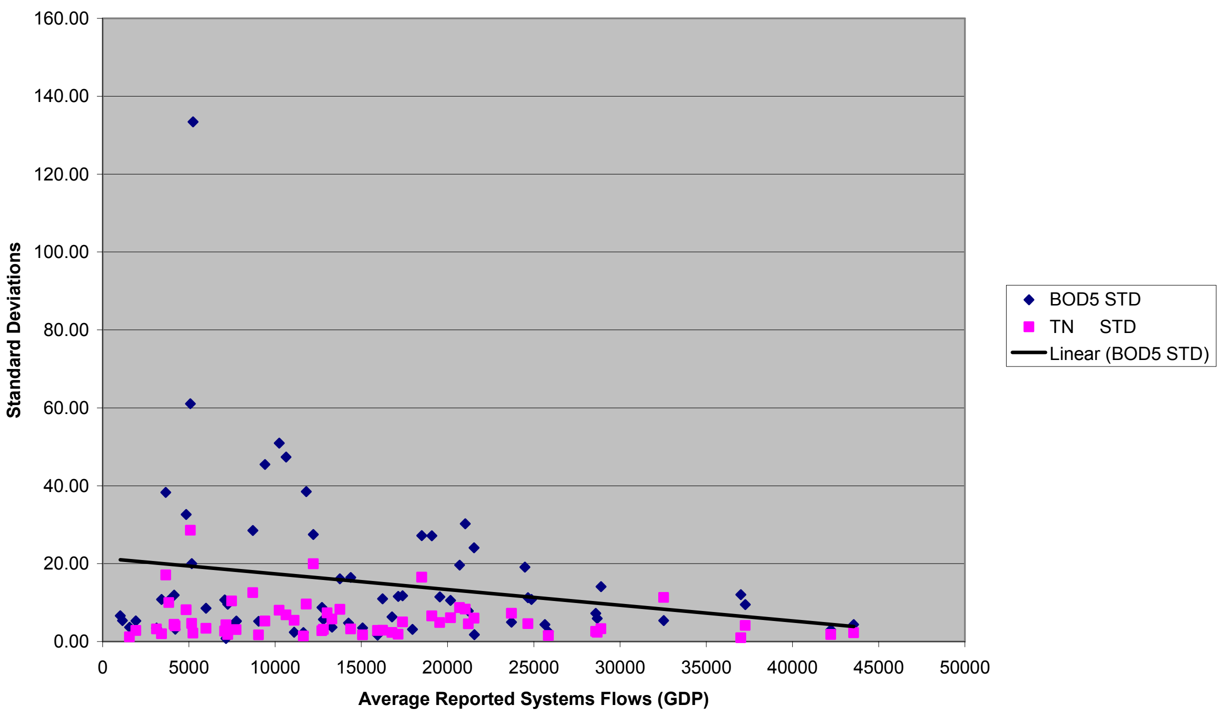
Of the larger (5,000-20,000 gpd) RBC systems serving day use sector types, the schools exhibited the most challenges relative to performance for both secondary treatment parameters and total nitrogen. In particular, schools 3, 5 and 6 had the highest average effluent BOD_5 levels, while those schools in addition to school 8 and the country club averaged highest for total effluent nitrogen.

For the overnight sectors systems served by larger RBC systems, there were no trends apparent in the performance for either secondary treatment or nitrogen species, based on sector type. Only one system averaged above 20 mg/L BOD_5 (residential system 7 – condos), though that system still reported an average effluent total nitrogen of less than 10 m/gL.

On average, the three predominant categories of Massachusetts treatment systems (based on numbers in the size range studied - Amphidrome, Bioclere and RBC) were operating at between 55% and 65% of their design capacities, based on average reported flows for those systems. The Massachusetts data was plotted for standard deviations of BOD_5 and total nitrogen performance versus average reported flows and for each of the systems in an effort to identify any tendencies for system size to affect the variability of system performance. The standard deviations for BOD_5 and total nitrogen data were also plotted against the % of design flow for average reported flows for all of the Massachusetts systems.

Below are three data "trending" plots (Figure 4-11 through 4-13) that were generated to look at those performance tendencies. Trend lines were generated for each of the plots to observe data scatter patterns with increasing system reported flows, and average reported flows as % of the design flows, for both BOD_5 and total nitrogen data for those systems.

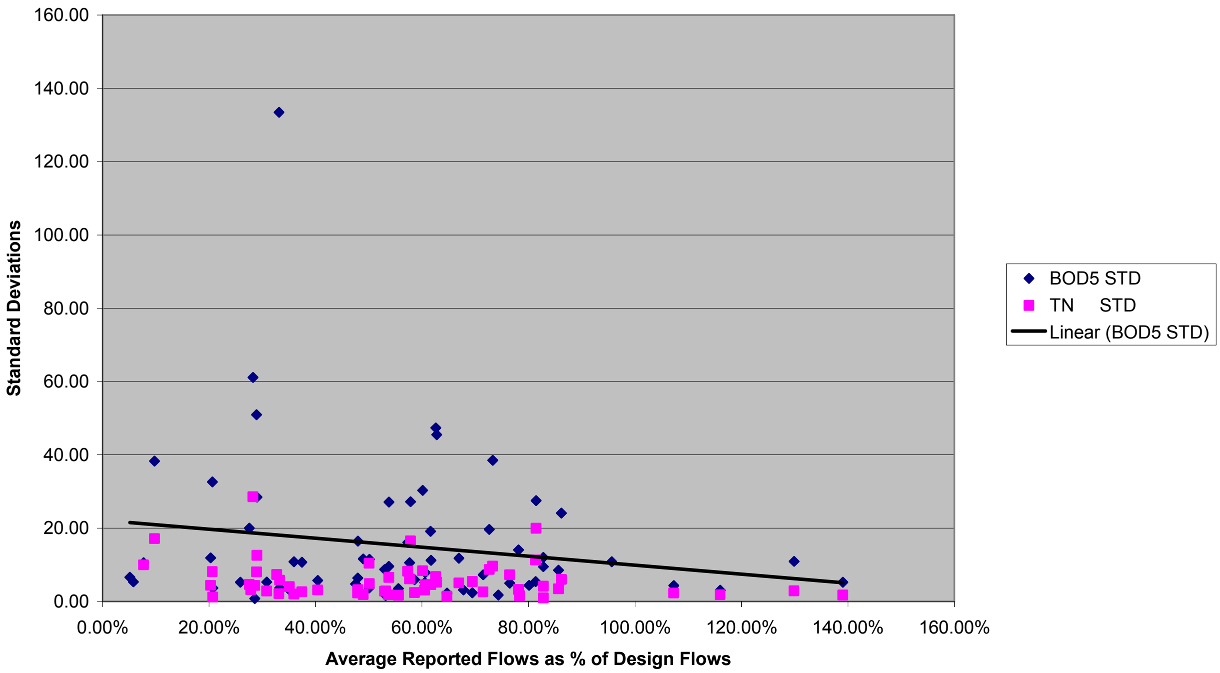
Figure 4-11. MA Systems Flow vs. BOD_5 and Total Nitrogen Standard Deviations



The plot in Figure 4-11 shows a tendency for somewhat less data "scatter", and at least slightly more consistent BOD_5 and TN performance with increased average reported flow.

Figure 4-12 above shows a tendency for less data scatter, and at least slightly more consistent BOD_5 and total nitrogen performance with plants operating more closely to their designed and permitted capacity. As shown by the chart below, that trend tends to be consistent with plants with larger flows.

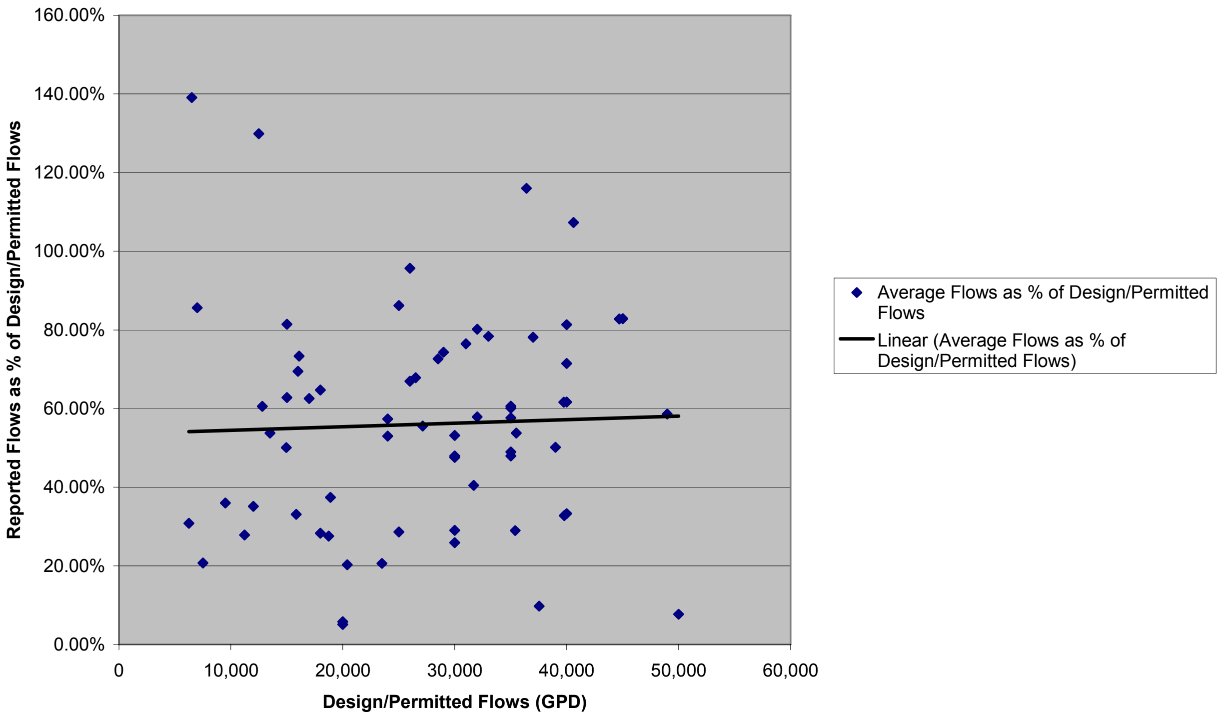
Figure 4-12. MA Systems Reported Flows As % of Design Flow vs. BOD_5 and Total Nitrogen Standard Deviations



The third trending plot below was generated to observe whether there appeared to be a greater tendency for larger plants to operate closer to their design/permitted flows. Based on that plot in Figure 4-13, there appears to be at least a very slight tendency for that to be the case.

While these trending plots are certainly not conclusive with respect to the various questions posed, they are consistent with trends that would be expected for larger domestic wastewater treatment systems approaching municipal scales. The larger the facility, the more equalization capacity and other operational controls there tend to be that would attenuate observed variations with systems performance.

Figure 4-13. MA Systems Flows as % of Design/Permitted Flows.



The trending charts presented below for the states of KY, VA, TX, CO, FL, NM, NC, and TN tend to follow the same general format. The graphs are intended to elucidate generalized trends for the data obtained, with various combinations of facility and system characteristics compiled and analyzed. Depending upon the number of systems for which data could be obtained from each state, the number of charts varies with those population sizes. As part of the study objective is to track performance trends associated with such factors as types of facilities served by certain types of treatment systems, for some states the fewer number of systems limits those possibilities. Systems "population" sizes for data are much larger for Kentucky and Virginia as compared with say Colorado or Florida, and thus more variables can be represented with charts for those states.

The x-axis of each plot identifies a number of effluent quality parameters of interest, while the parameter furthest to the right represents the average recorded daily flow rate for the systems, expressed as the proportion (percentage) of the systems' design flow. The "percent design flow" data corresponds to the secondary (right hand side) y-axis, while all of the other, water quality parameters correspond to the primary (left hand side) y-axis. All water quality parameters are expressed in units of mg/l, except for fecal coliform (FC), which is expressed in the units shown in parentheses next to that parameter on the x-axis.

Within each graph and each parameter on the x-axis, a series of bars represents different classifications of systems as identified in the legend on that graph. The height each bar represents the *average* of the system *mean* results within that grouping of systems. Error bars around each mean represent the *average* of the system *standard deviation* results within that grouping of systems. Finally, the "n" value represents the *number of systems* within that grouping contributing to that particular mean and standard deviation presented. So, for example, a bar with an n = 6 means that the *average* mean and *average* standard deviation for that grouping of systems was calculated using the means and standard deviations for six systems. As such, note that some of systems used to generate the average means or standard deviations may be represented by many monitoring data points, while other may be represented by only a few.

4.2.2 Kentucky

The 76 Kentucky systems for which data could be obtained were designated as "discharge" systems, though this designation pertains to both surface irrigation and point/stream discharging systems. The systems' data was organized into "low" and "high" flow ranges depending on whether the design/permitted flow was below or above 20,000 gpd, respectively. Systems were further categorized based on whether the type of facility served by the system was day use only, or was an overnight type use. Overnight use includes such facilities as motels, campgrounds, boarding schools and residential/community systems. Day use facilities would include schools, shopping centers, restaurants, etc. The systems were further categorized by general treatment method used. Those included:

- Activated sludge/extended aeration (AS)
- Activated sludge/extended aeration & Intermittent Sand Filters (AS-ISF);
- Activated sludge/extended aeration & Rapid Sand Filters (AS-RSF);
- Activated sludge/extended aeration & Multi-media Filters (AS-MMF);
- Activated sludge/extended aeration & Polishing lagoons (AS-PL);
- Septic Tanks/Anaerobic Treatment followed by Intermittent (or "slow") Sand filters (ST-ISF);
- Septic Tanks/Anaerobic Treatment followed by Rapid Sand filters (ST-RSF);
- Septic Tanks, Vegetative Filter, Intermittent or Slow Sand Filtration (ST-VF-SSF);
- Septic Tanks, Vegetative Filter, Trickling Filter (ST-VF-TF);
- Stabilization Ponds, Intermittent Sand Filters (SP-ISF).

The following breakdown into the above categories was used for organization the charts generated for the systems' average performance data:

High Flow Range (> 20,000 gpd) and Day Use:

- AS: 2 systems;
- AS-ISF: 1 system;
- AS-PL: 1 system.

High Flow Range and Overnight Use:

- AS: 9 systems;
- AS-ISF: 2 systems;
- AS-PL: 4 systems;
- AS-RSF: 1 system; and

- SP-ISF: 1 system.

Low Flow Range (5,000 to 20,000 gpd) and Day Use:

- AS: 3 systems;
- AS-ISF: 1 system;
- AS-PL: 2 systems;
- AS-RSF: 2 systems;
- ST-ISF: 1 system.

Low Flow Range and Overnight Use:

- AS: 26 systems;
- AS-ISF: 6 systems;
- AS-MMF: 3 systems;
- AS-PL: 2 systems;
- AS-RSF: 4 systems;
- ST-ISF: 2 systems;
- ST-RSF: 1 system;
- ST-VF-SSF: 1 system; and
- ST-VF-TF: 1 system.

A total of six charts were generated for Kentucky, as presented in Figures 4-14 through 4-19. Figures 4-14 through 4-16 are single plots that sort the systems by flow range (high or low) and Facility Type (day use or overnight) and then group data by system type. Figures 4-17 and 4-18 are essentially the same; however, there were so many system types for this sort (low range/overnight facility) that the data were split into two plots: Figure 4-17 for activated sludge based system types and Figure 4-18 for septic tank based system types. Finally, Figure 4-19 includes a subset of the systems for which we could compare public versus private management system performance. For this plot, combinations of facility type and system type for which there were multiple representatives of both public and privately operated systems (a total of six combinations) were included. For Figure 4-19, high and low flow range systems were combined.

[Note that "<u>RSF</u>" in this dataset refers to <u>rapid sand filter</u>, and not to recirculating sand filter.]

Figure 4-14. Kentucky Day Use Facilities (High Flow Range).

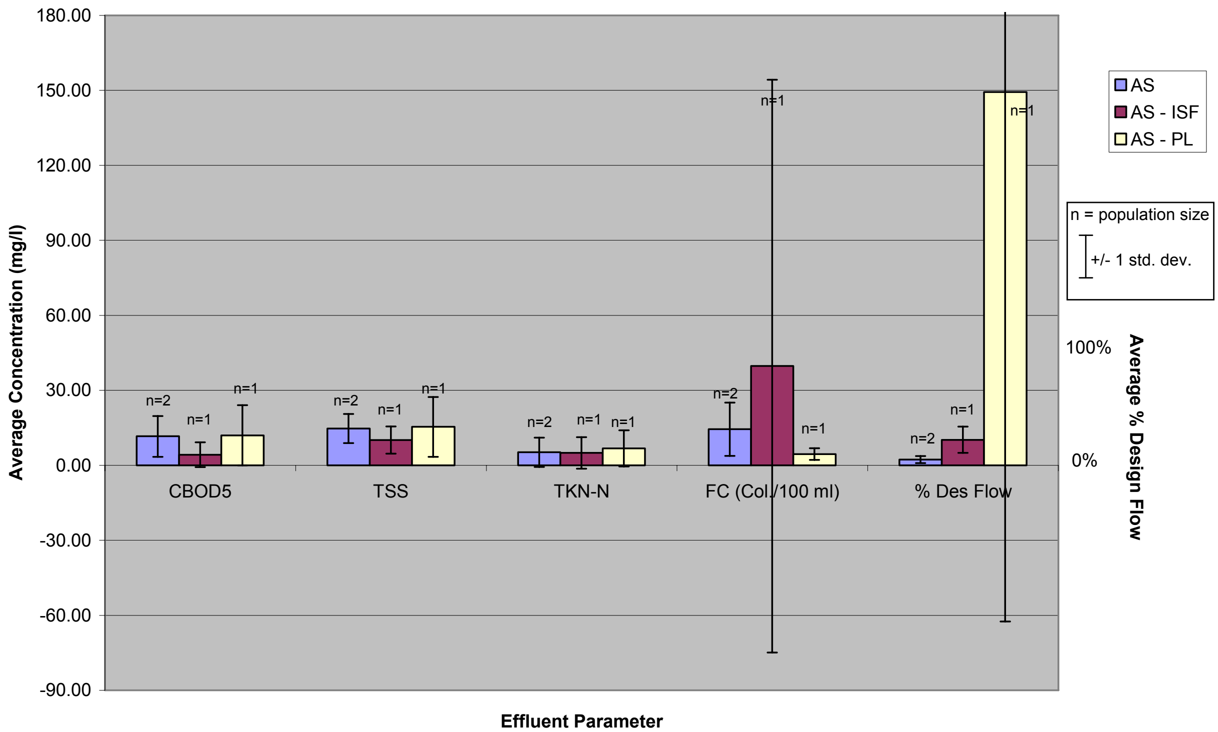


Figure 4-15. Kentucky Overnight Facilities (High Flow Range).

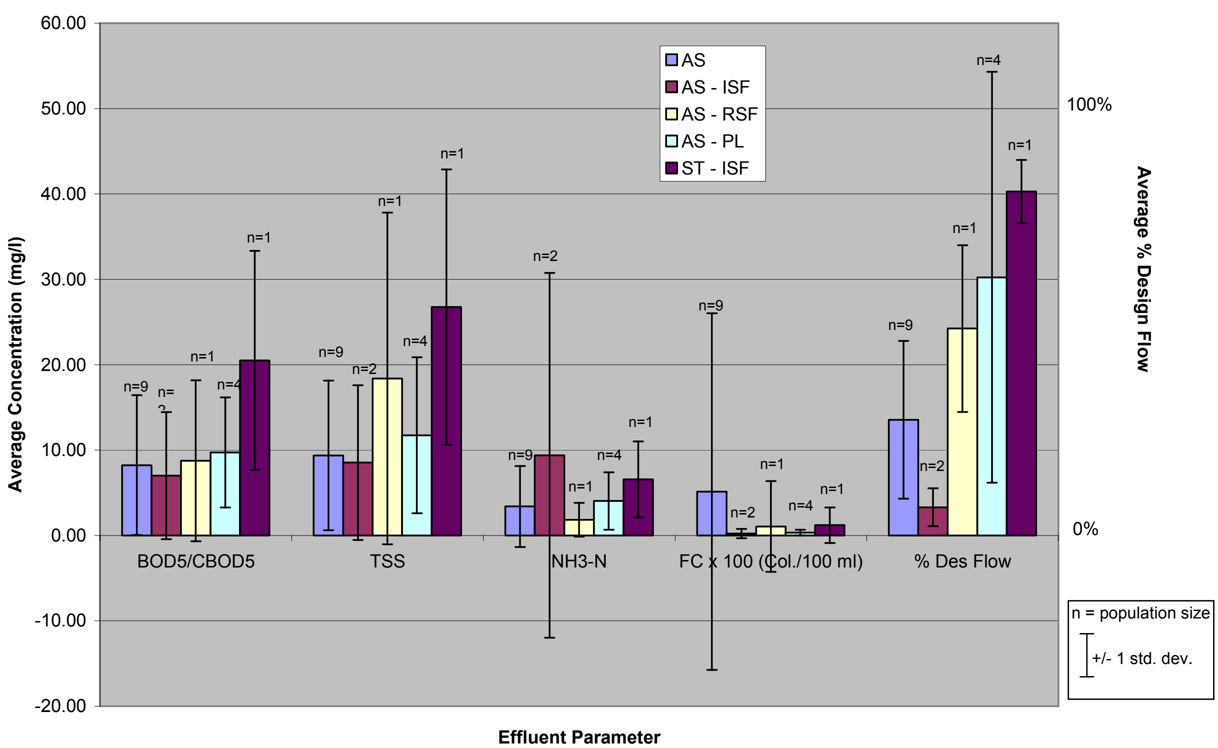


Figure 4-16. Kentucky Day Use Facilities (Low Flow Range).

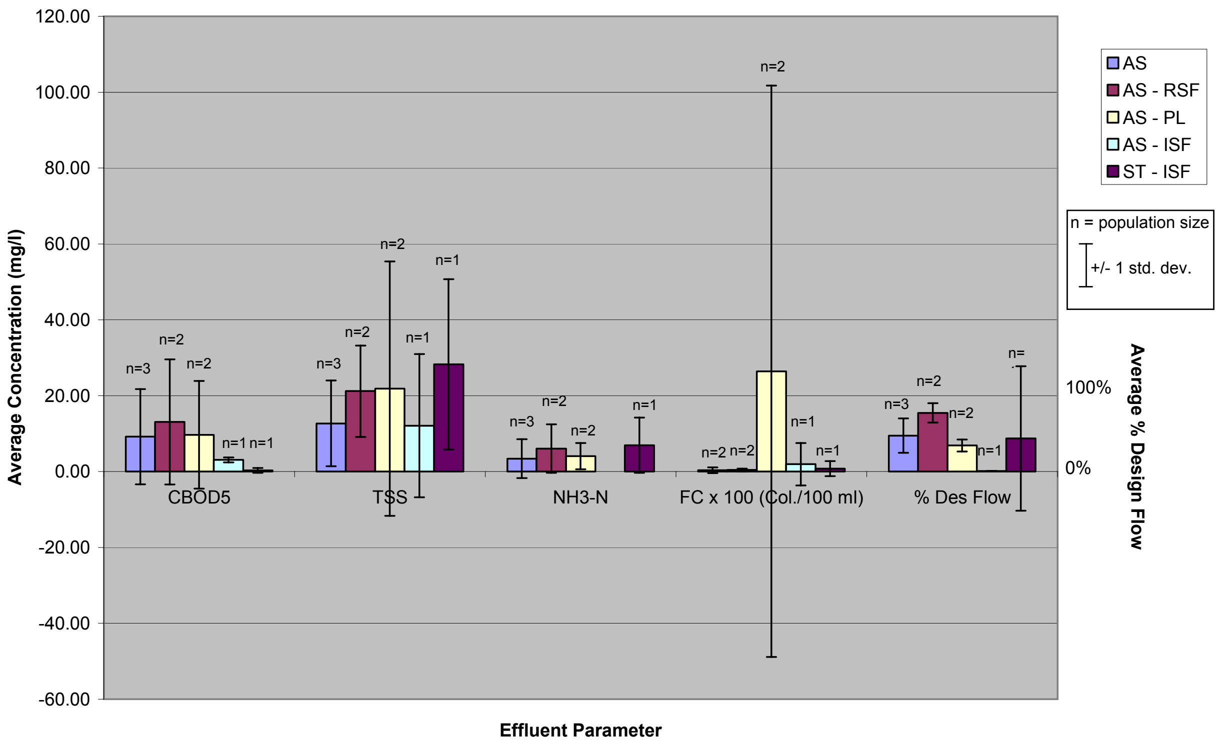


Figure 4-17. Kentucky Overnight Facilities - Activated Sludge Based Systems (Low Flow Range).

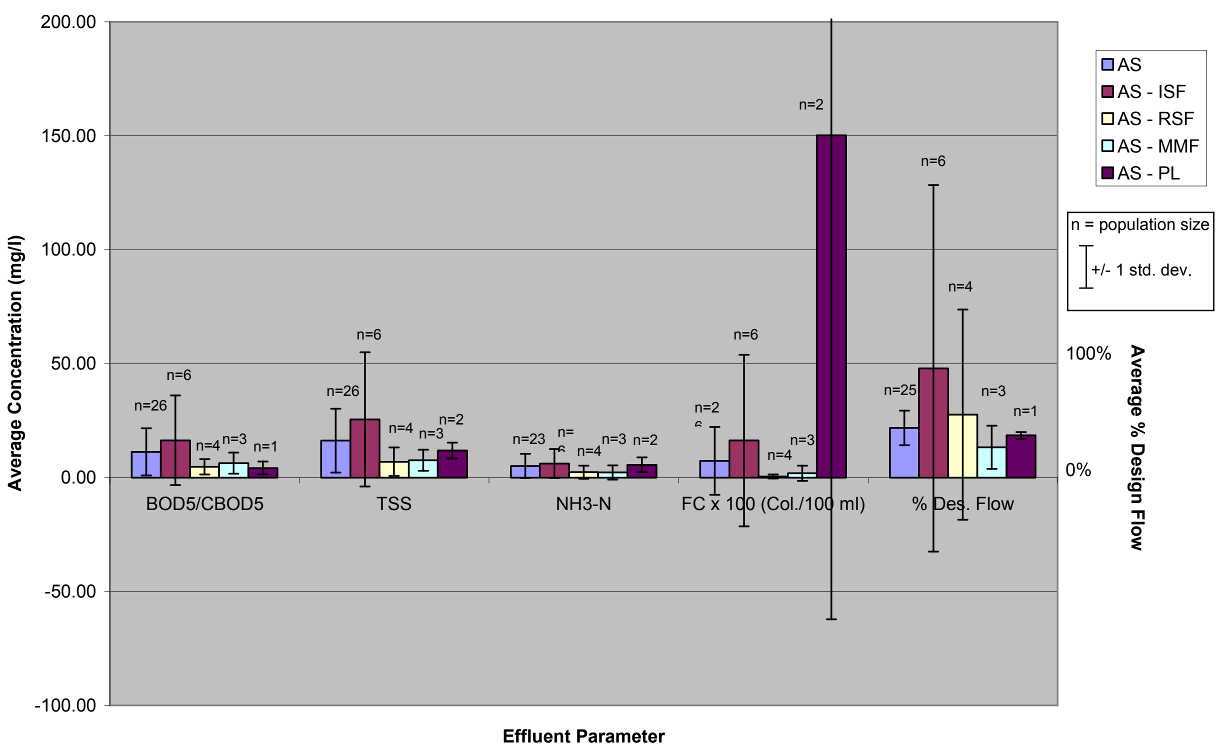


Figure 4-18. Kentucky Overnight Facilities - Septic Tank Based Systems (Low Flow Range).

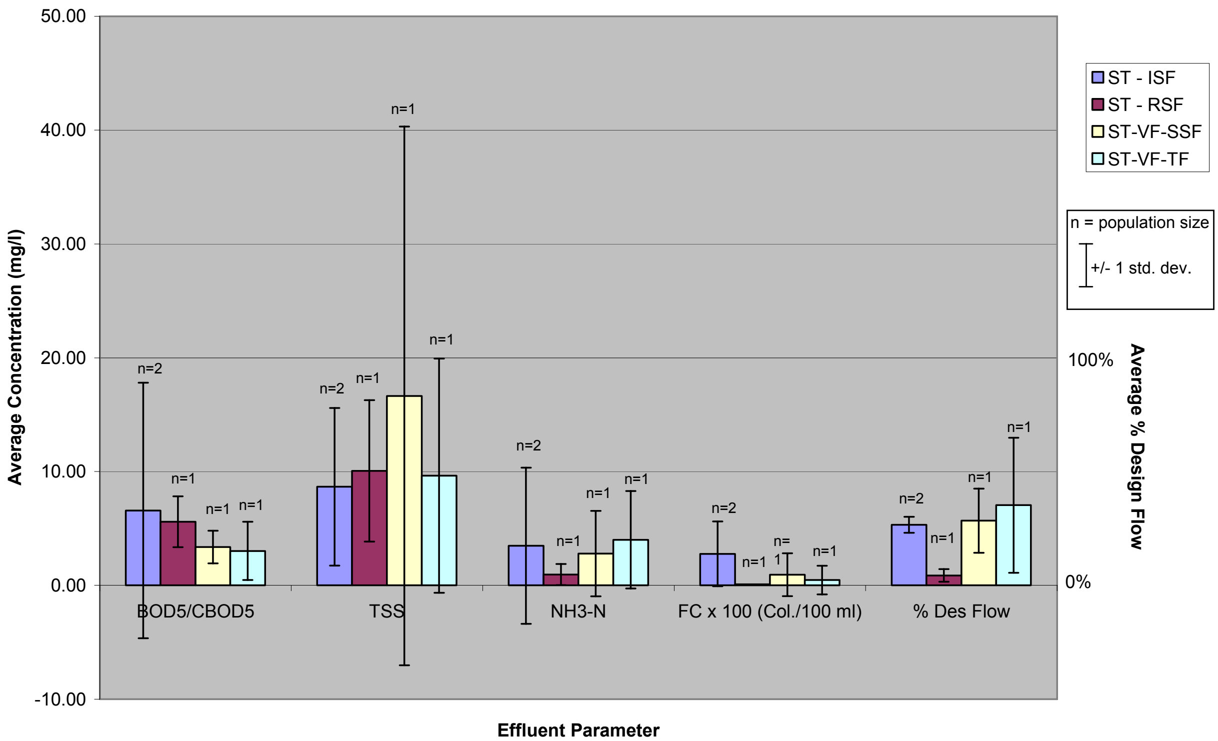


Figure 4-19. Kentucky Systems Performance By Type of Management, Treatment Method and Facility Types.

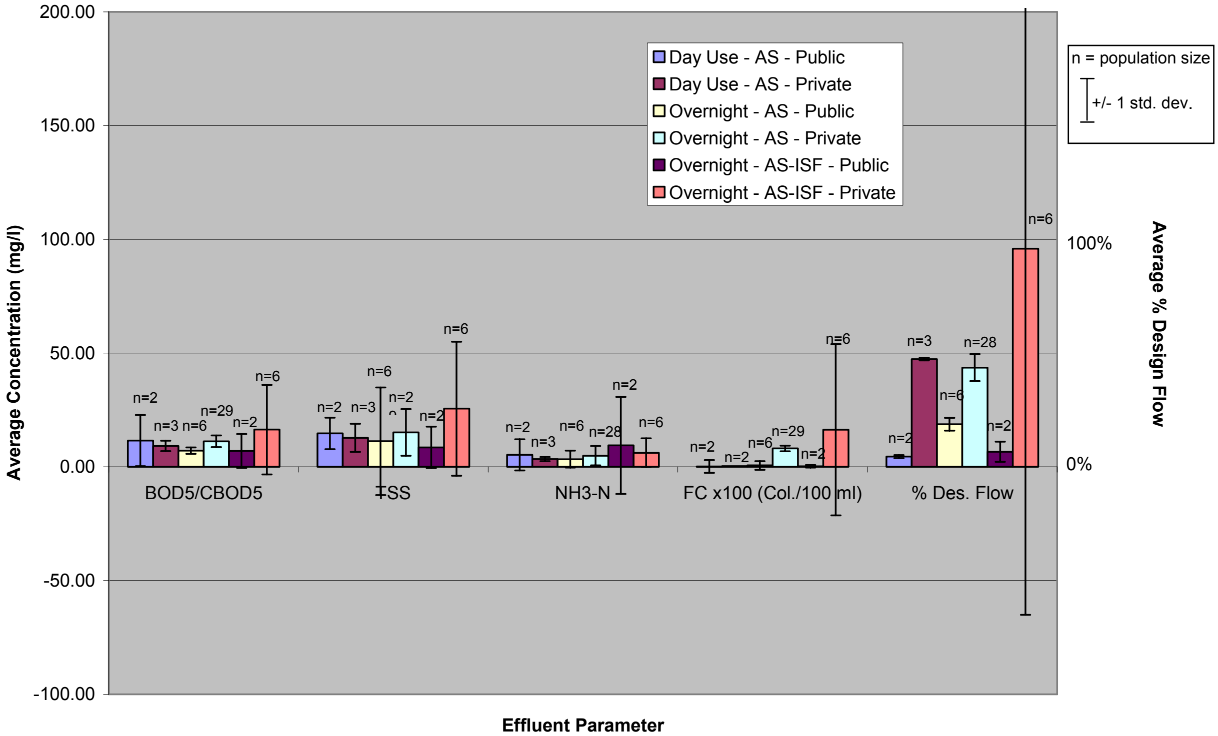


Figure 4-14 indicates that performance of activated sludge based system types serving day use facilities is comparable over multiple parameters, regardless of actual flow rates. Error bars overlap significantly. Figure 4-15, the same plot but for systems serving overnight facilities, again shows fairly comparable performance among activated sludge based systems; however, the septic tank-intermittent sand filtration system performed noticeably (and likely significantly) worse for BOD and TSS. It should be noted that this particular system was hydraulically loaded heaviest in relation to its design capacity. All of the systems, including the septic tank-ISF appeared to effect substantial nitrification, based on the ammonia-nitrogen results.

Figure 4-16 is the analogue to Figure 4-14 except for the differences in flow range (Figure 4-16 charts 5,000-20,000 gpd systems only. The results charted in Figure 4-16 are somewhat difficult to generalize. The septic tank/intermittent sand filter (ST-ISF) system represented in this dataset had extremely low $CBOD_5$ results but the highest TSS results. Sloughing of solids from the filter are a possible explanation for those observations.

The scale of Figure 4-l7 is skewed somewhat by a high fecal coliform average for one subset of systems. That notwithstanding, it appears that the performance of activated sludge systems followed by additional treatment in the form of filtration or polishing lagoons was better than activated sludge treatment alone and that the additional treatment may be needed to meet BOD/TSS limits of say 15 mg/l or less on a consistent basis. One exception to this observation might be the AS-ISF systems; however, it is noted that these systems were operating, on average, nearly at their design capacity, which may be influencing performance with respect to BOD/TSS. While the TSS averages for those systems were just over 25 mg/L, the BOD/CBOD averages were just over 16 mg/L. In particular, it is possible that for aeration systems hydraulic loading rates of clarifiers and tertiary filters may be excessive, resulting in solids carry over (incomplete settling, sloughing, etc.). It is also useful to note that the system populations (n values) represented, particularly by the activated sludge and the AS-ISF system groupings, are robust compared with some of the other evaluations we have considered. All systems appeared to nitrify well.

For the low flow range overnight facility septic tank-based systems represented in Figure 4-18, generally comparable performance can be seen among the limited population of systems evaluated. BOD/CBOD performance from these systems was particularly good, with all averaging well below 10 mg/l, with fairly tight error bars indicating good process stability. TSS results were both higher (but still generally good), with associated higher variabilities. The septic tank based systems, all followed by an aerobic filtration process, each appeared to nitrify well.

Figure 4-19 compares system performance by type of management entity. This graph may best be viewed by comparing each pair of bars. Each pair of bars represents a facility/system type grouping, with the first bar being public management and the second bar representing privately managed systems. A review of the graph shows no obvious trends with respect to BOD/CBOD and TSS, although the final combination (overnight/AS-ISF/private management) appears higher in both parameters than the other combinations. This grouping also had actual flow rates quite close to design, which may explain the observation.

With respect to the "% design flow" parameter on Figure 4-19, we do see that for each combination of system type and facility type, the privately managed systems had flow rates much closer to their designed/permitted flow. There may be some bias as a result of the groupings that at least partially explains this interesting observation. For example, the overnight facilities that are privately operated tend to include more private developments/subdivisions along with motels/hotels and mobile home parks, while publicly owned tend to include a greater number of facilities such as schools or campgrounds. Nevertheless, even day use facilities display a large difference between private and public management with respect to actual flow rates. It is certainly possible that the private sector, striving for greater efficiency and/or less conservatism, may be utilizing more aggressive designs or it may just be that these facilities are intensive enough to want to pay a private management entity for service (e.g., like a subdivision).

4.2.3 Virginia

Data was obtained from a total of 85 Virginia systems, with those designated as "discharge" systems using either surface irrigation or point/stream discharge. The systems' data was again organized into low and high flow ranges (5,000 to 20,000 gpd, and >20,000 to 50,000 gpd). Systems were further categorized by treatment category and whether they served day use only facilities, or some type of overnight use. Treatment types were broadly categorized into one of two types for the purposes of chart divisions: Some type of activated sludge process or non-activated sludge treatment process (e.g., natural process, fixed film, etc.).

Activated sludge processes included:

- Extended aeration (AS-EA);
- Extended aeration followed by sand filter(s) (AS-EA-SF);
- Nitrification-Denitrification (NDN)
- Oxidation ditch; and
- SBR.

In a number of cases the treatment method was noted as being "activated sludge", though no specific process was indicated. Those systems were assumed to be extended aeration (AS-EA).

Natural/non-activated sludge processes included:

- Septic tank (systems with this designation most likely included another process that was not noted in the database) (ST);
- Imhoff tank (this also likely included another process that was not noted in the database) (IT);
- Intermittent sand filter (ISF);
- Slow sand filter (SSF);
- Rotary Sand Filter (RSF)
- Rotating biological contactor (RBC);
- Trickling filter (TF);
- Upflow sludge blanket (USB);
- Lagoon;
- Constructed wetland (CW); and
- Nitrification/denitrification system (this may be some type of activated sludge system, but the specific process description was not noted in the database) (NDN).

The above categories resulted in the following breakdown for generating the charts:

Activated Sludge Systems:

- High Flow Range:
  - Day Use:
    - AS-EA: 5 systems;
    - NDN: 1 system;
    - SBR: 1 system;
  - Overnight Use:
    - AS-EA: 14 systems;
    - SBR: 1 system;
    - OD: 4 systems.
- Low Flow Range:
  - Day Use:
    - AS-EA: 6 systems;
    - AS-EA-SF: 1 system;
    - SBR: 2 systems;
  - Overnight Use:
    - AS-EA: 13 systems;
    - AS-EA-SF: 1 system;

Natural/Alternative Systems:

- High Flow Range:
  - Day Use:
    - RBC: 1 system;
    - USB: 1 system
  - Overnight Use:

        - CW: 1 system;
        - IT: 1 system;
        - Lagoon: 9 systems;
        - RBC: 1 system;
        - TF: 2 systems.
- Low Flow Range:
    - Day Use:
        - ISF: 4 systems;
        - Lagoon: 1 system;
        - SSF: 2 systems;
        - ST: 2 systems.
    - Overnight Use:
        - ISF: 1 system;
        - Lagoon: 6 systems;
        - RBC: 1 system;
        - SSF: 1 system
        - ST: 1 system;
        - ST-RSF: 1 system.

Figures 4-20 through 4-25 present the data for systems in the state of Virginia. Figures 4-20 and 4-21 present effluent results for activated sludge type systems, with Figure 4-20 for high flow systems and Figure 4-21 for low flow range systems. Figure 4-22 presents the data for non-Activated Sludge systems serving day use facility types, while Figures 4-23 and 4-24 are for overnight use facility types, with Figure 4-23 representing high flow range systems and Figure 4-24 representing low flow range systems. Figure 4-25 presents data from systems serving schools in Virginia. The data in these plots are grouped by the type of school and the type of treatment. The intention of that chart is to identify potential performance trends associated with the different school levels/grades (elementary vs. middle vs. high schools), and their associated differences in activities and water usage (e.g., fewer showers typically for elementary schools as compared with high schools).

[Note that "RSF" in Figure 4-24 refers to a rotary sand filter, and not a recirculating sand filter.]

Figure 4-20. Virginia Activated Sludge 20,000-50,000 GPD Systems by Facility Type.

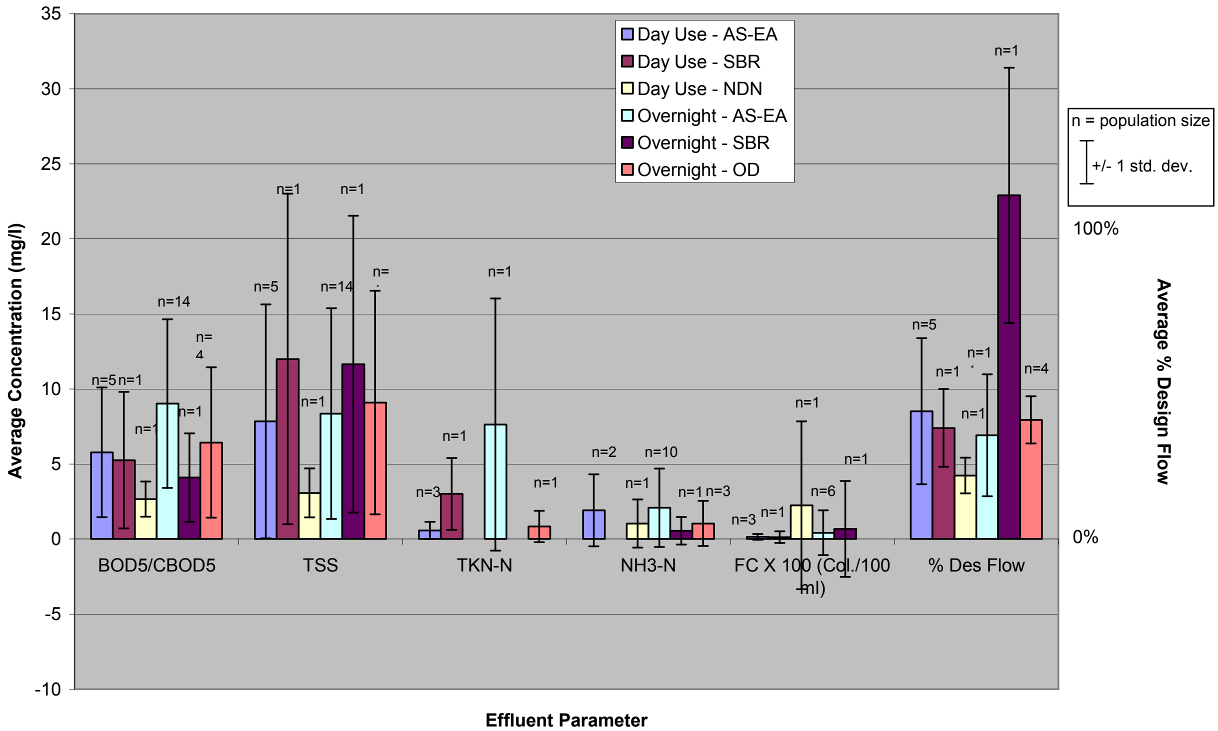
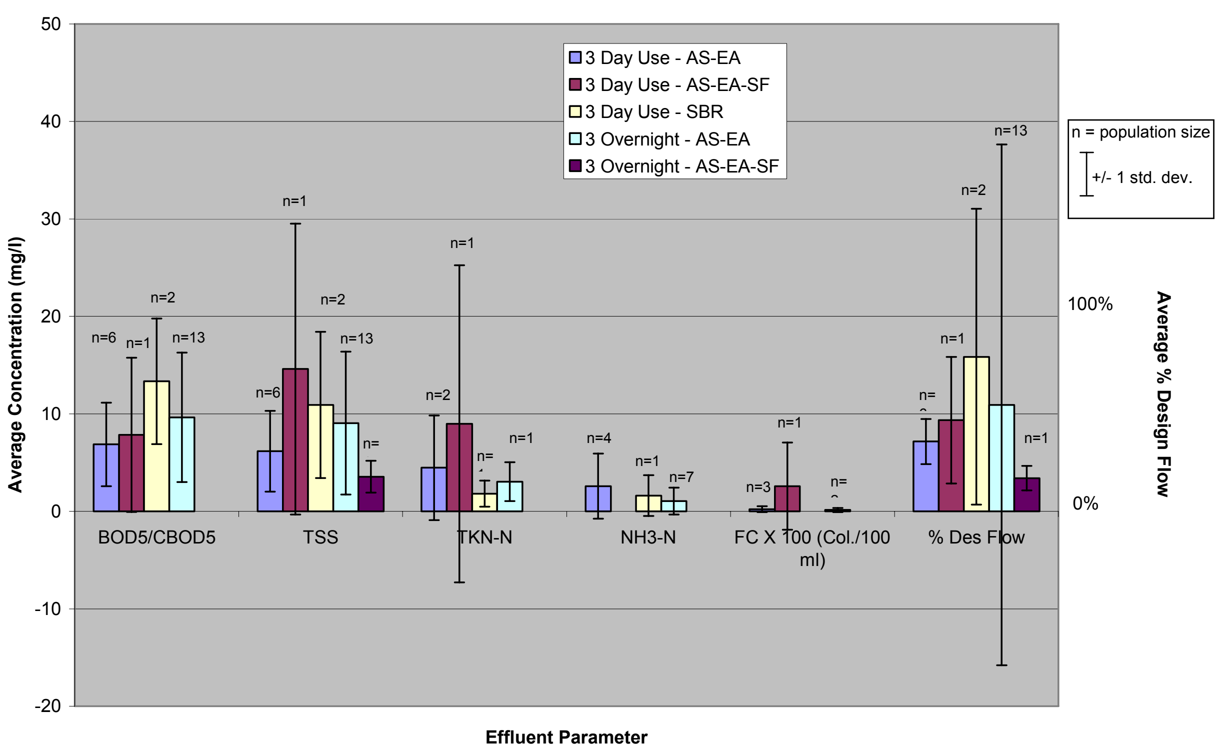


Figure 4-21. Virginia Activated Sludge 5,000-20,000 GPD Systems by Facility Type.



WERF

Figure 4-22. Virginia Non-Activated Sludge Systems Serving Day Use Facilities (Performance by Flow Range and System Type).

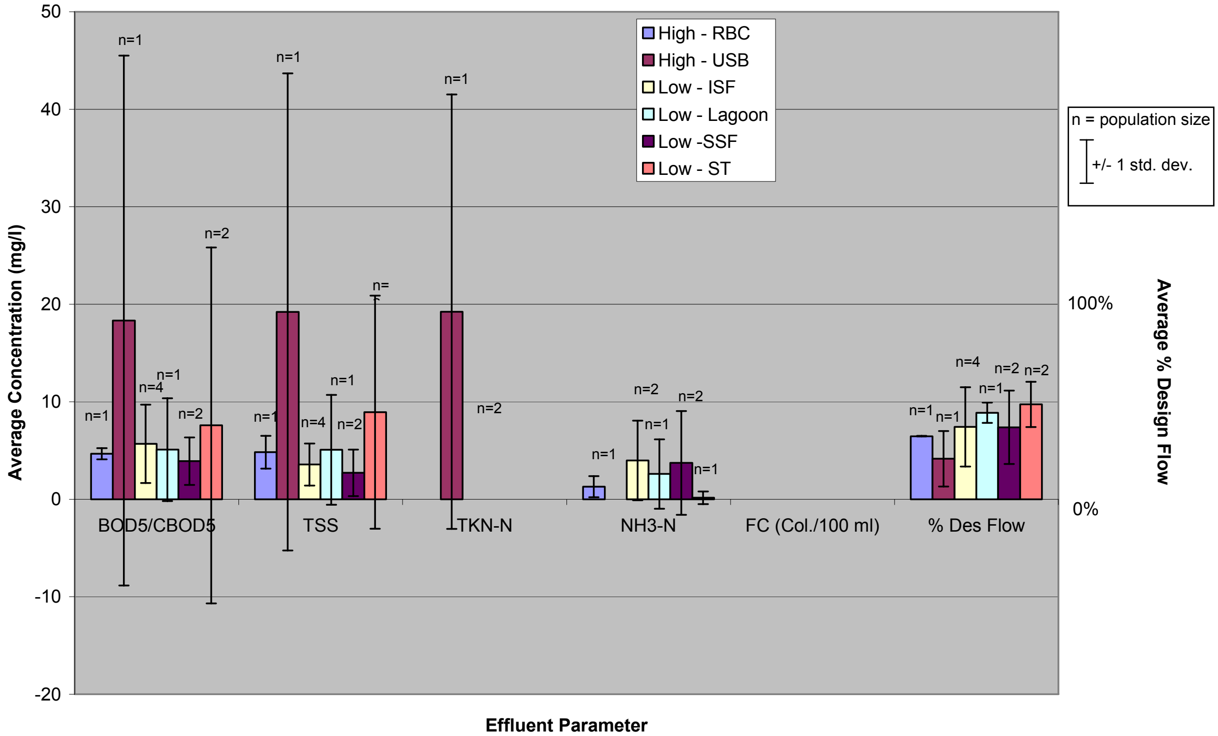


Figure 4-23. Virginia Non-Activated Sludge High Flow Range Overnight Use Facilities (Performance by System Type).

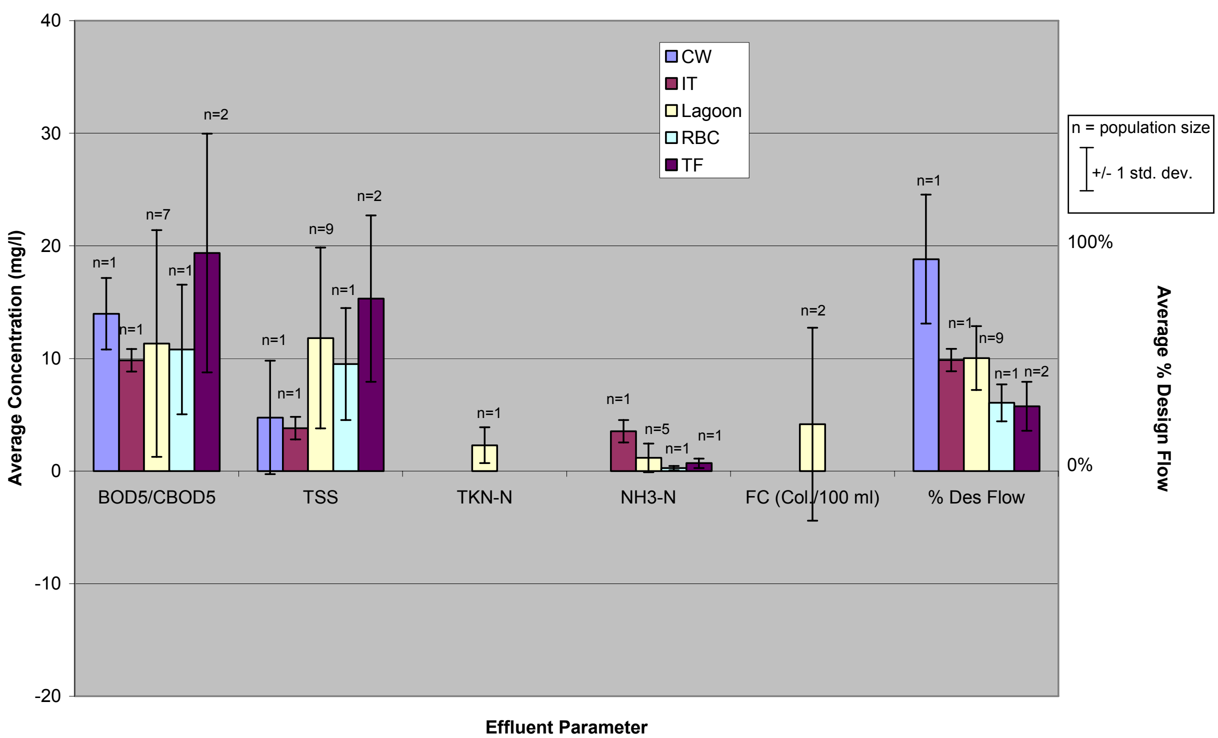


Figure 4-24. Virginia Non-Activated Sludge Low Flow Systems Serving Overnight Use Facilities (Performance by Treatment Type).

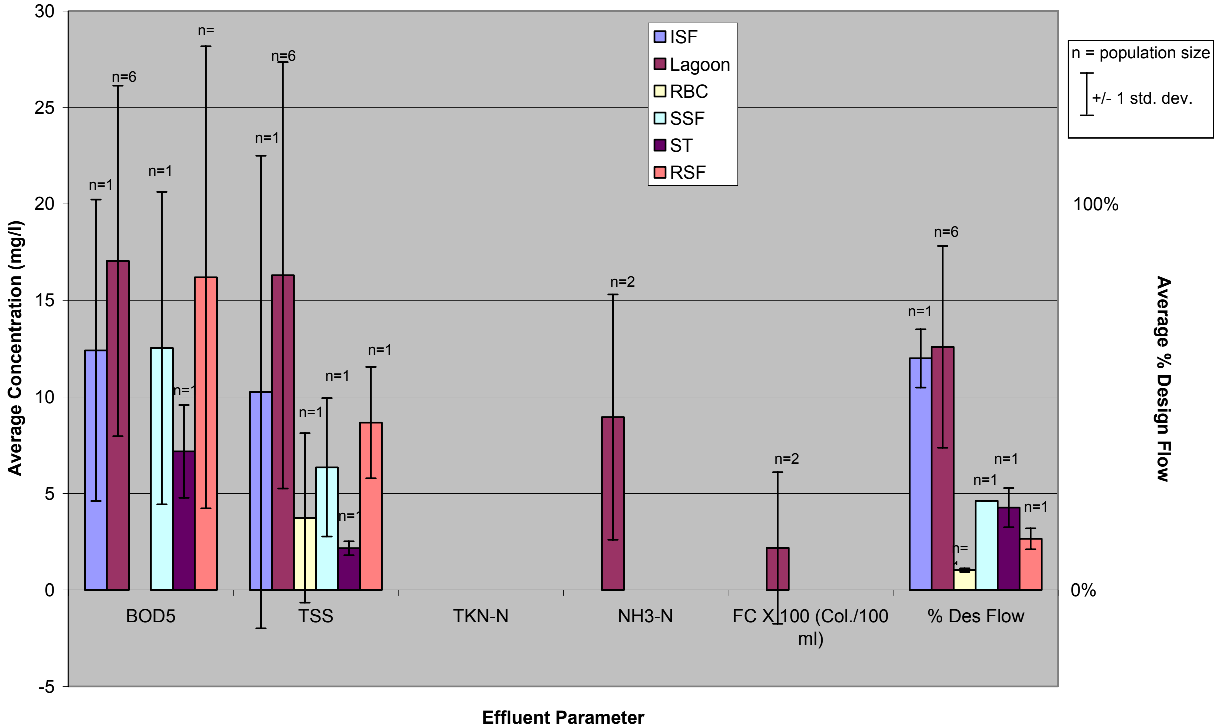


Figure 4-25. Virginia Systems Serving Schools (Performance by School Type and Treatment Method).

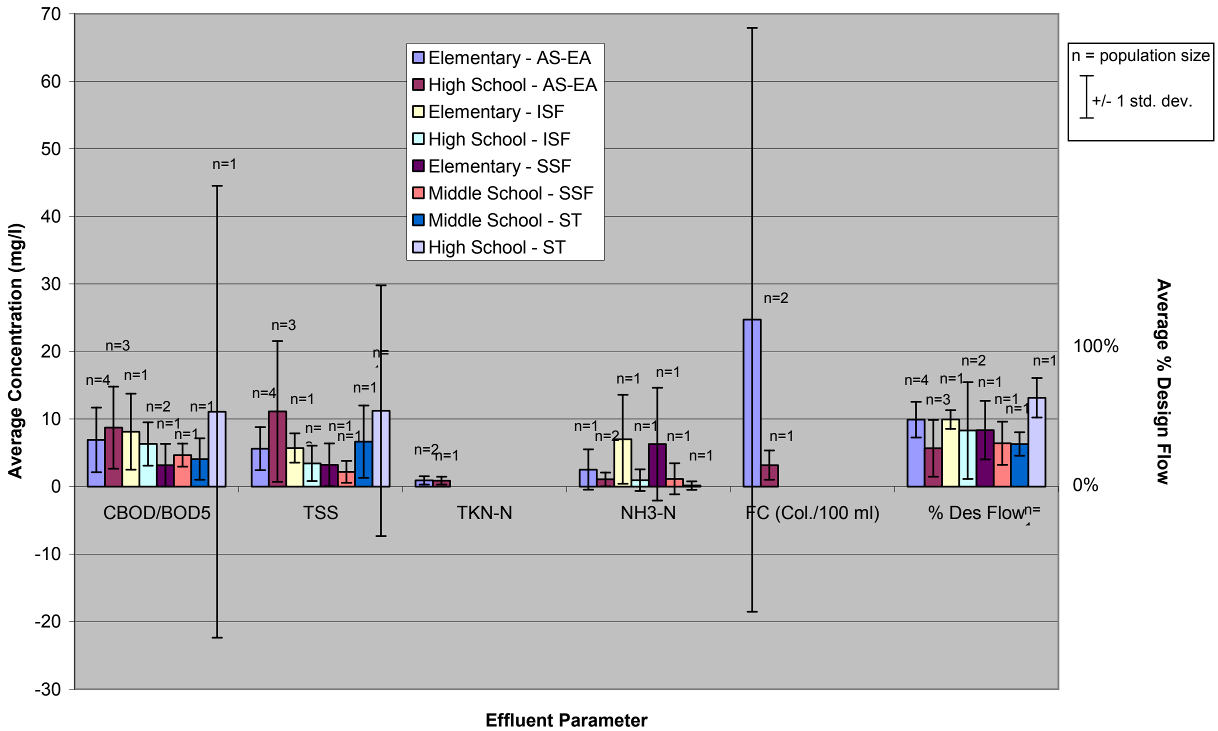


Figure 4-20 indicates that activated sludge type system performance in the 20,000-50,000 gpd flow range is fairly consistent for most parameters of interest. TSS results for SBR systems serving both day use and overnight facilities were notably higher than for other system types. It should be noted that the one overnight SBR system was overloaded on average. Likewise, the one system identified as a "nitrification-denitrification" system had extremely low BOD and TSS readings, although this system was the most under-loaded hydraulically.

For low range activated sludge type systems represented in Figure 4-21 performance did not show many obvious trends. The one SBR system had relatively high average effluent BOD/CBOD, although again this system averaged close to its design hydraulic loading.

For the alternative system types serving day use facilities represented by Figure 4-22, the upflow sludge blanket filtration system (identified as USB in the graph legend) stands out as having mediocre and highly variable performance for BOD/CBOD, TSS and TKN-N, despite being the most hydraulically under-loaded system (on average) evaluated. The systems identified only as "septic tank" (ST) treatment had much better effluent BOD/CBOD and TSS results than would be expected of septic tank effluent, implying that there is likely another unspecified unit process was included in the treatment train. In that the Virginia database obtained presumably includes only VPDES-permitted systems (surface discharging systems), that is particularly likely.

Figure 4-23 indicates that the Imhoff tank treatment system performed very well. Additionally, this system appears to have nitrified, which again raises the question about whether additional unspecified unit processes were included in the treatment train. The constructed wetland system had considerably higher BOD/CBOD than TSS in the effluent, which could be a result of dissolved organics resulting from decaying wetland vegetation. This system was also relatively heavily loaded hydraulically. The trickling filter represented in the dataset performed least effectively for secondary treatment parameters (BOD/TSS), despite being the lowest loaded hydraulically.

For low flow systems serving overnight facilities (Figure 4-24), the results indicate that intermittent and recirculating sand filters and lagoons performed only fair for secondary treatment parameters, with average results exceeding 15 mg/l for BOD and TSS (with the exception of the recirculating sand filter TSS). Once again, it appears that the "septic tank" system almost assuredly includes some other unit process(es), based on the low average BOD and TSS averages for that system.

The Virginia systems serving schools appeared to perform extremely well on average (Figure 4-25), with all systems averaging close to or less than 10 mg/l for BOD and TSS and all averaging less than 10 mg/l for ammonia-nitrogen (high nitrogen loading has been identified as a potential issue for school systems). The two lowest performing systems with respect to BOD and TSS were serving high schools, with one identified as a septic tank system (although again it appears that there must be some other unit process in the treatment train) having exceptionally high variability as indicated by the wide error bars. All of the attached growth process systems (filters) appeared to perform consistently well, while the suspended growth systems and septic tank-based systems had wider confidence intervals and generally higher average effluent concentrations for BOD and TSS. That trend is generally reversed for ammonia-nitrogen results. Finally, actual flows for the school systems appeared to be half or less of design, with the exception of on system serving a high school, where its average was about 65%. Nevertheless all confidence intervals for flow rate show that these systems are operating within their specified hydraulic design parameters.

4.2.4 Texas

Most Texas systems in the applicable size range of this study use either some type of activated sludge process, or pond/lagoon treatment. Figures 4-26 through 4-29 represent the results of system performance for the state. Figures 4-26 and 4-27 are divided by the overall type of facility: day use versus overnight facilities, with data grouped by system type. Figures 4-28 and 4-29 take commonly represented system types (activated sludge for Figure 4-28 and lagoons for Figure 4-29) and present results grouped by specific facility type.

Figure 4-26. Texas Systems Serving Day Use Facilities (Performance by System Type).

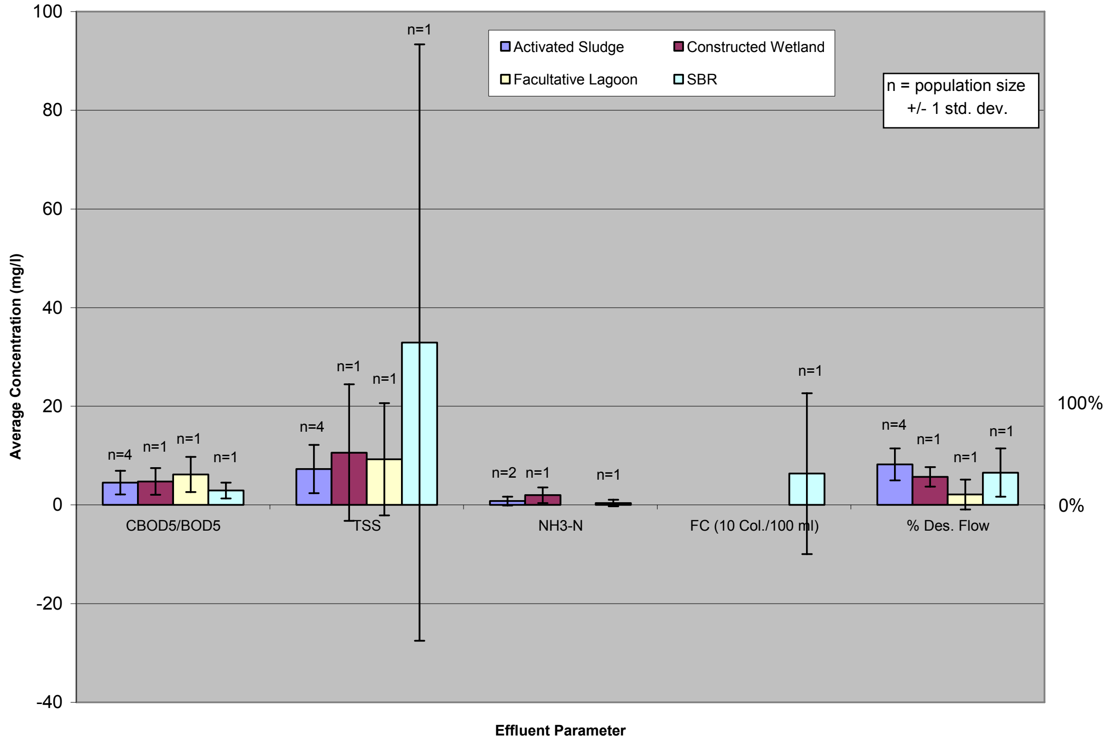


Figure 4-27. Texas Systems Serving Overnight Use Facilities (Performance by System Type).

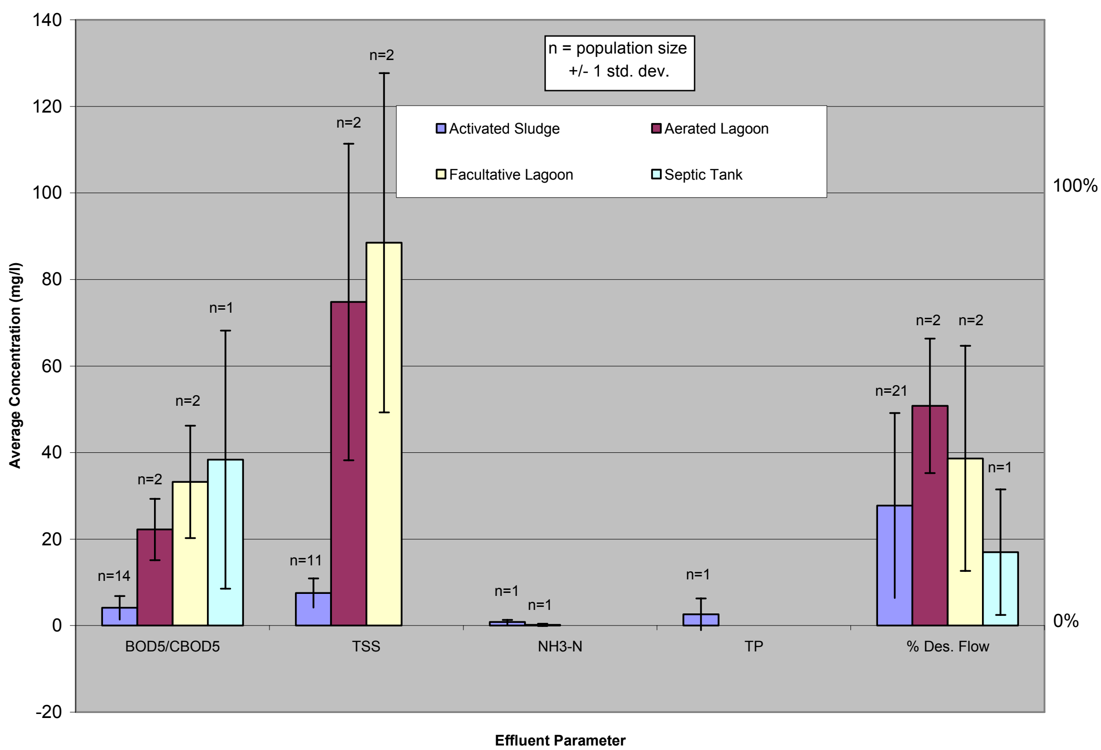


Figure 4-28. Texas Activated Sludge Systems (Performance by Type of Facility Served).

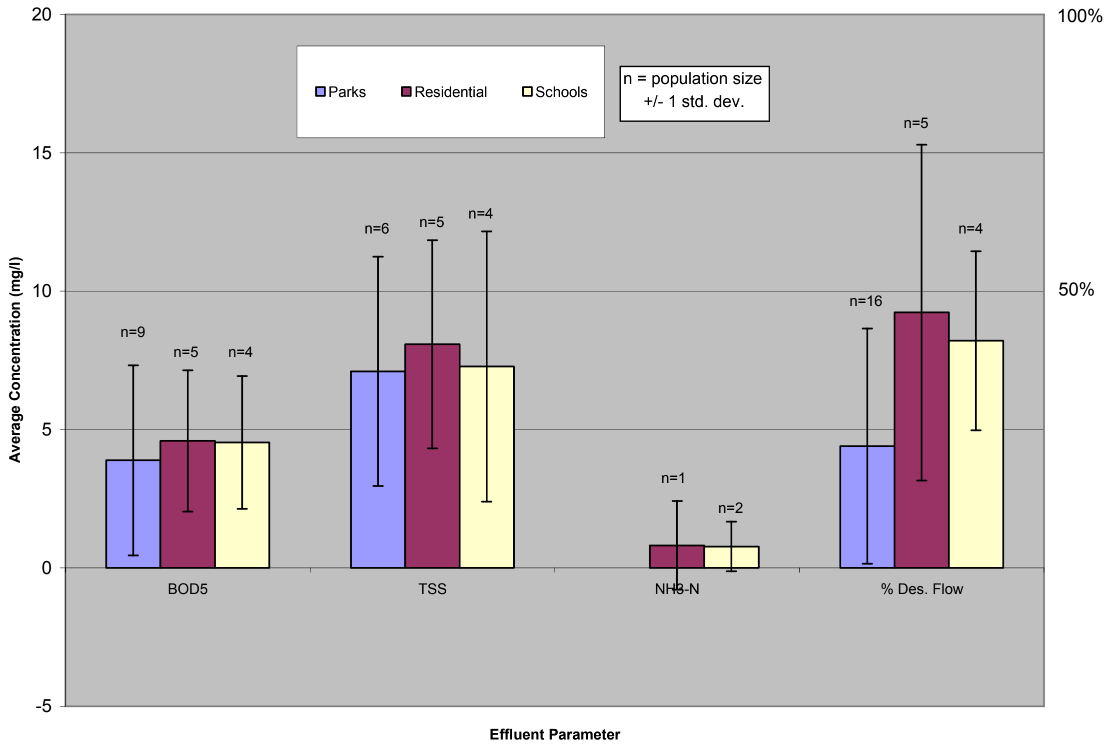


Figure 4-29. Texas Lagoon Systems (Performance by Type of Facility Served and Lagoon Type).

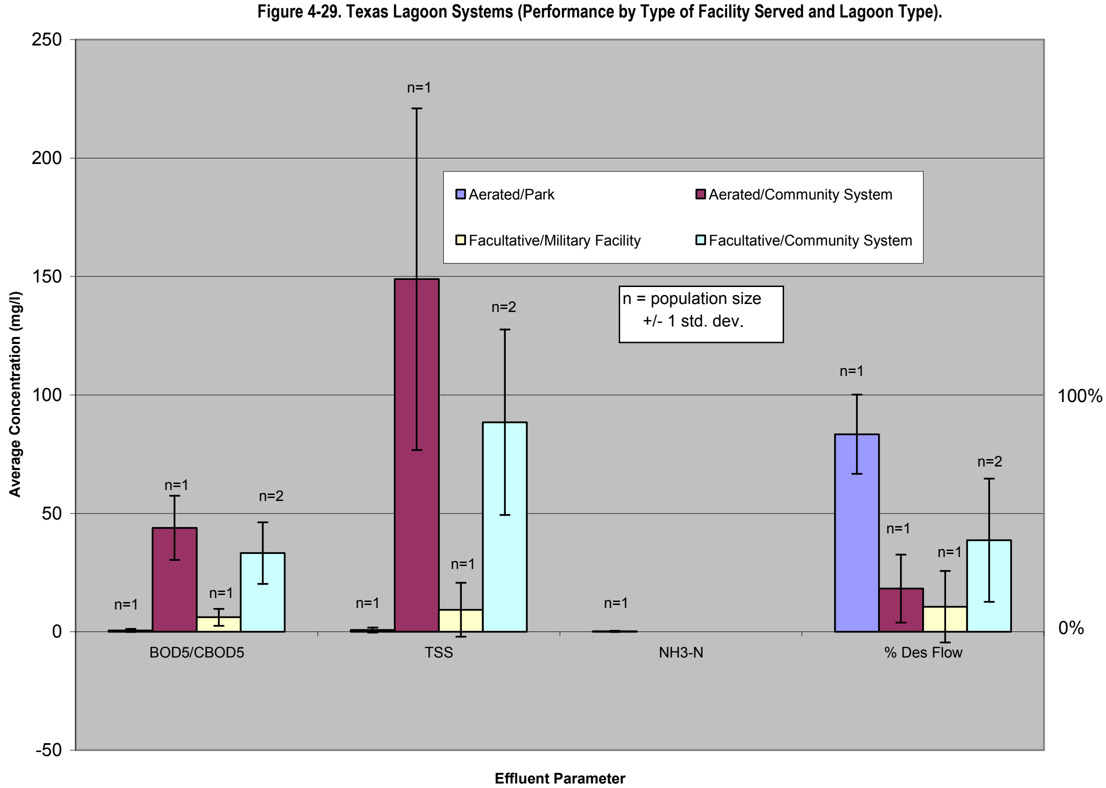


Figure 4-26 indicates that different systems performed comparatively well for day use facilities with the exception of the one SBR system which had high and variable TSS results and significant fecal coliform measurements. For overnight use systems (Figure 4-27), both aerated and facultative lagoons performed comparatively to a standard septic tank, while activated sludge systems performed much better with respect to BOD and TSS.

Figure 4-28 shows consistent performance for activated sludge types systems irrespective of facility type, while Figure 4-29 generally appears to indicate that lagoon system performance was variable from system to system. It is unclear how much of the variability may be due to facility type. It must be noted that the system population for each grouping is very low (n = 1 or 2) making any such observations particularly speculative.

No significant difference in performance is observed in Figure 4-28 for the three categories of facilities served by activated sludge plants. Systems serving all three facility categories averaged between 3 and 5 mg/L for BOD_5 and between 5 and 10 mg/L for TSS. With respect to nitrification/NH_3-N reduction, residential and school systems performed very similarly on average, with residential systems averaging 0.81 mg/L and school systems averaging 0.77 mg/L.

The performances of three types of Texas activated sludge plants for which there were at least two systems of that type were compared based on the data summary included for Texas in Appendix 12.A. Those activated sludge categories included extended aeration plants without filtration noted (18 systems); extended aeration with filtration noted (2 systems); and oxidation ditch treatment systems (3 systems). Secondary treatment parameter averages (BOD_5/TSS) were very similar for the extended aeration (no filtration) and oxidation ditches. Those averaged 5.3/7.7 mg/L and 4.3/7.6 mg/L BOD_5/TSS for the two categories respectively. Although there were only two systems in this dataset, sand filtration added to the extended aeration plants appeared to be successful in reducing effluent BOD and TSS, with averages of 2.3 and 4.3 mg/L respectively for those parameters. The addition of filtration also appeared to significantly reduce the maximum reported values for those parameters (reduce performance "excursions") for the two systems reviewed.

4.2.5 Colorado

Systems data was gathered from a total of 11 Colorado systems, including those using the following treatment categories:

- Recirculating sand/gravel filter (RSF): 5 systems
- Recirculating textile media filter (RMF): 2 system
- Activated sludge package plant (1 with filtration) (AS): 2 systems
- Sequencing batch reactor (SBR): 1 system
- Rotating biological contactor (RBC): 1 system.

Facilities served by those systems were organized by "day use" or "overnight", with those including the following facility types:

Day Use:

- School (1 system);
- Visitor Park with Food Service (though there is a certain amount of residential staffing here) (1 system); and
- Highway rest stop (1 system).

Overnight Use:

- Lodge/café/resort (2);
- Summer/recreational camps (3 systems);
- Community systems (3);

Figures 4-30 through 4-33 summarize the results from Colorado. Figures 4-30 and 4-31 compare performance as a function of treatment type. These are split into two graphs: one for systems serving overnight use facilities and one for systems serving day use facilities. Figures 4-32 and 4-33 also look at system type, but instead divide the graphs by design flow rate with Figure 4-32 including systems with design flow rates of 20,000-50,000 gpd and Figure 4-33 including those with lower flow rates.

Figure 4-30. Colorado Systems Serving Overnight Use Facilities (Performance by Treatment Type).

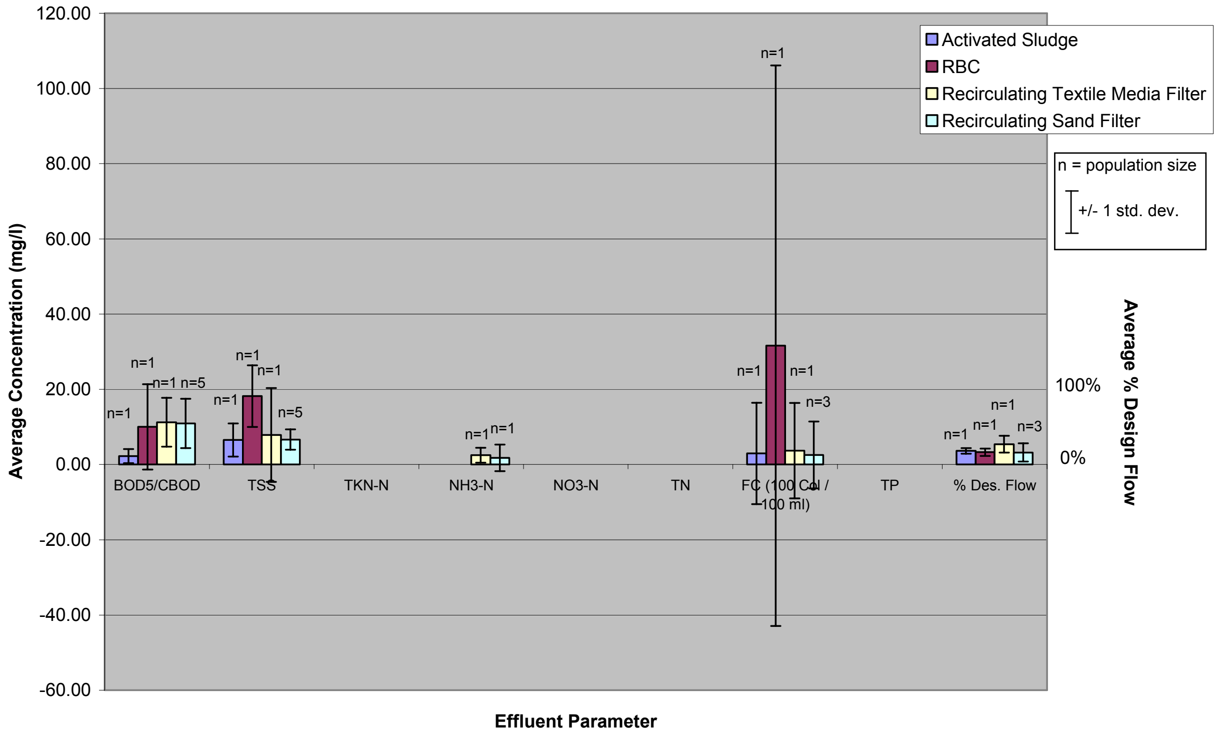


Figure 4-31. Colorado Systems Serving Day Use Facilities (Performance by Treatment Type).

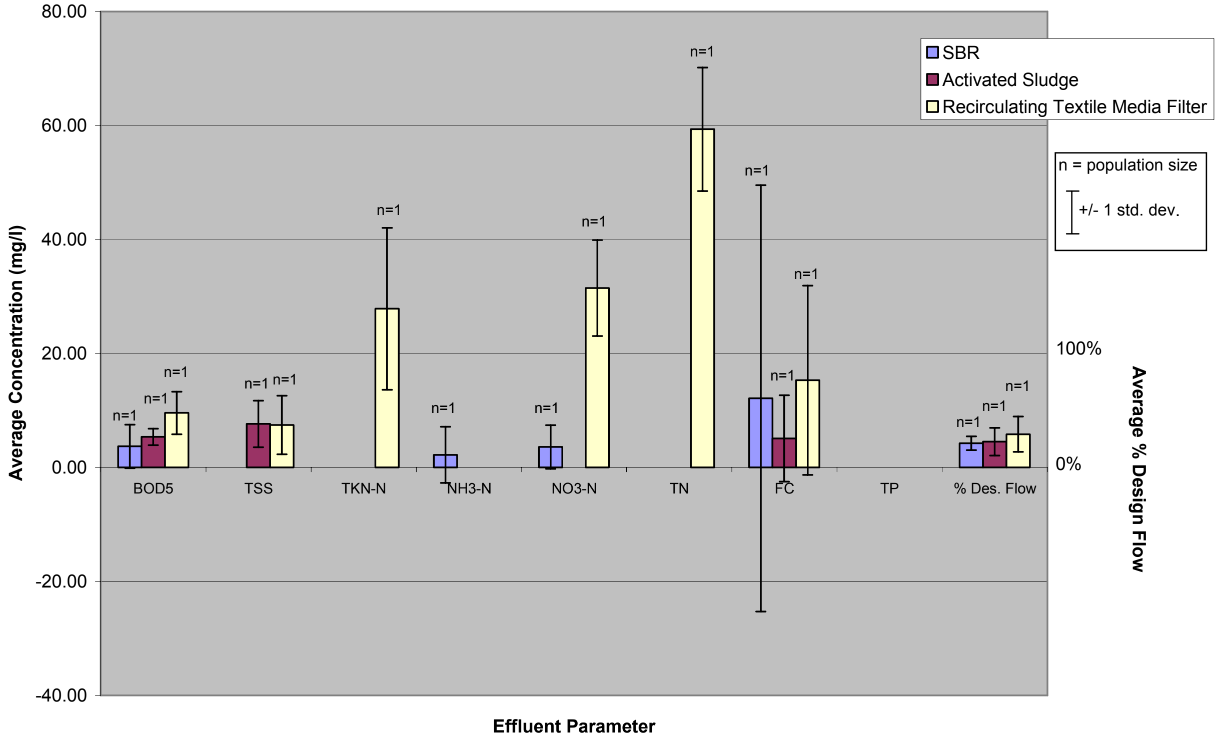


Figure 4-32. Colorado 20,000-50,000 GPD Systems (Performance by Treatment Type).

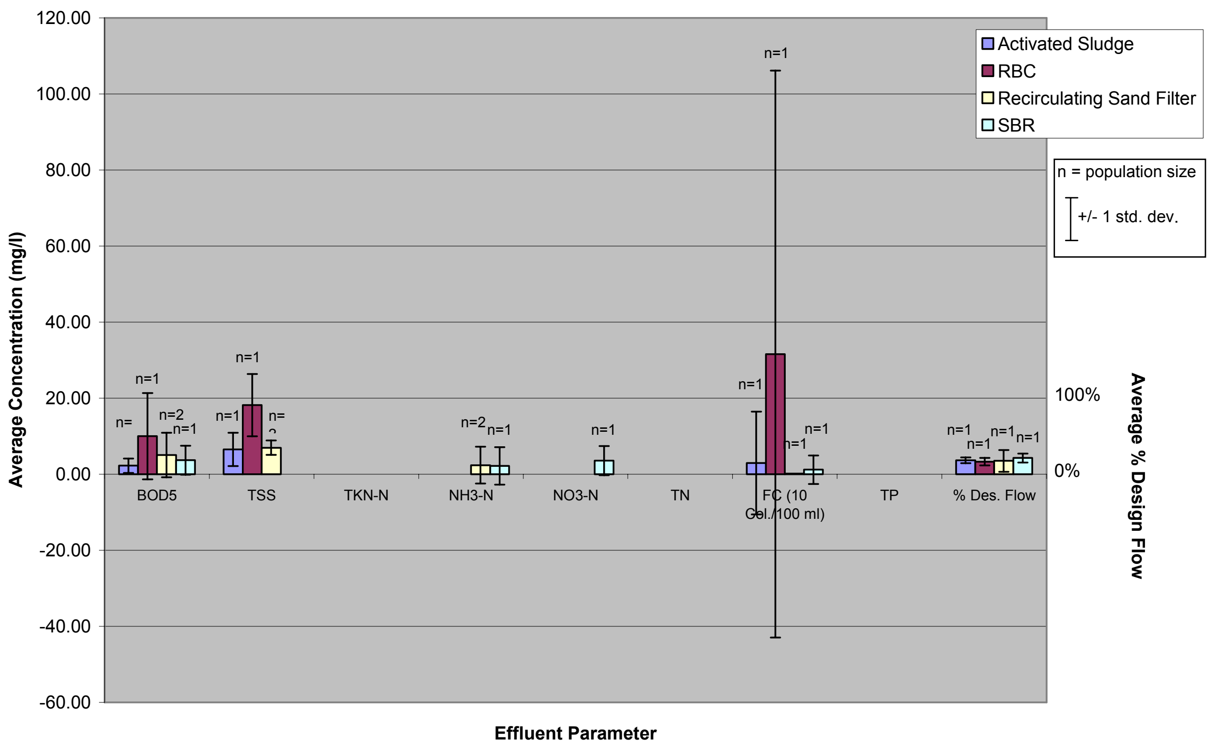
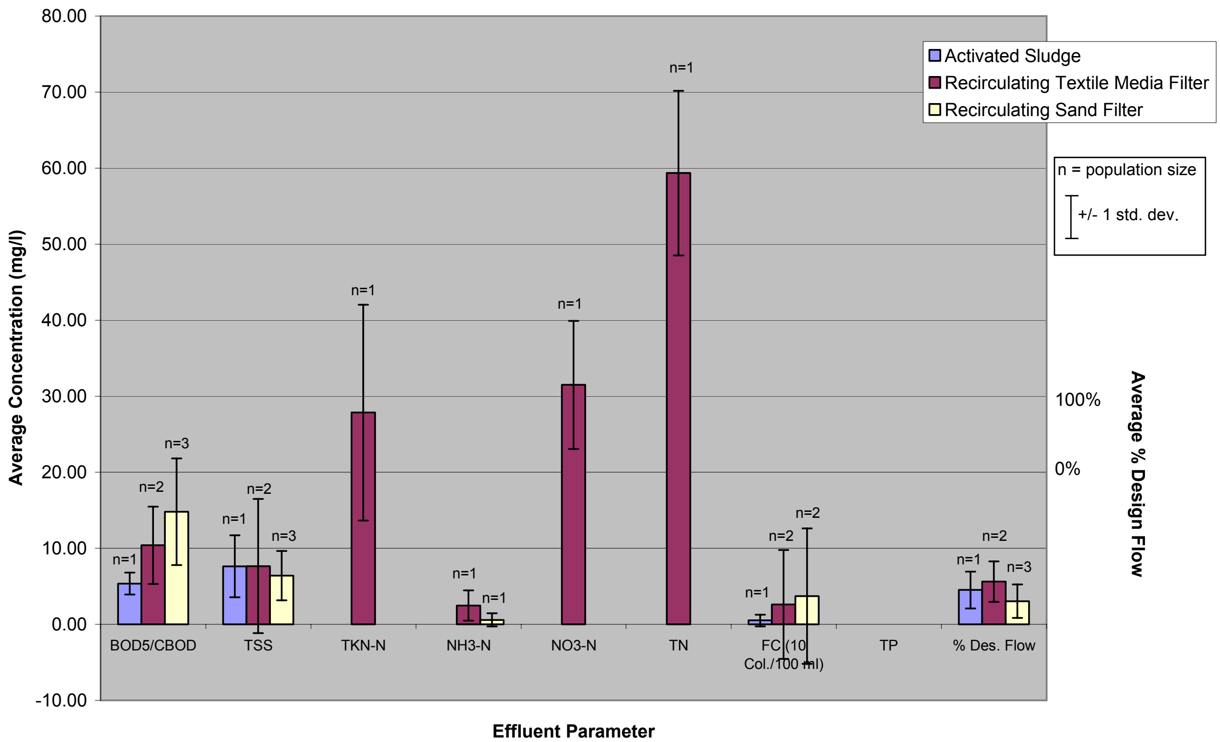


Figure 4-33. Colorado - 5,000-20,000 GPD Systems (Performance by Treatment Type).



From all of the figures, it is clear that most of these systems are operating well under their design flow rate. These plots appear to be influenced by several systems exhibiting substandard performance; in particular, the only RBC system (in Figures 4-30 and 4-32) and one of the textile media filters (in Figures 4-31 and 4-33). With these outlying systems noted, other system performance is, in general, overlapping. The activated sludge and SBR systems appears to perform consistently well over the various groupings presented in these plots, as did the recirculating sand filters although generally at somewhat higher concentrations (with the exception of TSS, the removal of which is expectedly good through the RSFs).

4.2.6 Florida

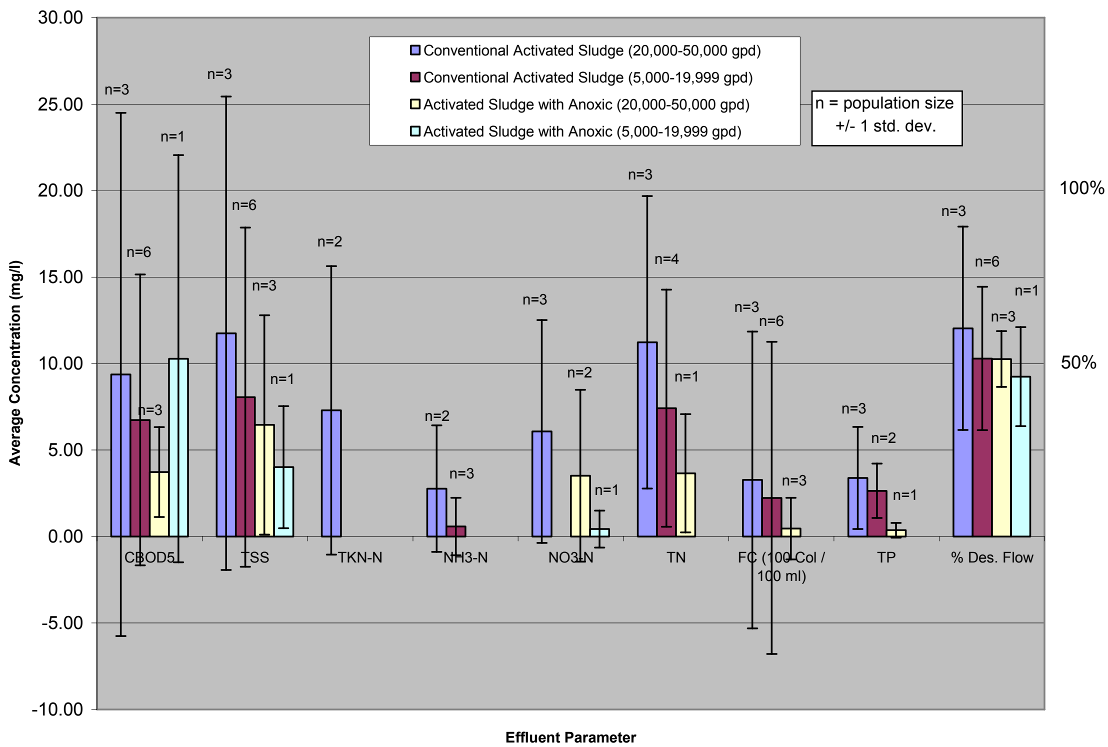
The types of facilities served by the thirteen Florida activated sludge systems studied included:

- Community/residential systems (8 systems);
- Truck stop/plaza (1);
- Highway rest stops (2);
- Motel (1 system);
- Mobile home park (1 system).

Figures 4-34 and 4-35 summarize the data collected for Florida, which was obtained only for activated sludge systems of some type. Figure 4-34 groups systems by system type (conventional versus activated sludge systems with an anoxic component) and design flow range.

Figure 4-35 groups systems again by treatment type/category (based on whether an anoxic/denitrification process was indicated or not), and also by facility type.

Figure 4-34. Florida Activated Sludge Systems (Performance By Flow Range and System Type).



The noteworthy observation from Figure 4-34 is that activated sludge systems with anoxic unit treatment processes outperformed conventional activated sludge systems on an average basis for nearly all parameters measured, although confidence intervals frequently overlap (a common feature of these plots in general), suggesting that the observed differences may not be statistically significant. Nevertheless, we can speculate that, for example, systems with anoxic features are somewhat more complex and, as such, may elicit more frequent or close inspection and maintenance, which may contribute to better overall performance in addition to. As expected, effluent nitrate-nitrogen and total nitrogen concentrations appear substantially lower in the anoxic systems than in the conventional systems (although again, the error bars do overlap).

Figure 4-35. Florida Activated Sludge Systems (Performance by Facility and System Type).

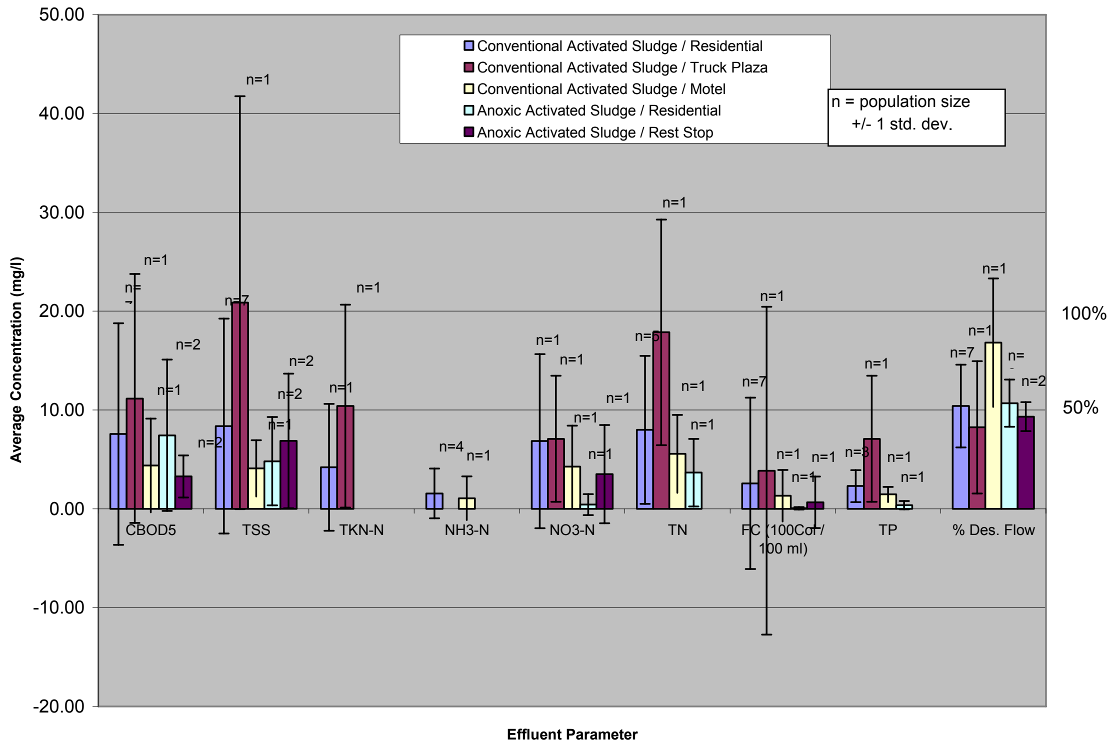


Figure 4-35 appears consistent with Figure 4-34; that is, the anoxic systems generally show better overall performance, although not in all cases (the conventional activated sludge system serving a motel/hotel notably performed well). Additionally, this plot reveals that a conventional activated sludge system serving a truck plaza performed, on average, worse than other systems (this system also has a high standard deviation which may indicate the influence of outlying data point(s)). Given that most “truck stops/plazas” have restaurants and a reputation for waste streams with high concentrations of oils/grease, that result is not particularly surprising.

4.2.7 New Mexico

Systems data was gathered from ten New Mexico systems using the following treatment categories:

- Recirculating sand/gravel filter (RSF): 1 system;
- FAST/wetland system: 1 system;
- Sequencing batch reactor (SBR): 3 systems;
- Trickling filter (TF): 4 systems; and
- Subsurface flow wetland system: 1 system.

Facilities served were organized by “day use” or “overnight”, with those including the following facility types:

Day Use:

- Schools (including 1 college): 3 systems;

- Research/visitor center: 1 system; and
- Shopping center: 1 system.

Overnight Use:
- Resorts: 2 systems.
- Mobile home parks: 2 systems; and
- RV Park: 1 system.

Performance data from New Mexico is presented in Figures 4-36 and 4-37. The averages in these two plots are generally represented by few systems (and often a limited dataset) and thus are subject to outlier influences. Accordingly, it is difficult to draw conclusions from these plots.

Figures 4-36 and 4-37 show that, with the exception of the subsurface flow wetland serving a school, systems serving day use facilities tended to perform more consistently within moderate to acceptable ranges while the performance of those serving overnight facilities was far more erratic and very poor for certain systems. However, within both the day use and overnight use categories there was still erratic performance among certain treatment categories for which multiple systems' data was available.

Based on the available data, performance was highly varied for two basic types: Trickling filters and SBRs. Of the two overnight usage SBR systems for which data was available, the system serving a mobile home park performed significantly better for total nitrogen reduction while nitrification and total nitrogen reduction were very poor for the system serving the RV Park. The mobile home park averaged about 5.6 mg/L while the RV park averaged about 64.7 mg/L, thus greatly affecting average reported performances for the two systems.

Of the day use systems, the performance of the two trickling filter systems was also highly varied, though with not as wide a performance range as the SBRs. The trickling filter system serving the shopping center seemed to perform moderately well relative to total nitrogen reduction while the one serving the research and visitor center performed fairly poorly for nitrification and total nitrogen reduction on average. The location of the research facility away from any urban centers where there would tend to be a greater number of potential trained service providers may be a factor with that system's performance.

The one recirculating media filter serving the middle school performed very well relative to secondary treatment parameters and TKN reduction (average of 1.3 mg/L TKN over 45 sampling events). Total nitrogen levels from this system averaged about 25.8 mg/L over 68 sampling events.

Figure 4-36. New Mexico Systems Serving Overnight Use Facilities (Performance by System Type).

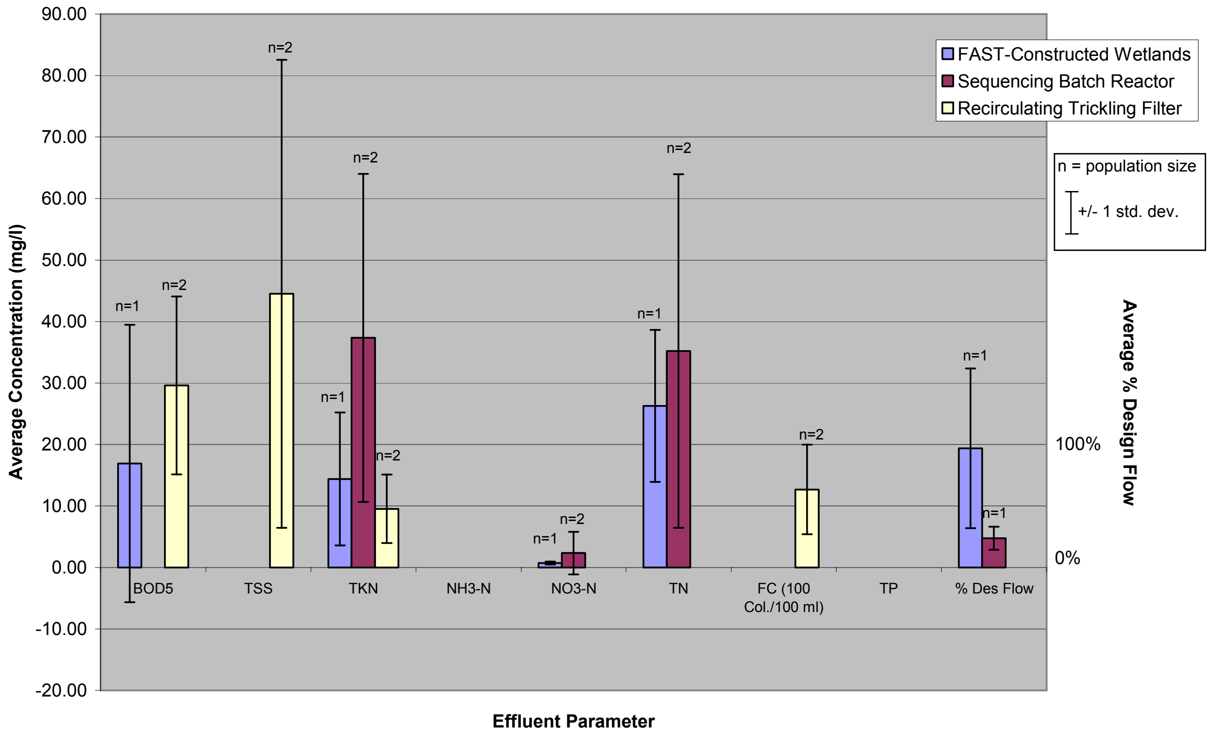
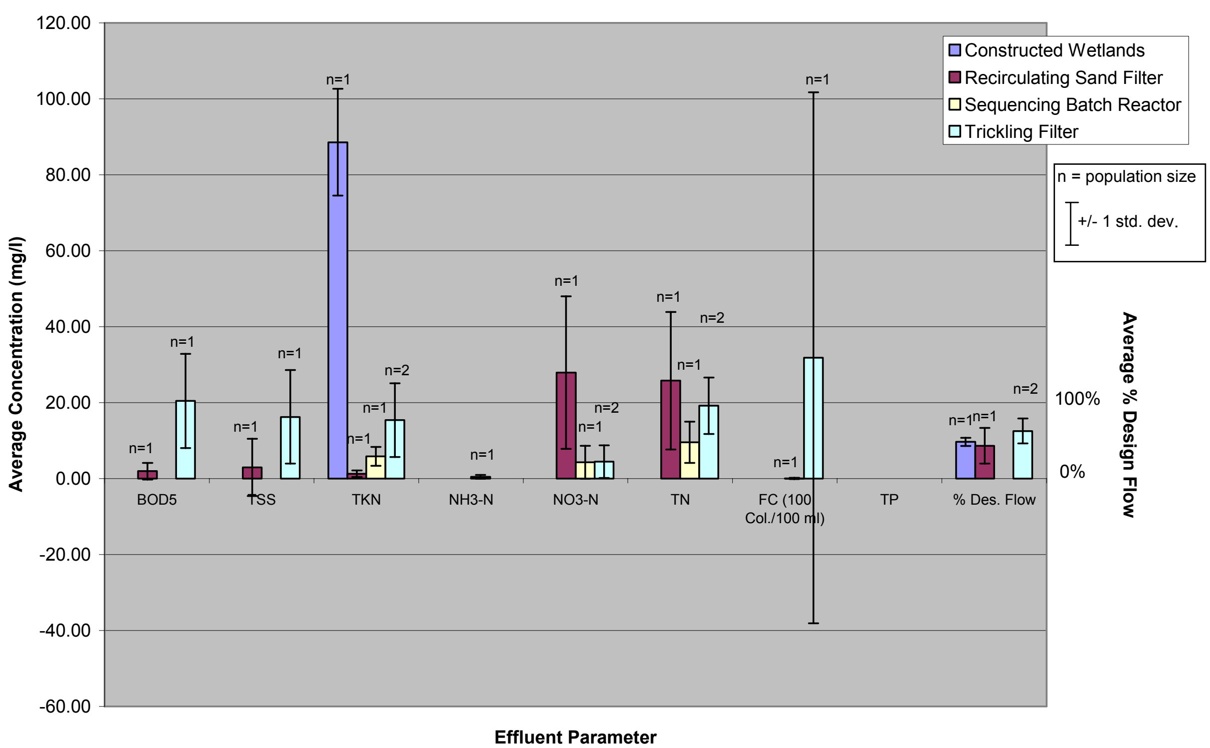


Figure 4-37. New Mexico Systems Serving Day Use Facilities (Performance by System Type).



No BOD_5 or TSS data, and only limited TKN results were available for the wetland system serving the school, but the three sampling events reported for TKN averaged about 89 mg/L, and reached a high of 104 mg/L. This system was clearly challenged relative to nitrification based on the available data. The wetland/FAST system serving the mobile home park/subdivision also reported fairly high average effluent nitrogen levels, with 26.3 mg/L reported for total nitrogen and a maximum value of 72 mg/L for 54 sampling events.

4.2.8 North Carolina

Systems data was gathered from a total of fifteen North Carolina systems, including those using the following treatment categories:

- Recirculating sand/gravel filter (RSF): 4 systems
- Trickling filter/Bioclere systems: 4 systems;
- Activated sludge package plant (with denitrification process noted): 2 systems;
- Activated sludge package plant (with filtration process noted): 5 systems.

Facilities served by those systems were again organized by "day use" or "overnight", including the following facility types for each category:

Day Use:

- Schools: 4 systems;
- Shopping center/mall: 2 systems; and
- Restaurant/tavern: 1 system.

Overnight Use:

- Rest home: 2 systems;
- Residential/community systems (including one with a marina): 4 systems;
- Hotel/inns: 2 systems.

North Carolina data are represented in Figures 4-38 through 4-41. Figures 4-38 and 4-39 analyze the data by system type and are split by day use systems and overnight systems. Figures 4-40 and 4-41 analyze the system by facility type and are split by suspended growth systems and attached growth systems.

Figure 4-38. North Carolina System Serving Day Use Facilities (Performance by System Type).

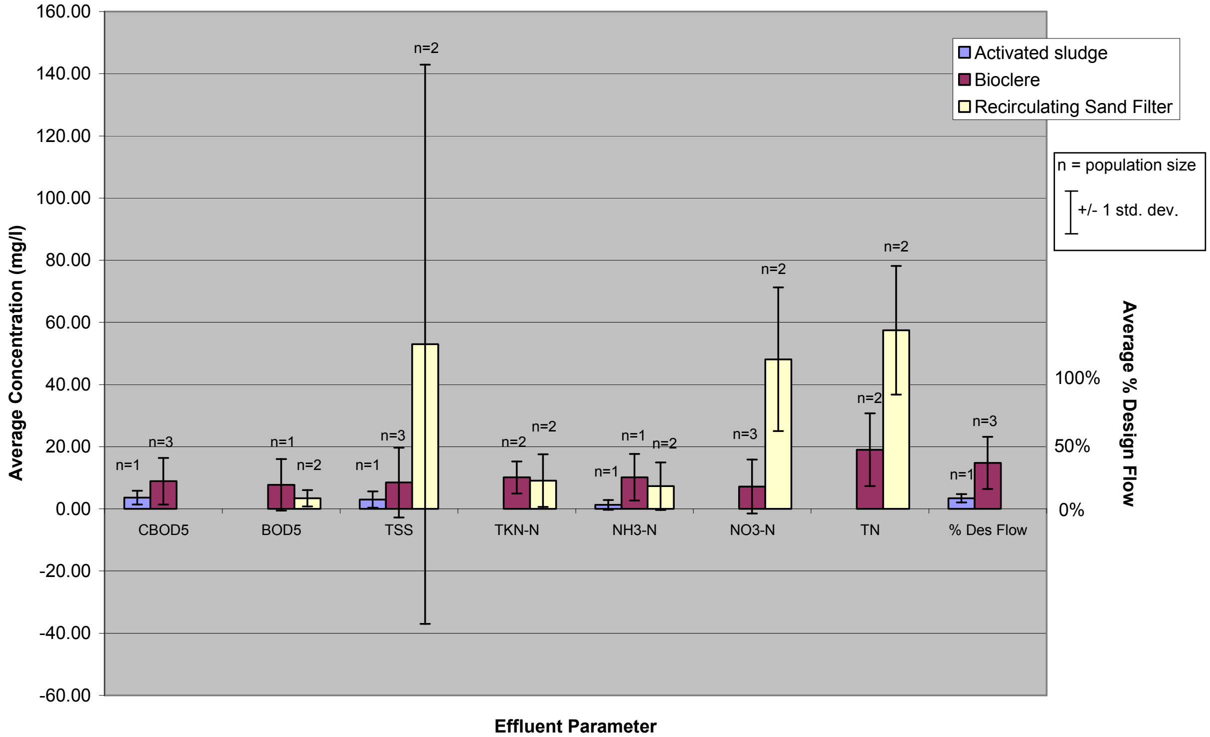


Figure 4-39. North Carolina Systems Serving Overnight Facilities (Performance by System Type).

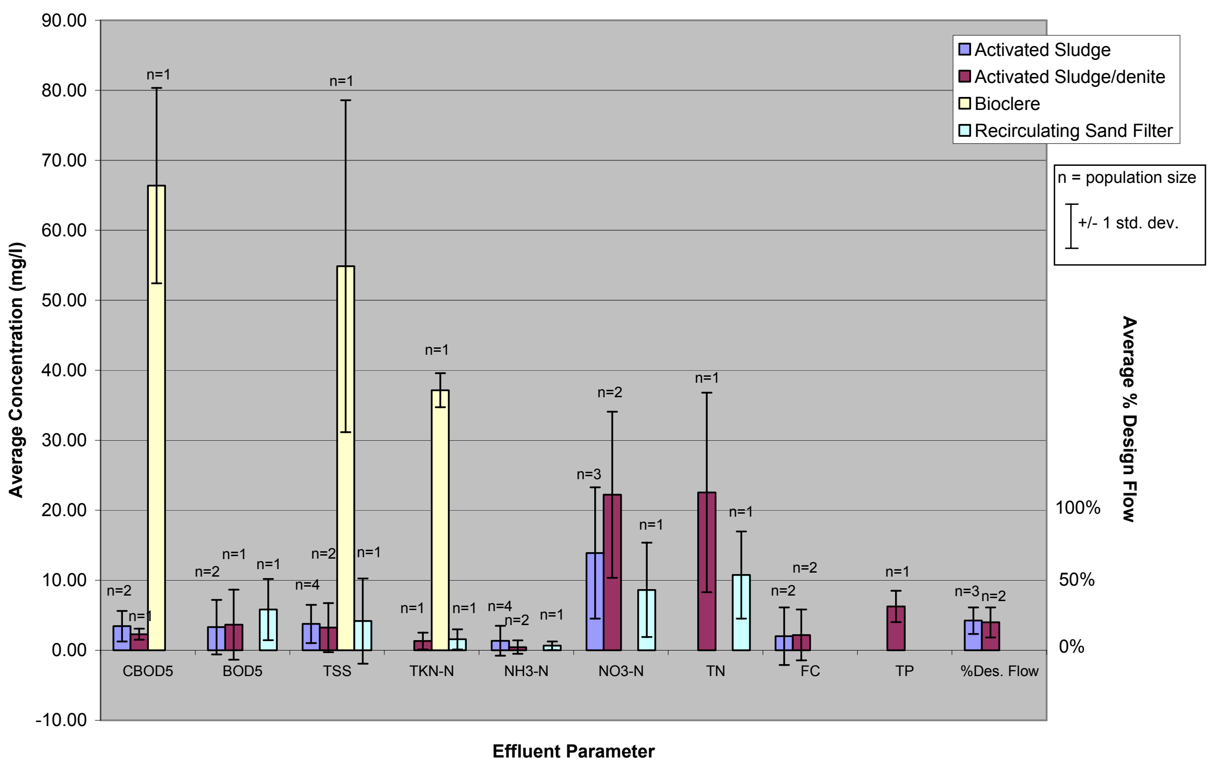


Figure 4-40. North Carolina Attached Growth Systems (Performance by Facility Type Served).

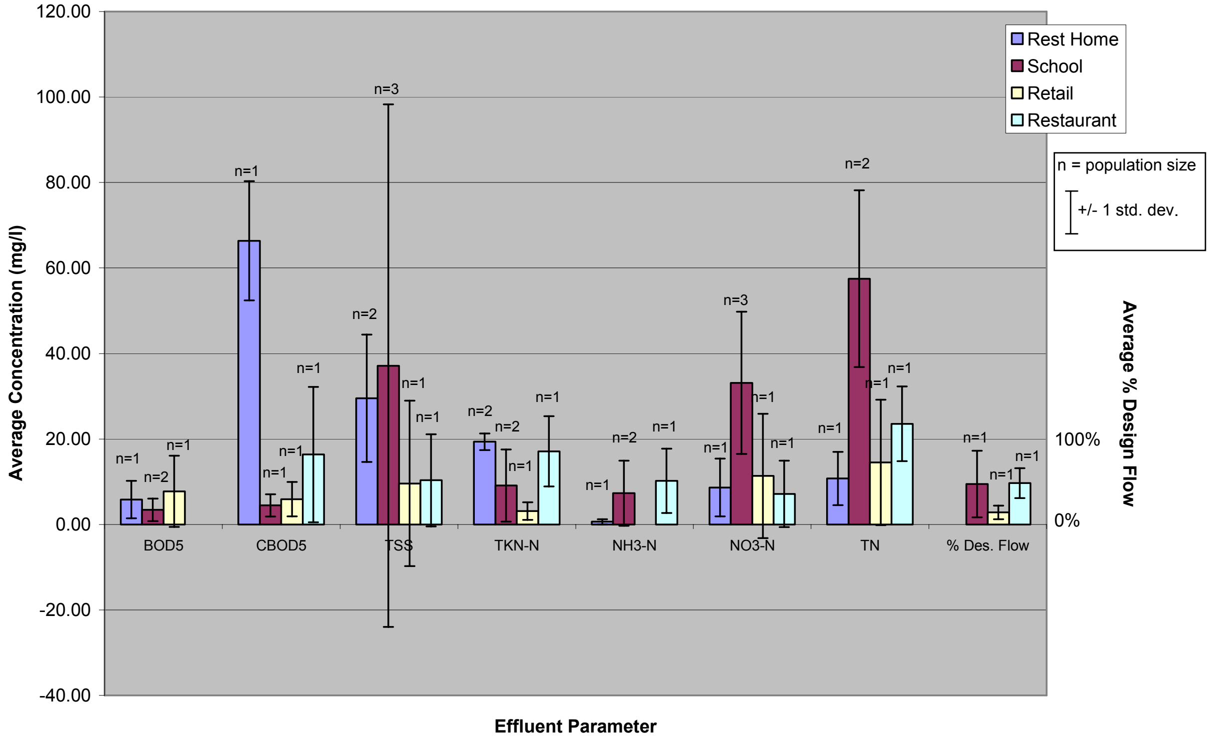
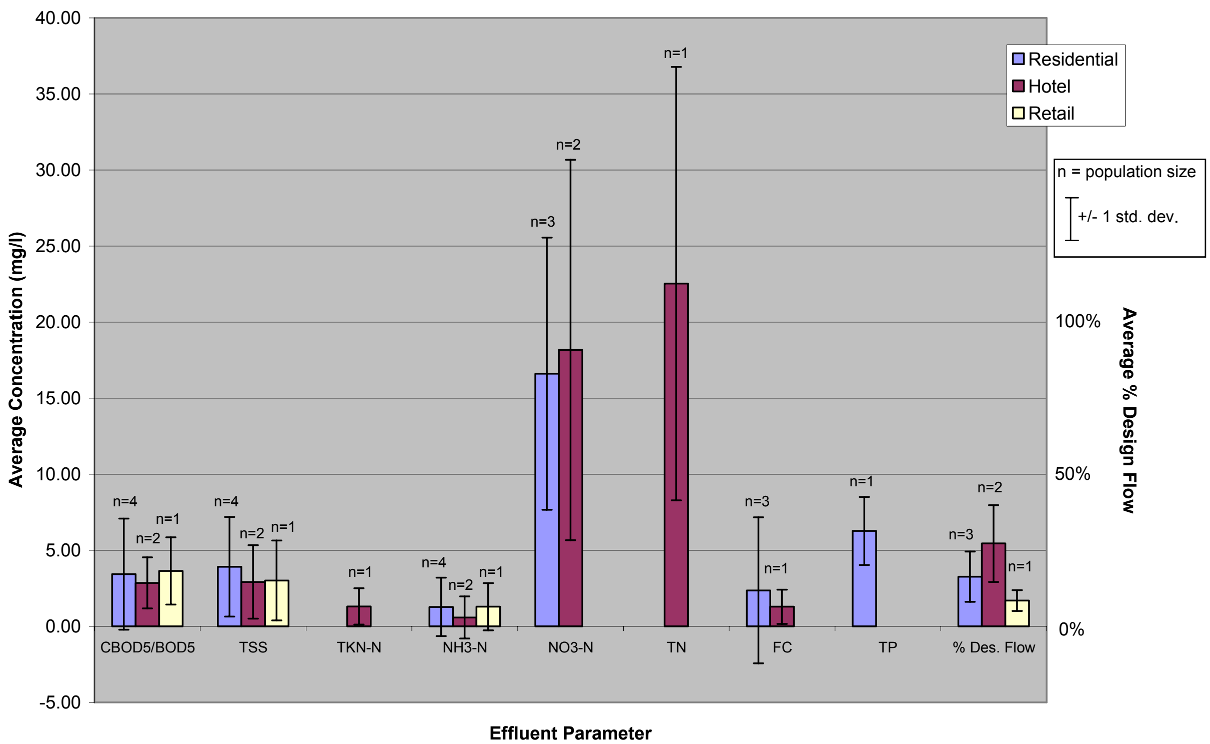


Figure 4-41. North Carolina Suspended Growth Systems (Performance by Facility Type).



For day use systems (Figure 4-38), activated sludge and hybrid (Bioclere) systems appeared to outperform recirculating sand filters across comparative parameters, although the large error bars associated with the recirculating sand filter performance measures suggest that outlying data point(s) may have impacted the graphical presentation. Likewise, Bioclere results for overnight use systems (n = 1) deviate far from the other systems analyzed (Figure 4-39). Activated sludge systems (both conventional and with anoxic) and recirculating sand filters performed consistently for the overnight use systems in the dataset, with mostly overlapping error bars. Additionally, performance for conventional parameters (BOD, TSS, ammonia) was uniformly excellent.

An interesting characteristic of Figures 4-40 and 4-41 is that there is relatively little overlap in facility groupings between the two graphs. This likely reflects a preference for associating certain treatment types with certain facility types in the state. Figure 4-40 indicates that attached growth systems have generally performed well for BOD removal in this system population, but TSS removal and ammonia nitrification are much more variable. This graph also indicates that school systems on attached growth systems may contain high nitrogen levels in their effluents (this observation was confirmed by state regulatory personnel also). Figure 4-41 shows very consistent performance for attached growth systems across several facility types. Overall nitrogen removal appears limited (although this is not an objective of most of these systems) in the under-loaded systems represented in this dataset.

4.2.9 Oregon

Data was obtained for the following categories and numbers of treatment systems in Oregon:

- Recirculating sand/gravel filters (RSF): 12 systems
- Recirculating textile media filter (RMF): 1 system
- Rotating biological contactor (RBC): 1 system
- Septic tank pretreatment (ST): 2 systems (one converted to RMF).

Of the types of facilities served by the above systems, those included:

- Hotel: 1 system
- Church: 1 system
- Community system (one of these systems converted to RMF from ST): 3 systems
- Mobile home park: 4 systems
- RV park: 3 systems
- School: 2 systems
- Restaurant/Inn: 1 system

Figures 4-42 and 4-43 summarize data collected for systems in the state of Oregon. The plots are split into day use facilities and overnight facilities, with data grouped by system type.

Figure 4-42. Oregon Systems Serving Day Use Facilities (All Recirculating Sand/Gravel Filters).

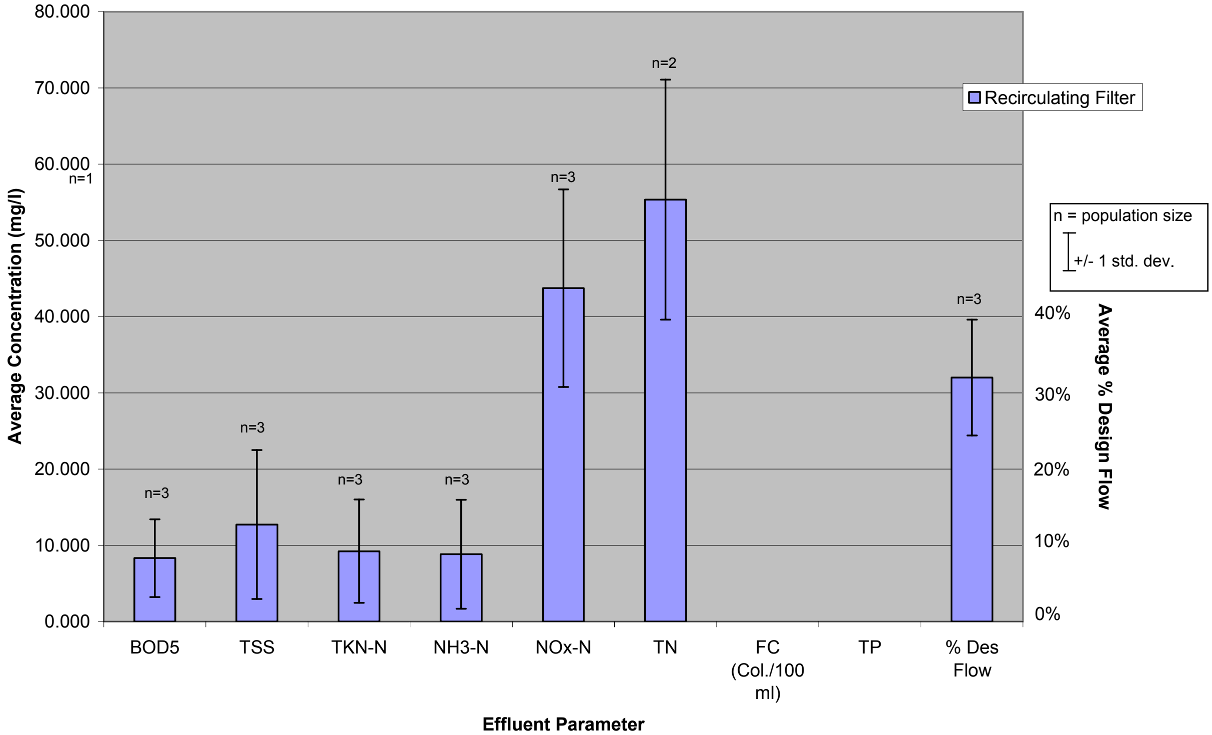


Figure 4-43. Oregon Systems Serving Overnight Facilities (Performance By System Type).

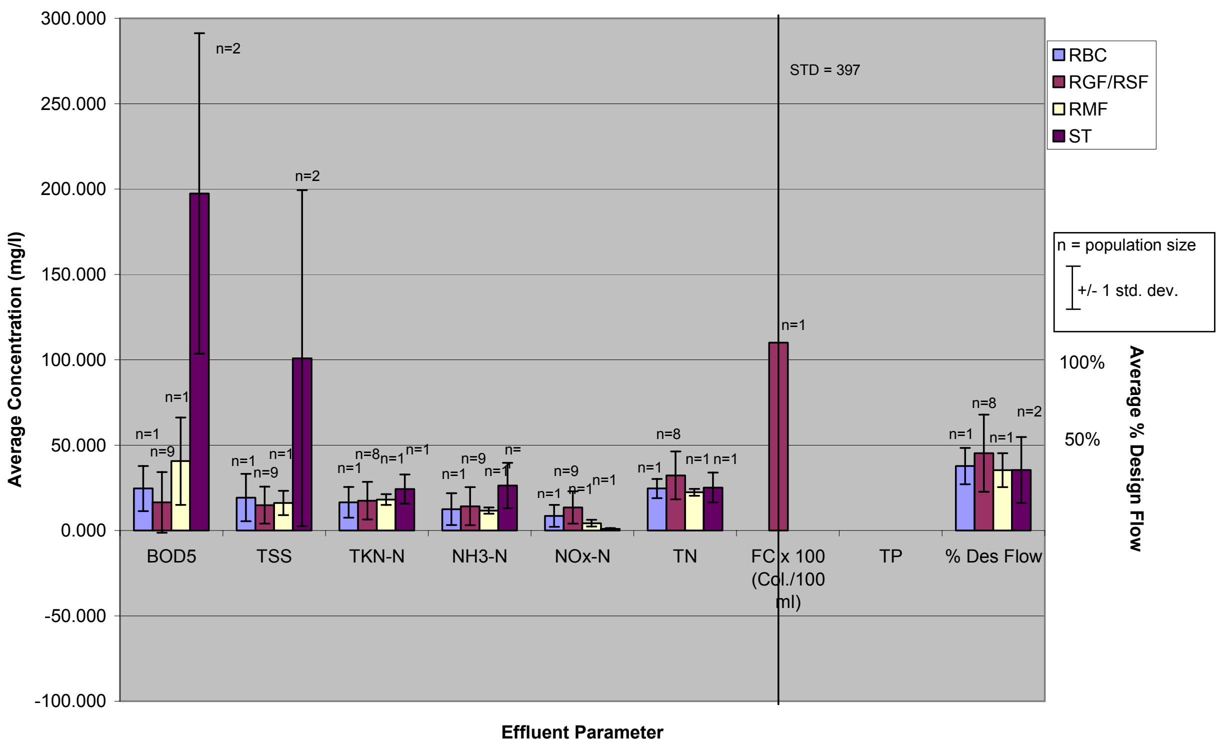


Figure 4-42 indicates that recirculating gravel filters and recirculating sand filters performed similarly for day use facilities. Overall performance would be considered quite good, although the systems were significantly under-loaded with respect to design flows. In Figure 4-43 as expected, septic tank effluent is high in BOD_5, TSS and un-nitrified nitrogen species (i.e., TKN and NH_3-N) compared with the other pretreatment technologies. Of the other treatments studied, on average, recirculating sand and media filters appeared to perform best with regards to the secondary treatment parameters measured, although error bars for all parameters overlap significantly.

4.2.10 Tennessee

The Tennessee systems for which data was gathered used either recirculating sand/gravel filters (RSFs), or Bioclere systems. Those systems served the following facility types:

RSFs:

- Church: 1 system;
- Rental cabins/resort: 2 systems;
- Residential: 3 systems.

Bioclere treatment systems:

- Rental cabins/resort: 2 systems.

Figures 4-44 and 4-45 present the data for Tennessee systems. In Figure 4-44, systems in the higher design flow range are represented, with the population including two Bioclere systems and two recirculating sand/gravel filter systems. Figure 4-45 shows average performance results for systems in the 5,000-20,000 gpd flow range.

The results of the plots appear to show that the recirculating sand/gravel filters performed substantially better with respect to BOD removal and nitrification, although the average flow rates for the Bioclere systems was higher (but still low relative to design flows). Effluent nitrate results were approximately equal on average, suggesting that total nitrogen removal was much better for the recirculating sand/gravel filters. Figure 4-45 includes all recirculating sand/gravel filters designed for flow rates between 5,000 and 20,000 gpd and for this limited population, it appears that the RSF/RGFs performed better when serving overnight facilities versus day use facilities. In this case however, day use facilities were represented by only one system serving an extremely under-loaded church. RSF/RGFs performed well for both categories of facilities, with the church system having somewhat higher average effluent nitrate concentrations in comparison with the other systems. All of the Tennessee systems had significant average fecal coliform readings. This is not surprising, since disinfection was not implied for any of the systems.

Figure 4-44. Tennessee 20,000-50,000 gpd Systems (Performance By System Type).

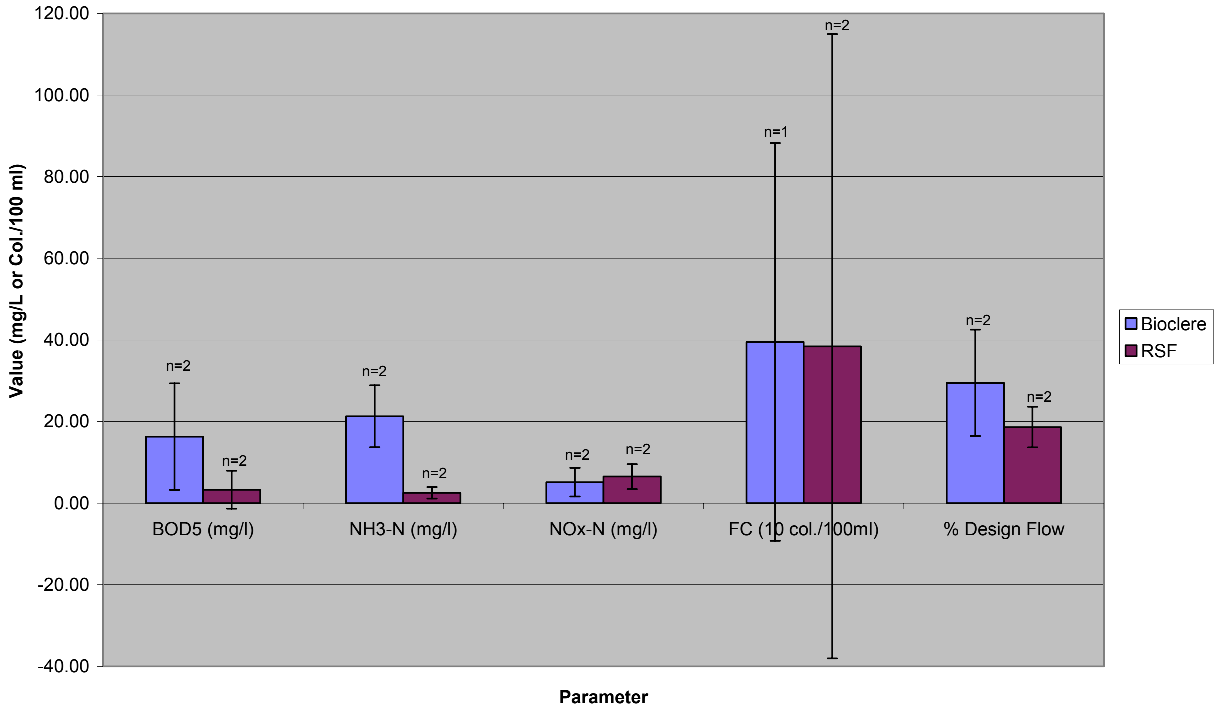
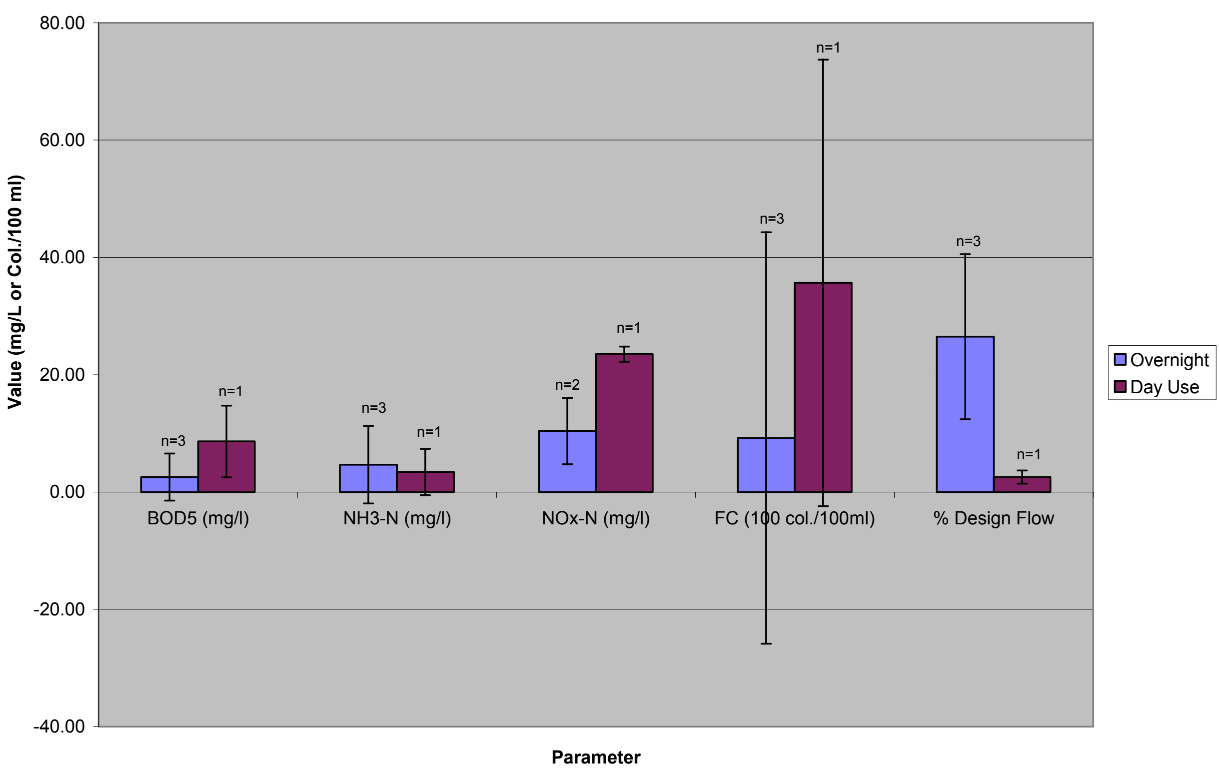


Figure 4-45. Tennessee 5,000-20,000 gpd RSF Systems (Performance By Facility Category Served).



4.3 Summary of Performance Data by State/Region

Observations from the data analyses and trending done in this chapter of the report for each state in regions across the U.S. are summarized below.

4.3.1 New England States

The only New England state for which a significant amount of data was gathered is Massachusetts. Trending charts were developed to track systems performance relative to category of treatment process, type(s) of facilities served and high/low flow category (5,000-20,000 gpd and 20,000-50,000 gpd). The following observations were made from that compliance monitoring data:

- For low flow range systems RBC performance was relatively good on average for secondary treatment parameters, with all but one system in all sector types averaging around or below 20 mg/L. That one system served residential facilities and averaged close to 40 mg/L for BOD_5. Total nitrogen removal appeared excellent for RBC systems serving all sectors, with averages below 15 mg/L for all but one of those systems during the monitoring periods reviewed, and most averaging below 10 mg/L.
- RBCs serving schools had the most erratic and challenged secondary treatment performance for the high flow range category serving all sector types, with BOD_5 averages ranging from a low of around 5 mg/L (the low for residential/overnight use sectors) up to just under 50 mg/L for one of the schools. Two schools averaged above 40 mg/L for BOD_5 removal. All overnight use sectors for the high flow range systems performed relatively well as related to secondary treatment, with all averaging around 20 mg/L BOD_5, and most averaging well below that.
- Of the 57 Massachusetts systems for which TN data was obtained, 72% were reportedly able to meet average TN effluent limits of 10 mg/L. Over a quarter of those (29%) did not exceed 10 mg/L for their monthly reported TN results for at least 20 reported sample events. Of the 12 systems comprising that 29%, most (seven) were RBC with six of those reported to have some type of anoxic/denitrification process in conjunction with the RBC. It is likely the seventh does as well. The remaining five are a Bioclere system with denitrification filter; two Amphidrome systems, with one reportedly in conjunction with a denitrification filter (though the other may as well); and two activated sludge treatment systems with one reportedly in conjunction with a denitrification filter (and the other also most likely having an anoxic/denitrification unit process).
- With respect to total nitrogen reduction, RBCs serving overnight use sectors tended to perform well, with most for which TN data was reported averaging below 10 mg/L. Six of the 15 RBC overnight use systems for which data for that parameter was reported averaged between 10 and 15 mg/L, and all were below 15 mg/L.
- Performance of RBCs serving certain day use sectors was more erratic relative to TN removal, although only one system averaged above 15 mg/L on average for that parameter (one of the schools, averaging around 23 mg/L).
- For the seven Bioclere systems analyzed, only two had average BOD_5 levels above 20 mg/L (an elementary/middle school and a retail business facility). Those same two systems also had the highest total nitrogen averages, although all the Bioclere systems reported TN averages below 15 mg/L.
- Of the seven Amphidrome systems, most averaged around or below 20 mg/L for secondary treatment parameters (BOD_5 and TSS), although two hotels and an elderly

housing facility averaged higher for TSS reduction. Only one facility averaged significantly higher for BOD_5 removal (a high flow category residential condo system averaging just under 35 mg/L).

4.3.2 Mid-Atlantic States

Of the Mid-Atlantic States, systems' data was obtained from two states, although data/information from only one system was obtained from Pennsylvania. Regulatory compliance reporting data was obtained and evaluated for a total of 85 Virginia systems. Observations from those analyses included:

- In general, activated sludge type system performance in the 20,000-50,000 gpd flow range performed consistently well for most parameters of interest. TSS averages for SBR systems serving both day use and overnight facilities in this flow category were notably higher than for other system types. The one system identified as a "nitrification-denitrification" system had extremely low BOD and TSS readings.
- For activated sludge facilities in the low flow range, again most performed well on average for reported parameters. Most of these systems were hydraulically loaded at less than half their design capacity on average.
- For the high flow range "alternative" (non-activated sludge) system types serving day use facilities, the upflow sludge blanket filtration system stands out as having more variable and generally lesser performance for BOD/CBOD5, TSS and TKN-N removal, despite being the most hydraulically under-loaded system (on average) evaluated. The constructed wetland system had somewhat higher BOD/CBOD than TSS in the effluent, which would likely be a result of dissolved organics associated with decaying wetland vegetation. The one trickling filter represented in the dataset and serving overnight use facilities performed least effectively despite being the lowest loaded hydraulically.
- For non-activated sludge systems in the low flow range serving overnight facilities, pond/lagoon systems performed least well of those system types evaluated. Those systems and the rotary sand filter were the only ones averaging above 15 mg/L for BOD5.
- Virginia systems serving schools appeared to perform very well on average, with all systems averaging close to or less than 10 mg/l for BOD and TSS and all averaging less than 10 mg/l for ammonia-nitrogen (high nitrogen loading has been identified as a potential issue for school systems). The two lowest performing systems with respect to BOD and TSS were serving high schools, having exceptionally high variability as indicated by the wide error bars.
- Actual flows for the school systems appeared to average half or less of the designed/permitted flows, with the exception of one system serving a high school, which averaged about 65%. Nevertheless all confidence intervals for flow rate show that these systems are operating well within and below their specified hydraulic design parameters.

4.3.3 Southeastern States

Data/information was obtained for systems in four of the southeastern U.S. states: Kentucky, Tennessee, North Carolina, and Florida. The largest of those datasets was for the state of Kentucky, though considerably less descriptive information was obtained for those systems as compared with the other three states. Observations from the datasets from those four states are summarized below.

4.3.3.1 Kentucky

- Performance of activated sludge based system types serving day use facilities was comparable over multiple parameters, regardless of actual flow rates.
- Of the systems serving overnight facilities in the high flow range, fairly comparable performance was observed among activated sludge based systems with respect to secondary treatment parameters except for one system. The septic tank-intermittent sand filtration system in this category performed the least well for BOD_5 and TSS reduction, averaging over 20 mg/L for both parameters while all others averaged less than 10 mg/L for BOD_5. That system was more heavily-loaded hydraulically than the other systems in this category. The activated sludge to rotary sand filter system averaged significantly higher for TSS (18.4 mg/L) while still averaging less than 10 mg/L for BOD_5. That result suggests the possibility of at least a certain amount of filter media pass-through effects.
- In the high flow/overnight use category, the two activated sludge systems followed by intermittent sand filters averaged the highest with respect to effluent ammonia levels (just under 10 mg/L). This result is somewhat surprising in that these systems were relatively lightly loaded as compared with the others, and intermittent sand filters are typically considered to produce relatively good nitrification results. No information was available however on the details of these designs, including the media gradation for the sand filters or their loading rates. All but one other system in this flow category appeared to achieve very good nitrification results based on the ammonia-nitrogen averages (less than 5 mg/L NH_3-N on average). The septic tank to intermittent sand filter averaged around 6.7 mg/L for NH_3-N.
- In the high flow range of systems serving both day use and overnight facilities, activated sludge plants followed by several other process categories showed approximately the same average effluent levels for BOD/COD_5, TSS and NH_3-N, as for extended aeration/activated sludge systems for which nor further process was noted.
- For low flow range systems, and in particular in the overnight use category, the addition of rapid sand filters or multi-media filter treatment process following the extended aeration/activated sludge process seemed to significantly improve average performance results for secondary treatment parameters and nitrification. Either of those two processes following AS/EA systems resulted in approximately half the effluent BOD/COD_5/TSS/NH_3-N levels on average for the monitoring periods reviewed, although for whatever reason activated sludge systems followed by intermittent sand filters did not perform as well.
- Most activated sludge-based systems in the 5,000 to 20,000 gallon flow range for both day and overnight use facilities had BOD_5/$CBOD_5$ averages of less than 20 mg/L, with only one treatment category averaging above 15 mg/L (the AS-ISF systems in the overnight use category at 16.4 mg/L on average). There was no apparent pattern observed in terms of seasonal versus non-seasonal overnight uses, with some campgrounds averaging below 10 mg/L on average with others over 20 mg/L, and the same observation for subdivisions and other types of non-seasonal overnight uses. The overnight low flow category AS-ISF systems averaged over 25 mg/L for TSS, indicating possible solids breakthrough.
- All of the treatment categories using septic tank pretreatment followed by one of four further treatment processes (or multiple processes following septic tanks) performed well with respect to secondary treatment parameters, except that the ST-VF-SSF system

averaged higher for TSS (16.6 mg/L) while still performing well for BOD_5 reduction. Ammonia reduction/nitrification was very good for all of these systems.

- In reviewing the results for systems performance as related to public or private management, treatment performance seemed comparable for both categories of management, while privately managed systems had average flow rates much closer to their designed/permitted flows.

4.3.3.2 Tennessee

- For Tennessee systems in the high flow range, recirculating sand/gravel filters performed substantially better with respect to BOD_5 removal and nitrification. Although the average flow rates for the two Bioclere systems was higher than for the RSF/RGFs, they were operating on average well below their design/permitted flows. Effluent NO_3-N results were approximately equal on average for the two treatment types, suggesting that total nitrogen removal was much better for the recirculating sand/gravel filters.
- It appears that the RSF/RGFs performed better when serving overnight facilities versus day use facilities, although day use facilities were represented by only one system serving a church. More data for day use facilities would be needed to adequately evaluate trends relative to the performance of either of the two treatment types serving day use versus overnight use facilities.
- If the Tennessee RSF/RGF systems' performance are considered based on whether the facilities are "seasonal"/resort versus or residential, it appears that performance was better for the non-resort facilities, particularly as related to nitrification/ammonia-nitrogen reduction. Along with lower ammonia averages, the maximum NH_3-N reported values for the resorts/cabins served by RSF/RGFs were both around 34 mg/L, while the maximum value for all three residential systems was 4.8 mg/L.

4.3.3.3 North Carolina

- Of those 14 North Carolina systems for which a significant number of sampling events were reported, only one system - a restaurant served by a 9,600 gpd Bioclere treatment system - averaged higher than 10 mg/L for monthly BOD_5/$CBOD_5$ monitoring records reviewed.
- Only three systems reporting either TKN or NH_3-N averaged more than 2.0 mg/L for the period reviewed. Those systems included two coastal area Bioclere treatment systems (one serving a restaurant and the other a shopping center) and a recirculating sand/gravel filter system serving an elementary school.
- For day use systems, the activated sludge system appeared to outperform Bioclere and recirculating sand filter systems for secondary treatment parameters and NH_3-N reduction/nitrification. The activated sludge system was however hydraulically loaded at a very small percentage of its design flow, and no data was available for effluent nitrate levels.
- Although only very limited data was available for each category of system type, for overnight use systems Bioclere systems appeared to on average be the most challenged relative to secondary treatment parameters and TKN reduction/nitrification. No data was available for Bioclere systems relative to nitrate-nitrogen or total nitrogen monitoring results.

- ♦ Of the overnight use systems, the recirculating sand/gravel systems performed the best for total nitrogen reduction, averaging less than 10 mg/L, while both categories of activated sludge systems (conventional and with anoxic/denitrification process) averaged from about 14 - 22 mg/L. Interestingly, the activated sludge systems that reportedly included an anoxic/denitrification process averaged higher than the conventional activated sludge systems for total nitrogen reduction.
- ♦ All schools in the North Carolina dataset were served by some type of fixed film/attached growth process: either Bioclere systems or recirculating sand/gravel filters. Of those, the only two for which total nitrogen effluent quality data was available were two served by recirculating sand/gravel filters. Both showed very low effluent TKN/NH_3-N levels, and thus very good nitrification, but very high total nitrogen levels. Thus, denitrification for the RSF/RGFs serving schools was very limited for the datasets reviewed.

4.3.3.4 Florida

- ♦ Activated sludge systems with anoxic treatment components appeared to outperform conventional activated sludge systems in Florida on average for nearly all parameters measured, although confidence intervals frequently overlap. The exception was an activated sludge system serving a motel for which no anoxic/denitrification process(es) was reported, but which produced average total nitrogen levels of less than 5 mg/L. It seems likely that this system includes some type of anoxic/denitrification process, since only very limited information was obtained about that system. The system reportedly discharges to a constructed wetland, which would tend to be relatively anoxic. It is possible that monitoring data believed to be from the treatment facility are actually from the constructed wetland at some point.
- ♦ As expected, effluent nitrate-nitrogen and total nitrogen concentrations appear substantially lower for the activated sludge systems followed by an anoxic process, as compared with the conventional activated sludge systems (although again, error bars do overlap).
- ♦ The conventional activated sludge system serving a truck stop performed, on average, worse than other systems (this system also has a high standard deviation which may indicate the influence of outlying data point(s)). Given the type of waste stream that would be expected from a truck stop/plaza, this observation was not surprising.

4.3.4 Midwest and Upper Midwestern States

There were only two states in the Midwest or Upper Midwestern States region for which any monitoring or performance data were obtained for systems meeting the flow range and years in service qualifying them for inclusion in the study: Two systems in Indiana and three systems in Minnesota.

- ♦ One of the Minnesota systems was the only one of those five systems for which monitoring results were reported for a significant number of sampling events for secondary treatment parameters or nitrogen species. That system is an 11,000 gpd recirculating sand/gravel filter followed by subsurface dispersal of effluent, and serves a lodge and cabins. Despite average flow for that system reported to be well below the designed/permitted flow, monitoring data showed very poor results for both BOD_5 and total nitrogen reduction. Those averages were about 65 mg/L for both parameters, with TSS averaged at about 18 mg/L. Insufficient information was obtained about that system, including detailed description of unit processes, sizing, media, etc. to comment on why performance may be so poor for the monitoring period reviewed.

- The two Indiana systems for which monitoring data was obtained both use some type of recirculating media filter followed by drip irrigation. One system employs a community/common recirculating sand/gravel filter, while the other has recirculating media filters installed at each residence served, with the treated effluent going to a common subsurface drip dispersal system. For the limited number of samples available from the RSF/RGF system, performance was good for secondary treatment parameters and for nitrification (NH_3-N reduction). Total nitrogen reduction was limited however, with average results about 31.3 mg/L for the eight sampling events reviewed.

- No total nitrogen data was available for the recirculating media filters installed at residences, but BOD_5 reduction was not particularly good, with an average of about 17.5 mg/L for ten sampling events. NH_3-N and NO_3-N averages reported for that system were about 11.5 and 3.5 mg/L respectively, indicating some possible nitrification issues with that system.

In recent years, site visits to several Indiana cluster systems of the size and age range considered in this study were made by staff of the ICCMODS organization, with reports of those systems observations referenced previously in this report. While no data was obtained for those systems from the state of Indiana, the reports offer useful observations about several types of large/cluster scale decentralized systems, including mounds and other large scale subsurface drainfields. Cost information was also obtained for some of those systems.

4.3.5 South and Southwestern States

Of the South and Southwestern States shown on Figure 2-1, systems data/information was obtained from two of those states, including Texas and New Mexico.

4.3.5.1 Texas

- Most Texas systems studied use some type of activated sludge process or pond/lagoon treatment. Activated sludge plants were most often extended aeration package plants, sometimes with added filtration, along with a few oxidation ditch systems and one SBR system serving a park/visitor center.
- The use of sand filtration following extended aeration plants appeared to reduce BOD and TSS on average, while also significantly reducing the occurrence of treatment "excursions" (maximum values well above reported averages).
- Of the four different treatment categories serving day use facilities for which monitoring data was obtained from at least one system (extended aeration, SBR, facultative lagoon and constructed wetland), all performed comparably well for secondary treatment parameters and NH_3-N reduction, with the exception of the one SBR system that showed higher TSS and fecal coliform measurements.
- For overnight use systems both aerated and facultative lagoons performed comparably to just septic tank pretreatment, while the activated sludge systems performed significantly better with respect to BOD and TSS.
- When comparing the performance of Texas activated sludge plants serving residential/community facilities, schools, and parks, there was no appreciable difference noted. Those systems averaged between 3 and 5 mg/L for BOD_5 and between 5 and 10

mg/L for TSS in all three facility categories. No NH_3-N data was available for park facilities, but the systems performed very similarly on average for schools and residential facilities, with averages of 0.77 and 0.81 mg/L respectively.

4.3.5.2 New Mexico

- Of the New Mexico day use facilities, the recirculating sand filter serving the middle school performed the best on average relative to secondary treatment parameters, but NO_3-N and total nitrogen averages for that system were high as compared with the sequencing batch reactor system serving the college. No BOD_5 or TSS data was found in the files for the college SBR system. BOD_5 and TSS averaged about 2 mg/L and 3 mg/L respectively for the RSF serving the school, though effluent total nitrogen averaged about 26 mg/L. By contrast, the college SBR's total nitrogen averaged just under 10 mg/L for thirteen sampling events.
- The performance of the two trickling filter systems serving day use facilities was mixed. One of those two systems performed relatively well with respect to total nitrogen reduction (shopping center, with average of 11.9 mg/L for 14 sampling events), while the other system serving a research/visitor center produced relatively high total nitrogen levels on average (about 26.5 mg/L) with accompanying high TKN values. Nitrification was therefore not occurring efficiently for that system. BOD_5/TSS data for the research/visitor center system averaged about 20.5 and 16.2 mg/L respectively, with a maximum reported BOD_5 value of about 48 mg/L for eight sampling events. Given the relatively remote geographic location of the research center's system, it seems possible that management may be an issue for this system, with respect to the availability of trained service providers and frequency of visits to ensure proper operation of the system.
- For the overnight facilities served by SBRs, performance varied greatly for the two systems for which TKN data and a limited amount of NO_3-N data were. The averages for the two systems were very high relative to total nitrogen data for each, but were highly impacted by the poor performance of one of those systems. Based on the aggregate of that data, it appears that nitrification and total nitrogen reduction were very poor for the SBR system serving the RV Park (average TKN of 64.5 mg/L for 17 sampling events), while the system serving a mobile home park performed significantly better for total nitrogen reduction from the limited data available for that system (average of 5.6 and max value of 6.7 mg/L for seven sampling events).
- Neither system which included a constructed wetland (subsurface flow) performed well based on the reported data. Although there was only limited data for this system, a septic tank to wetland system serving a school showed very high TKN levels, averaging about 89 mg/L with a high of 104 mg/L for the three sampling events for which data was obtained. The FAST/wetland system serving a residential subdivision/mobile home park also performed fairly poorly relative to nitrogen parameters, averaging 26.3 mg/L for total nitrogen with a high of 72 mg/L for 54 sampling events. Some problems reported for this system by the manufacturer of the FAST unit were described previously.

4.3.6 Central and Western Mountain States

The only state in the central/western mountain region for which systems data and information was obtained is Colorado. Although limited in some cases, data/information was obtained for a total of eleven Colorado systems.

Colorado data offered the opportunity to compare the performance of several fixed film treatment systems, including recirculating textile media (AdvanTex) systems (to a limited extent) and recirculating sand/gravel filters, as well as one RBC system. Three activated sludge systems (including one SBR) were also included in the Colorado dataset.

- With the exception of one of the RSF/RGF systems that served a summer camp, those systems performed somewhat better than the AdvanTex recirculating textile media treatment systems with respect to BOD_5 reduction. The summer camp systems tended to significantly impact those averaged results for the RGF/RSFs, with an average performance of 5.3 mg/L without including the summer camp (four systems averaged together), and an average of 10.9 mg/L when including the summer camp system. The AdvanTex systems seemed to perform comparably with respect to $CBOD_5$ reduction, with averages of 9.6 and 11.2 mg/L for those two systems. The RBC system performed comparably with the AdvanTex systems with respect to $CBOD_5$/BOD_5 reduction, also averaging around 10 mg/L. The RBC system however reported a much higher maximum BOD_5 measurement of 71 mg/L, while 29 mg/L was the highest reported $CBOD_5$ for the AdvanTex systems. The RGF/RSFs tended to have significantly lower maximum values than either of those other fixed film treatment categories.
- The three RSF/RGFs for which NH_3-N or TKN data were available showed very good nitrification performance, with all three systems averaging less than 5 mg/L NH_3-N, and two of those three systems averaging less than 1.0 mg/L for NH_3-N. The AdvanTex systems' performance for NH_3-N/TKN reduction was much more varied, although there were only four sampling events reported for the highway rest stop system. A restaurant/lodge averaged about 2.5 mg/L while the highway rest stop averaged about 27.9 mg/L for its limited monitoring data. Total nitrogen levels for the rest stop AdvanTex system were also high based on that limited data, averaging 59.4 mg/L for four sampling events. No NO_3-N or total nitrogen data were available for any of the RGF/RSF systems, and no data was available for any form of nitrogen for the RBC system.
- BOD_5 treatment performance was very good on average for the three activated sludge systems, although the one SBR system had a relatively high maximum reported value of 26 mg/L as compared with highs of around 10 mg/L for the extended aeration/activated sludge plants (one with a "walnut shell" filter). All three systems however averaged around or less than 5 mg/L for the relatively large datasets associated with each of those systems.
- The SBR reported good averages for both NH_3-N and NO_3-N (no TKN or total nitrogen data available), although maximum values for each of those were relatively high (27 and 22.5 mg/L respectively). No nitrogen data was available for either of the two other activated sludge systems.

4.3.7 West Coast States

Oregon was the one West Coast state for which systems data was obtained. Of the sixteen systems for which some amount of compliance monitoring data was obtained, all but two were some type of fixed film/attached growth treatment system. Two systems employed only septic tank pretreatment followed by subsurface effluent dispersal, although one of those systems was later modified by adding AdvanTex treatment units. Fairly limited data (less than 12 sampling events) was available for about a third of the Oregon systems.

- Secondary treatment performance for the RSF/RGF systems in Oregon was very mixed. On average day use facilities served by that type of treatment system performed fairly well with respect to BOD_5 reduction, reporting an aggregate average of just over 8 mg/L. Those systems performed moderately for nitrification, with average TKN results ranging from 7.3 to 11.4 mg/L for those three systems. The K-12 school reporting the highest of those results averaged much higher for NOx-N and total nitrogen, with 54.2 and 65.5 mg/L respectively for those parameters. Nitrification was therefore still fairly good for that system, given that influent total nitrogen levels were high on average.

- The performance of RSF/RGFs for overnight use facilities was much poorer on average, and highly variable. Average reported results for systems ranged from 6.5 to 33.4 mg/L for BOD_5. There was no clear pattern with respect to performance and types of overnight facilities served. An RSF/RGF system serving an mobile home park or RV park/campground was found to perform well while another such facility's system would be found to perform poorly.

- Of the other fixed film system types, the RBC system (with methanol feed and anoxic unit process) reported high BOD_5 results on average (24.6 mg/L), and also appeared challenged with respect to nitrification given that its effluent TKN averaged about double the reported effluent NO_x, with means of 16.5 and 8.6 mg/L for those two parameters, respectively. There was insufficient data available for the one AdvanTex system represented in the Oregon dataset to evaluate its performance, though based on data over a six-month period it appeared challenged with respect to secondary treatment and nitrification. Results for the last sample event over the six months of apparent start-up time for that system were (all in mg/L): 13.8-BOD_5; 9.9-TSS; 15-TKN-N; 12-NH_3-N; 4.7 NO_x-N; and 19.7-TN.

- Most of the Oregon systems were hydraulically loaded at about half or less of their design flow, with the most heavily loaded system an RSF/RGF serving a subdivision. That system was reportedly converted to an AdvanTex treatment system in 2006, though the data obtained for this study appeared to only cover the period during which the RGF/RSF was in service. That system was performing fairly well with respect to BOD_5 reduction, but less well for nitrification (effluent averages of 9.1 and 1.1 mg/L respectively for NH_3-N and NO_x-N).

Table 4-1. Total Nitrogen Compliance Monitoring Data for SystemTypes and Locations Having At Least 12 Sample Events Reported.

State	Type(s) of Facility(ies) Served	Design Flow (gpd)	Method of Treatment Used	Total Nitrogen Limits (mg/L), or Measurement Basis	Sampling & Reporting Frequency	# of TN Sample Events Reviewed	Avg. TKN or NH3-N for Sample Events Reviewed (mg/L)	Avg. NOx-N for Sample Events Reviewed (mg/L)	Average Total Nitrogen (TN) for Sample Events Reviewed (mg/L)	Max. TN for Sample Events Reviewed (mg/L)	Average Influent TN for Sample Events Reviewed (mg/L)
FL	Residential Condos	36,000	Extended Aeration w/ Anoxic Zone with Recirculation, and Sand Filtration	3.75 mg/L Monthly Average (6.0 Max)	Monthly	23	ND	ND	3.7	13.2	
MN	Lodge/Cabins	11,000	Recirculating Sand/Gravel Filter	Subsurface (GW and field perimeter) monitoring limits of 10 mg/L	Monthly	56	ND	ND	64.8	186	
NM	College	30,000	SBR	N mass loading to irrigation field	Quarterly	13	5.86 TKN & 0.47 NH_3-N	4.3	9.6	20.5	
NM	Research & Visitor Center	10,000	[1]Trickling Filter	20	Quarterly	19	21.74 TKN	4.76	26.5	44.4	
NM	Shopping Center	5,802	Trickling Filter	20	Quarterly	14	9.04 TKN	4.15	11.9	19.3	
NM	Mobile Home Park	9,000	[2]FAST to S.F. Wetland	30 mg/L Quarterly Basis, and 20 mg/L Annual Basis	Quarterly	54	14.4 TKN	0.72	26.3	72	
NM	Middle School	30,000	[3]Recirculating Sand/Gravel Filter	20	Monthly	68	1.3 TKN	27.9	25.8	74.9	
NC	High School and Elementary School	27,600	Recirculating Sand/Gravel Filter	30	Quarterly	17	1.6 TKN	59.8	61.4	96.3	
NC	Shopping Center	10,232	[4]Bioclere	30	Monthly	21	3.2 TKN	11.4	14.5	51.6	

Table 4-1. Total Nitrogen Compliance Monitoring Data for SystemTypes and Locations Having At Least 12 Sample Events Reported.

State	Type(s) of Facility(ies) Served	Design Flow (gpd)	Method of Treatment Used	Total Nitrogen Limits (mg/L), or Measurement Basis	Sampling & Reporting Frequency	# of TN Sample Events Reviewed	Avg. TKN or NH3-N for Sample Events Reviewed (mg/L)	Avg. NOx-N for Sample Events Reviewed (mg/L)	Average Total Nitrogen (TN) for Sample Events Reviewed (mg/L)	Max. TN for Sample Events Reviewed (mg/L)	Average Influent TN for Sample Events Reviewed (mg/L)
NC	Hotel	13,800 (20,000 gpd treatment capacity)	[5]Extended Aeration Package Plant, Sand Filters w/ Methanol Injection	Monthly Avg. Limits for TKN = 4 mg/L (6 max); Monthly Avg. Limits for NO3/NO2 = 6 mg/L (8 max).	Monthly	29	1.3 TKN & 0.3 NH_3-N	20.6	22.5	46.4	
NC	Restaurant	9,600	Bioclere	30	Monthly	27	17.1 TKN & 10.2 NH_3-N	7.2	23.6	39	
NC	Rest Home	10,800	Recirculating Sand/Gravel Filter	40	Monthly	20	1.6 TKN & 0.7 NH_3-N	8.6	10.8	27.6	
NC	Elementrary School	11,400	[6]Recirculating Sand/Gravel Filter	40% Reduction from Septic Tank Effluent to Field Dosing Tank	Monthly	18	16.6 TKN & 13.1 NH_3-N	36.5	53.6	106.6	
OR	Church	8,000	Recirculating Sand/Gravel Filter	[7]None	Quarterly & Semi-Annually	18	9.0 TKN & 8.6 NH_3-N	40.5	49.6	78.4	NR
OR	Inn/Resort	16,000	Recirculating Sand/Gravel Filter	[7]None	Quarterly	19	6.7 TKN & 6.8 NH_3-N	11.4	18.1	53.1	57.6
OR	Church Camp	14,500	Recirculating Sand/Gravel Filter	[7]None	Quarterly (Approx.)	21	9.7 TKN & 9.1 NH_3-N	22.9	32.2	79.5	NR
OR	School (K-12)	19,110	Recirculating Sand/Gravel Filter	[7]None	Quarterly to Semi-Annually (Varies)	16	11.4 TKN & 9.4 NH_3-N	54.2	65.5	93	84.1
OR	Mobile Home Park	19,500	RBC w/ Methanol feed & Anoxic treatment unit	45% Reduction	Monthly	49	16.5 TKN & 12.5 NH_3-N	8.6	24.6	40.5	
OR	Mobile Home Park	19,750	Recirculating Sand/Gravel Filter	[7]None	Approx. Quarterly (Varies)	15	30.2 TKN & 28.1 NH_3-N	1.2	30.6	52	37.6

Table 4-1. Total Nitrogen Compliance Monitoring Data for SystemTypes and Locations Having At Least 12 Sample Events Reported.

State	Type(s) of Facility(ies) Served	Design Flow (gpd)	Method of Treatment Used	Total Nitrogen Limits (mg/L), or Measurement Basis	Sampling & Reporting Frequency	# of TN Sample Events Reviewed	Avg. TKN or NH3-N for Sample Events Reviewed (mg/L)	Avg. NOx-N for Sample Events Reviewed (mg/L)	Average Total Nitrogen (TN) for Sample Events Reviewed (mg/L)	Max. TN for Sample Events Reviewed (mg/L)	Average Influent TN for Sample Events Reviewed (mg/L)
OR	Mobile Home Park	5,750	Recirculating Sand/Gravel Filter	[7]None	Quarterly to Semi-Annually (Varies)	24	3.7 TKN & 2.7 NH_3-N	23.5	26.3	57.1	38.6
PA	Community System	40,000 (Changed to 56,300 in 2006)	Primary, secondary & tertiary aerated lagoon system	NR (Surface Irrigation Dispersal System)	Monthly	32	ND	ND	13.2	31.1	

[1] The following was observed during a 1995 visit to the system by the NM Water Utilities Technical Assistance Program, after which certain changes were made to the plant.

- o Primary clarifier full of septic sludge;
- o Trickling filter plugged with trash & solids;
- o Secondary clarifier full of septic sludge and no mechanical means to remove sludge;
- o Chlorine contact chamber full of septic sludge;
- o High nitrogen level noted in effluent.

[2] [The manufacturer of the FAST unit, Bio-Microbics, was contacted for comments about this system's performance, and reported the following: The system was evaluated by their technical staff in 2005 based on the 4 areas where they tend to observe treatment issues: (1) initial design (they knew this to be an issue/factor), (2) installation (3) operation, and (4) wastewater characteristics. Every area had issues needing to be addressed according to the manufacturer, including system flows.]

[3] The effluent limits for this system were decreased from 27 mg/L to 20 mg/L in 2003. If only the TN values after that time are considered, the average for the remaining data points is 20.9 mg/L, with a maximum value of 50.9 mg/L (27 sampling events).

[4] There was a time gap of close to two years during the sampling period reviewed, with the maximum reported TN value occurring at the end of that period. There may have been repairs or system modification(s) during that period.

[5] TN values were calculated from reported TKN and NO_3/NO_2 reported monthly measurements.

[6] The mean of reported influent TKN values for the reviewed data was 85.2 mg/L (max of 108.6 mg/L). The requirements for 40% TN reduction appeared to not have been met on 7 occasions out of 19 sampling events reviewed. The average reduction for all of the sampling events reviewed was approximately 37.1%.

[7] These recirculating sand/gravel filters were designed for secondary treatment (BOD/TSS reduction and loading), and not for total nitrogen reduction.

CHAPTER 5.0

COST DATA

5.1 Summary of Cost Information Obtained

Systems' capital and operating cost data was gathered as available for systems from several states as a part of the detailed information gathering for a targeted number of systems in each major geographic region. After obtaining contact information for systems of interest to the study, team members contacted systems owners, designers and operators to inquire if this information was or could be made available. It was found that most private sector owners were not willing to share this type of information, and oftentimes public entities such as schools and small community offices did not have the available staff time to search files for some of the types of information sought relative to capital and operating costs. In other cases, the administrative steps needed to obtain permission for sharing that information were found to make that infeasible.

Despite those obstacles, some amount of cost data was gathered for a total of over 60 systems, in addition to information provided by two regional responsible management entities (RMEs) about their user charges. Table 5-1 summarizes the cost data obtained. As seen from the table, all categories of requested cost information were available for only a very few systems. However, the combined information from all of the systems afforded the identification of several possible trends which are discussed below. Since the majority of cost information gathered for systems fell into one of about four principal categories, the discussion below is organized in that way: Initial/capital costs; operation and maintenance costs for labor; sludge/septage removal/pumping costs; and power costs. Laboratory service costs were another category of information requested, but tended to be relatively minor as compared with other operations costs categories, and were sometimes included with the reported labor costs. The last section of this chapter comments on some basic observations made from the cost data as related to monitoring data obtained for systems, and overall performance.

5.1.1 Reported Systems Capital Costs

Capital costs were reported for a total of 29 systems for which some amount of data/information was gathered in the study. Table 5-1 should be referred to for clarifying comments relative to system costs. Based on information provided, those capital costs may or may not include engineering and surveying, as well as other factors that would affect cost comparisons between systems.Charts were generated to compare costs for systems based on dollar per gallon of daily design flow, and dollar per gallon of average reported daily flows for the systems. The data was also segregated based on whether the system is publicly or privately owned, to identify possible trends. Figure 5-1 shows reported capital costs per gallon of daily design flow, and Figure 5-2 shows capital costs per gallon of average daily reported flows from the monitoring data obtained for the particular system.

Capital costs for systems tended to vary greatly, ranging from a low of $6.23 per gallon (TN-5) to a high of $140 per gallon (CO-7). The two most costly systems on a per gallon basis were publicly owned (CO-7 and TX-25). Both projects were built under the direction of public agencies according to information obtained for each. For both publicly and privately owned systems, two Colorado recirculating textile media filter systems cost the most per gallon of design flow of the systems in each ownership category. Construction locations and conditions likely weighed considerably on the costs of those projects, since both are located in mountainous areas of the state. Other than those two textile media filter systems, publicly owned activated sludge systems in Texas tended to be the most costly to construct per gallon of design flow. The Texas systems serving parks and recreational areas (seven of the systems on the right half of the chart with higher costs) tended to be operating well below their design flows on average, though some were reaching capacity during peak seasonal periods.

The five publicly owned Tennessee projects (TN 1-5) are owned by a privately held public utility, but were built by a single design/build/operate firm. Those five systems are among the least costly per gallon of design flow. In general recirculating sand filter systems in the states of Tennessee, New Mexico and Colorado were the least expensive to construct (per gallon design flow).

Figure 5-1. Reported Capital Costs Per Gallon Daily Design Flow.

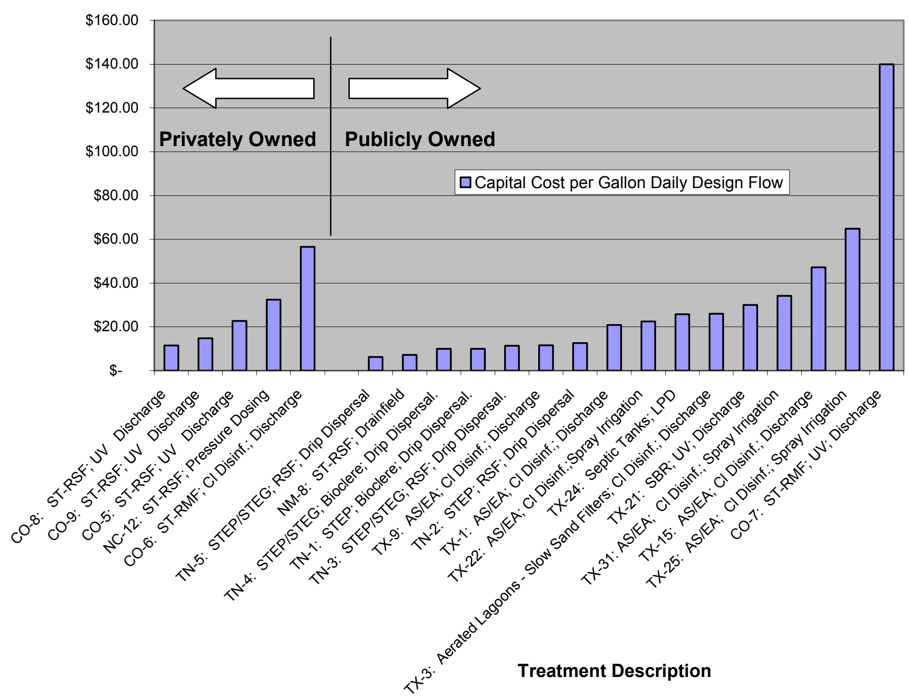


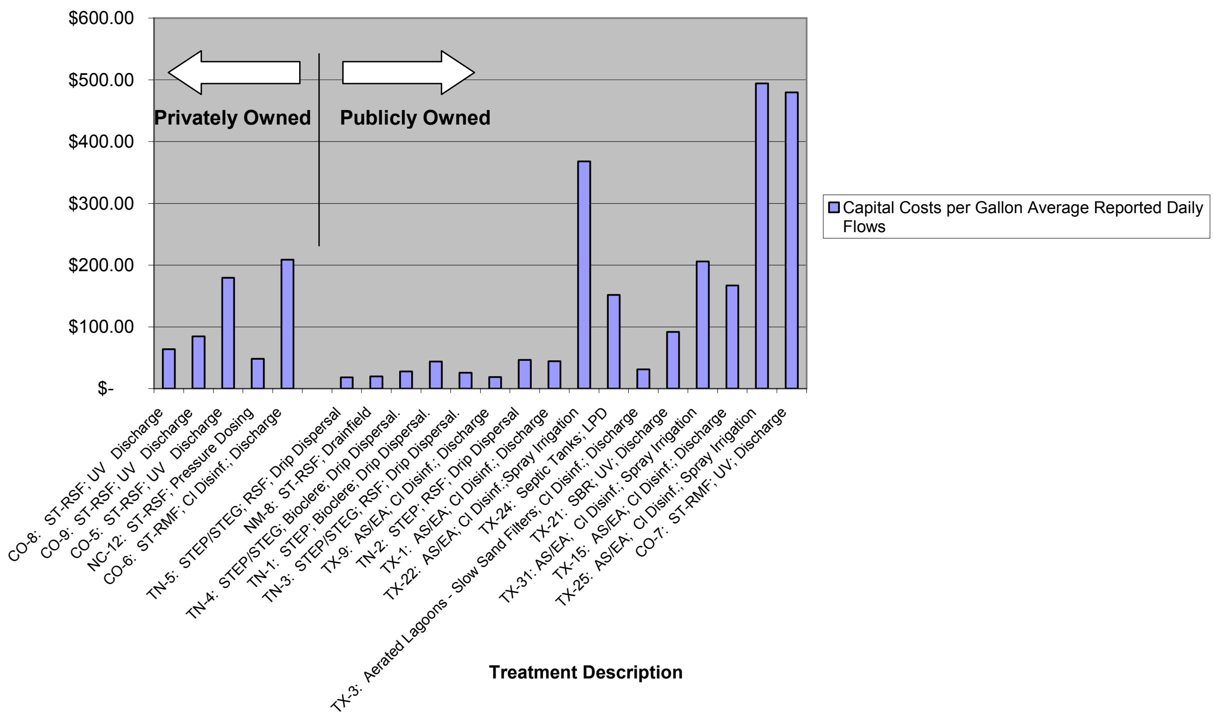
Figure 5-2 shows more dramatic results by plotting the reported capital costs per gallon of average reported flow for each of the systems. The order of the systems from left to right has been left the same as for Figure 5-1 to more easily enable comparisons for individual systems.

Note however that the vertical axis is almost four times the height for Figure 5-2 as for 5-1, due to the increased costs per average treated gallon.

Costs calculated and plotted based on reported average flows ranged from a low of \$18.31 per treated gallon (TN-5) to a high of \$494.26 (TX-25). With the exception of the publicly owned system serving the Colorado highway rest stop (CO-7), all of the publicly owned systems costing more than \$50 per average treated gallon of flow serve parks and recreational areas in Texas.

A number of the systems in the two tables use direct discharge, and thus capital costs for those systems are not directly comparable to costs per gallon for systems that include some type of effluent dispersal system (surface or subsurface). It should be noted that the reported capital costs for the five Tennessee systems include engineering costs, and constructed collection system costs except for septic/interceptor tanks located by buildings served by the STEP/STEG systems. It is also noteworthy that all of the Tennessee systems for which capital cost data was obtained were operating at less than 50% of their flow capacity for the monitoring periods reviewed. Given all of these considerations, the Tennessee systems appear on average to be by far the least costly in terms of initial constructed costs per gallon of treated wastewater.

Figure 5-2. Reported Capital Costs Per Gallon Average Reported Daily Flows.



In general based on the data reviewed, publicly owned systems tended to cost more per design or treated gallon as compared with privately owned systems, with the exception of the five Tennessee design/build/operate systems. The owner for those systems is however a privately owned public utility. One possible explanation for the high costs associated with a number of the publicly owned Texas systems is that engineering services for public projects in the state cannot lawfully be procured on a “bid” basis, but rather a “qualifications” basis, with the latter being somewhat subjective depending on the background and experience of the qualifications reviewer. Engineering services for wastewater systems being planned for public projects may oftentimes be included in larger scopes of work for buildings and infrastructure. Prime firms responsible for such work may not be experienced with decentralized wastewater systems’ planning and cost-effectiveness considerations. Even where sub-consultants are contracted to perform that work, an absence of knowledge/familiarity in that area by the prime firm might tend to affect the selection of sub-consultants charged with design of the wastewater systems, and ultimately systems selections and designs. Engineers working for public entities may also be less familiar and experienced with decentralized systems, also possibly tending to affect the choice of engineering consultants and designs (for contracted services).

With respect to construction practices, regulatory requirements and other conditions in a particular state may offer some explanation of the higher per gallon costs. For example, in Texas rules for large/community scale domestic wastewater systems (> 5,000 gallons per day, and all cluster systems) currently do not include a requirement that the installer of the wastewater system be trained/certified in that area of construction. By contrast, residential scale decentralized systems in Texas (< 5,000 gpd) permitted under the state’s Chapter 285 rules do carry such a requirement: Depending on the complexity of system, an installer must be used who is licensed by the state at some specified level of training and certification. Statewide training and certification programs based on nationwide industry-accepted practices would likely tend to bring a greater measure of consistency of methods, materials, and accompanying costs for the construction of certain types of systems which was not observed in the large-scale systems cost data for Texas. Such training would also likely introduce the consideration of more cost-effective approaches not commonly used locally.

Costs per average measured daily flow tended to be much higher than cost per gallon of design flow. In some cases, systems may be completely "built-out", with actual resulting flows significantly less than planned. In other cases, such as residential subdivisions, all planned connections may not yet be on-line. The first scenario seems to point to a need for better initial assessment of system flows for the purposes of design and permitting. The latter underscores the financial benefits of wastewater treatment and dispersal systems that can be phased-in as development occurs. Flow tracking and performance data compiled over time might well indicate that expansion of the system is not necessary, and would at least provide valuable information for design/sizing adjustments if needed.

Where public funds have been awarded to small communities for wastewater systems improvements, most (if not all) funding programs require that those funds be expended, which can present problems for phasing-in wastewater system components where it is more cost-effective to do so. Also in some cases, regulatory authorities may have legitimate concerns that if the system is not completely built up-front, the funds may not be available later for the community or owner to expand the system as needed. Hopefully there will be legal and accounting measures developed and adopted by states and local entities that can address these types of obstacles for large scale decentralized systems in the future.

5.1.2 Reported Operation and Maintenance Costs

Operation/maintenance cost information was obtained for 38 of the systems studied, with costs associated with sludge/septage pumping/hauling, power, and laboratory services (when performed by outside labs) requested separately and segregated from those. Costs associated with labor or outside services associated with routine operation and maintenance of systems was requested for the most recent years of system operation (at least three years requested) as a separate category of expense, as shown in Table 5-1.

The majority of operation and maintenance cost information was for Texas systems (and in particular publicly owned parks/recreational area systems) with most of those some type of activated sludge system. Figures 5-3 and 5-4 show the labor portion of operation and maintenance costs for systems reporting that category of expense. Sludge/septage removal, outside laboratory costs, power usage and repair costs for the system are not included in those plots. Those expenses tend to reflect only the labor category of expenses associated with routine operation and maintenance of the systems. Figure 5-3 plots those systems with monthly costs per gallon of design flow of less than $0.075 per gallon, and Figure 5-4 shows systems with monthly costs per gallon of design flow greater than $0.075. The data is plotted to the same vertical scale for each of the two figures.

Although there is no apparent governing trend observed in the figures in terms of the costs for certain categories of treatment, the systems for which the highest costs were reportedly spent per gallon of design flow tended to be facilities served by either (or both) of the following: 1) activated sludge systems or 2) those that are publicly owned and operated (and often also some type of activated sludge treatment plant), and which serve recreational campgrounds in Texas. Of the Texas systems, those that are publicly owned and operated, and serve parks and recreational campgrounds include system numbers 3, 12, 14-16, and 20-35. All of the Texas systems shown on Figure 5-4 (higher per gallon operations costs) are among that list. Interestingly also, one of those systems (TX-24) consists of septic tank pretreatment followed by low pressure dosing of effluent, which is the simplest type of system among those reporting staffing/labor costs associated with system care. However, there are several separate wastewater systems located in the park/recreational area (on the same property) where TX-24 is located, with all of those systems relying on the same operator(s) for checks and maintenance. It is possible that the time reported may actually be split between those systems, since all are the same basic type (septic tank pretreatment followed by low pressure dosing of effluent).

Figure 5-3. Monthly Reported Operation & Maintenace Labor Costs Per Gallon Daily Design Flow (Systems Costing < $0.075 per Gallon).

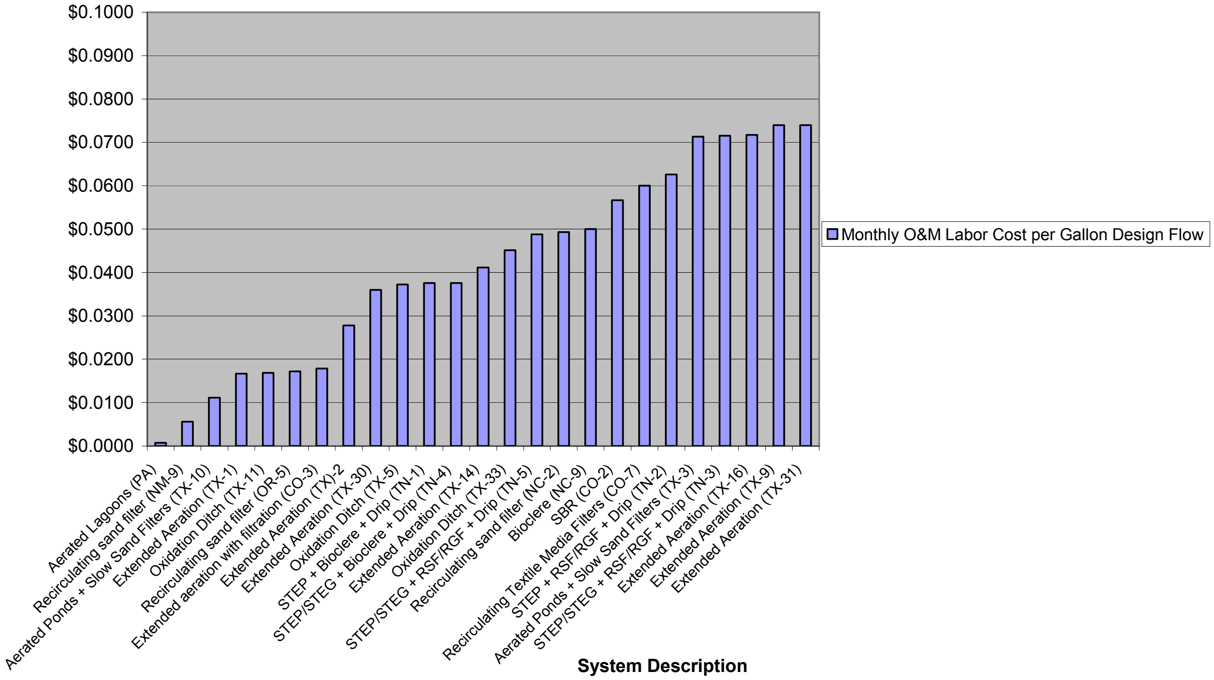
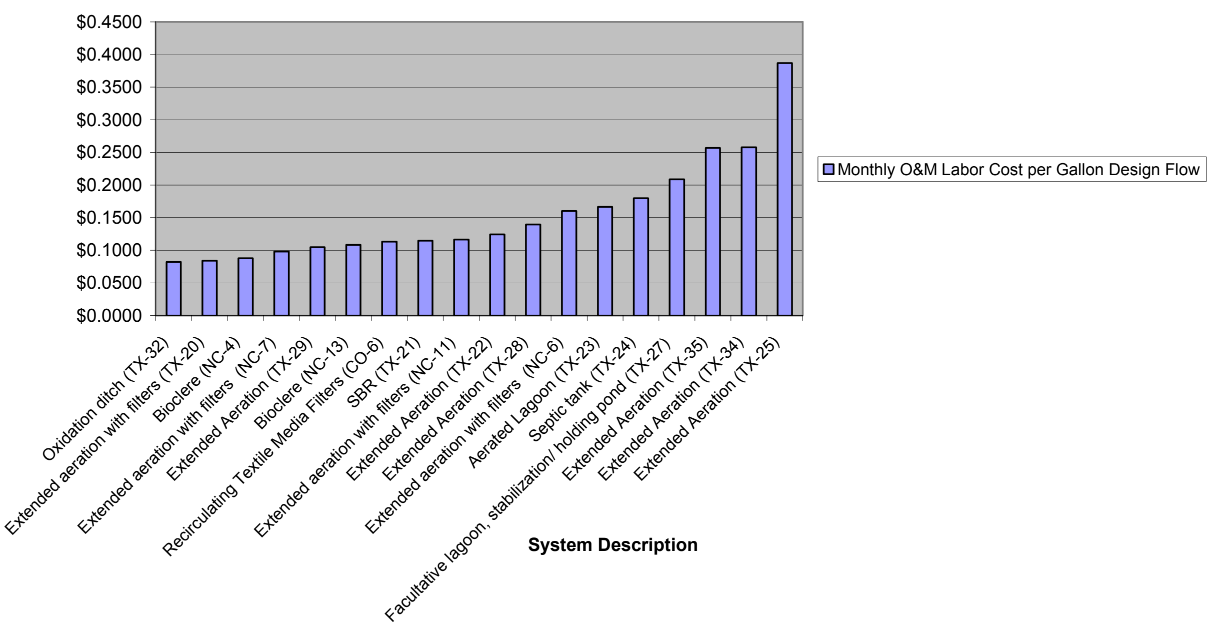


Figure 5-4. Monthly Reported Operation & Maintenance Labor Costs Per Gallon Daily Design Flow (Systems Costing > $0.075 per Gallon).



Figures 5-5 and 5-6 show those same systems (and in the same order) for which flow data was available, but plot monthly O&M labor costs per gallon of average daily reported flows for those systems. Due to the increased costs per gallon of those systems it was necessary to change the y-axes scaling for both graphs. Flow data was not available for some of the systems shown in Figures 5-3 and 5-4, and so are not included in Figures 5-5 and 5-6.

Figures 5-5 and 5-6 show substantially increased costs per gallon when considering actual versus design flows for operations costs. Whereas the highest costs per gallon of design flow shown in Figures 5-3 and 5-4 were just under $0.40 per gallon, costs per measured flow for most of those same systems in Figures 5-5 and 5-6 reach close to $6.00 per month per gallon average flow. The two systems having by far the highest per gallon costs were two oxidation ditch systems serving parks and recreational areas that are owned and operated by a public entity.

Figure 5-5. Monthly Reported Operation & Maintenance Labor Costs Per Gallon Average Daily Reported Flow (Same Systems as Fig. 5-3).

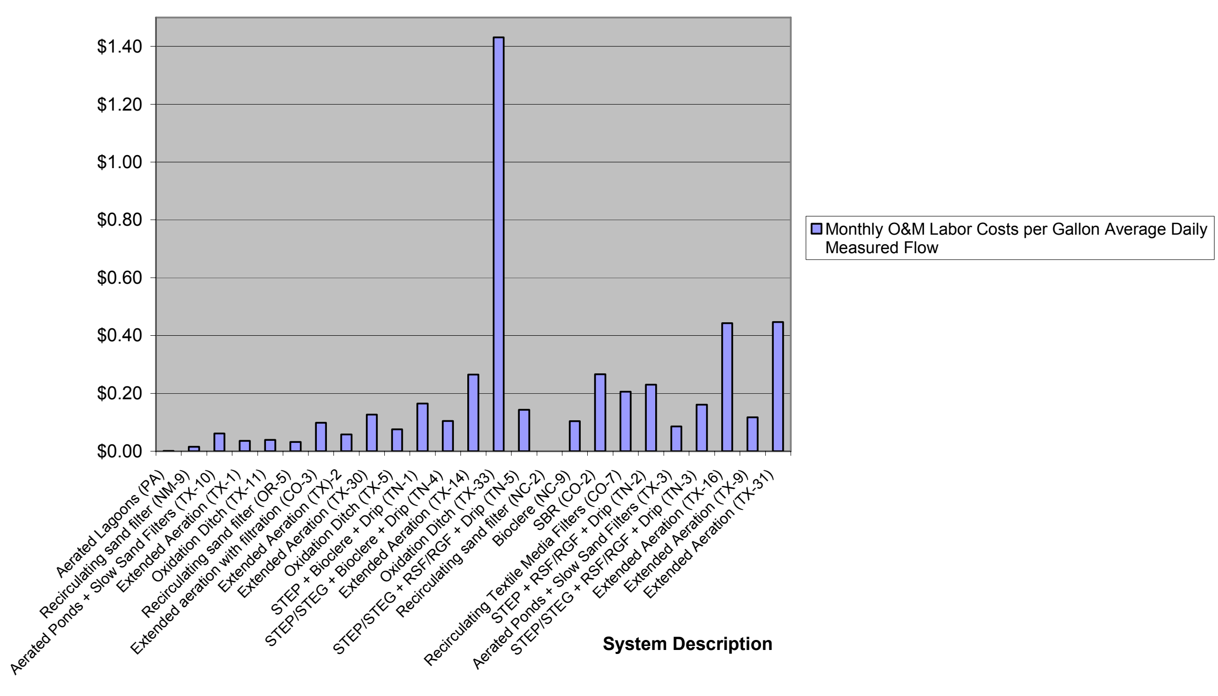


Figure 5-6. Monthly Reported Operation & Maintenance Labor Cost Per Gallon Average Daily Reported Flow (Same Systems as Fig. 5.4).

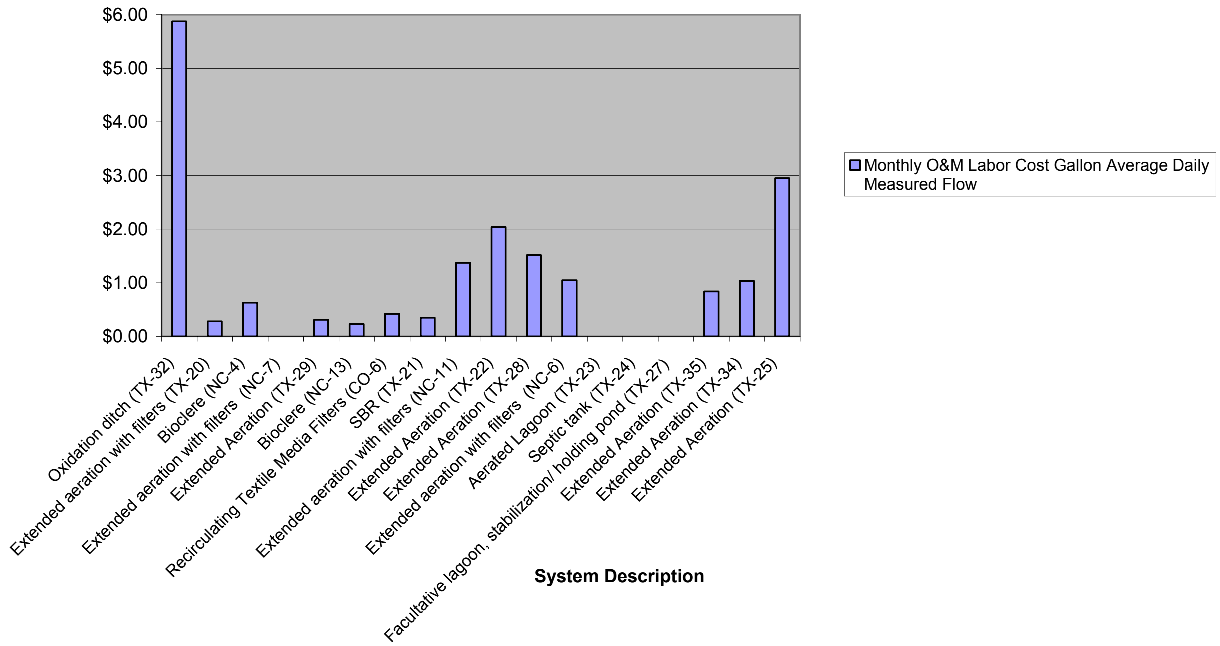


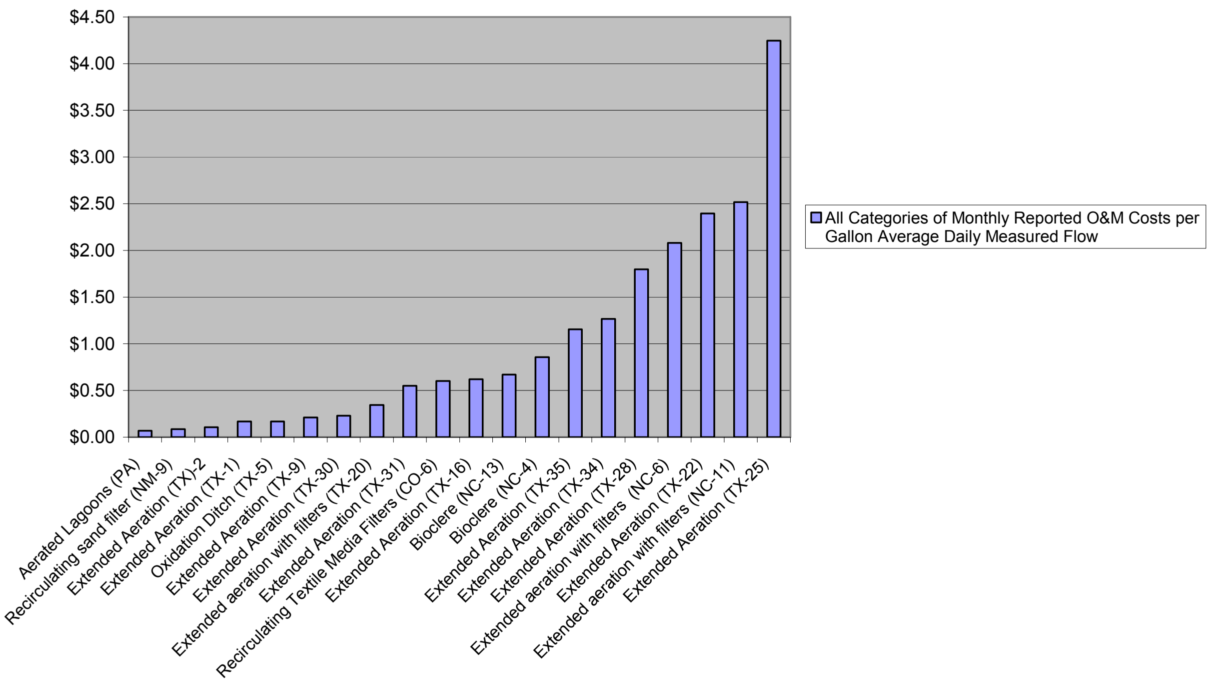
Figure 5-7 combines monthly operating costs for systems where at least sludge and O&M services were reported of the five categories of operating costs (labor/materials for routine operations/maintenance, sludge/septage hauling, power, and lab costs). For several of the systems in Figure 5-7 no power usage costs were reported. Using an average of reported power usage costs per average measured flow associated with that treatment category, estimated power costs per gallon were added to the other reported costs for those systems. For recirculating textile media systems, averaged reported power costs for three recirculating sand filters were used, due to the absence of available power cost data for the media filters. For two extended aeration plants, power usage costs averaged from cost data for fourteen extended aeration plants were used on a per gallon measured flow basis.

Laboratory testing costs were also not available for some of the systems included in Figure 5-7. These costs tended to be relatively minor relative to other operational costs categories, and estimates based on comparable systems was considered not to significantly skew general trending results. Therefore, for the purposes of this particular cost comparison where that information was not available and where lab work was not reported to have been done as a part of the reported O&M activities and costs, it was estimated from lab services cost data from systems of similar types and flows from that particular state.

All of the systems to the right of the four systems on the left side of the chart fall into one of two categories: 1) activated sludge treatment process; 2) publicly owned system. The only non-activated sludge system on the right side of the chart (CO-7) is a publicly owned system serving a highway rest stop. This system is privately managed however, and travel time to/from the site for the operator no doubt contributes to the higher operating costs associated with this system.

Observations regarding operation and maintenance costs are not particularly surprising, given the reported routine maintenance activities and needs for most activated sludge treatment facilities as compared with the packed media filter and less mechanized systems. Those activities are reported for specific systems identified by state and system number in the appendices, where that data was made available by owners and/or operators of systems.

Figure 5-7. Monthly Reported Operation and Maintenance Costs (All Categories of O&M Costs) Per Gallon Average Daily Reported Flow.



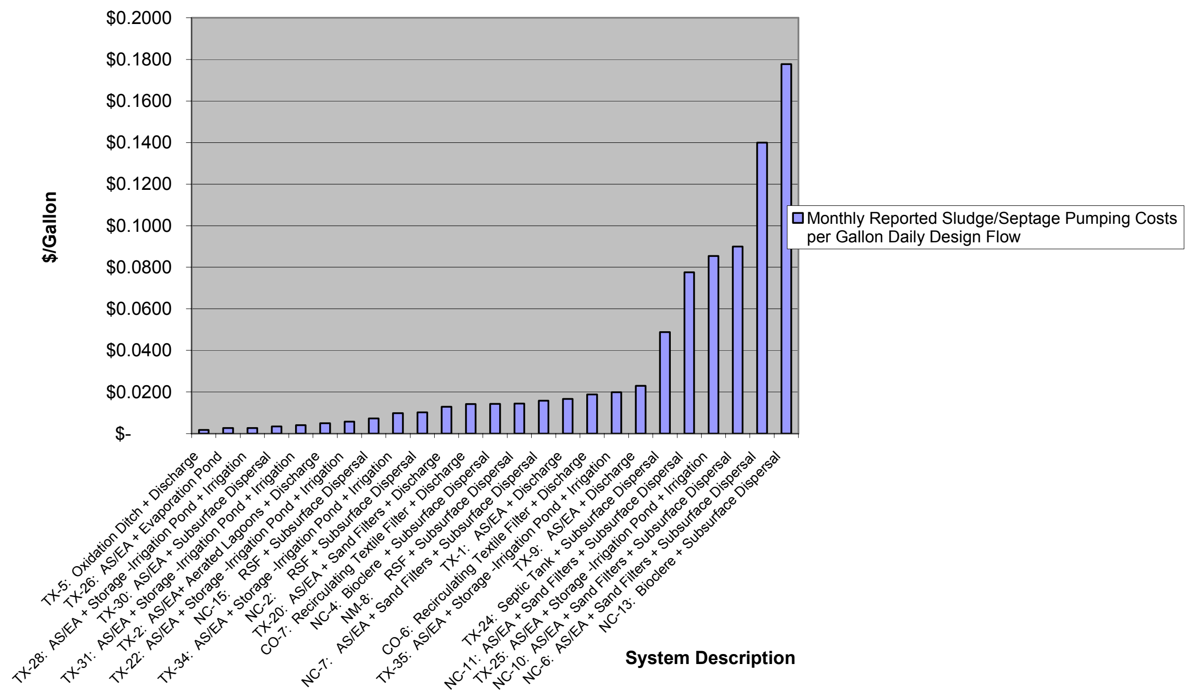
5.1.3 Sludge/Septage Removal Costs

As a significant portion of decentralized wastewater systems' operational costs, data/information obtained for sludge and/or septage removal was tracked, as shown in Table 5-1. Sludge/septage removal cost data was obtained for a total of 26 of the systems studied. Data was requested for the most recent three or more years of system operation, and so may not reflect averages over long periods of time (e.g., where septic tanks may not require pumping for a period significantly longer than the period covering the cost data reviewed). In most cases data was obtained in paper format rather than direct communications with operators, and it was often not known or reported whether septage was removed at set time intervals or based on systems inspections and/or operational controls. For extended aeration systems however, sludge removal frequency was likely most often based on some type of visual inspection or operational observations, rather than set intervals. The reported information by operators also does not directly reflect whether systems are pumped sufficiently often to ensure proper performance.

For five of the Tennessee systems served by effluent collection system, although no sludge removal costs were available, it was reported that very few septic tanks associated with those systems have needed pumping to date. For those recirculating sand/gravel filter and Bioclere systems, it appeared that sludge/septage removal/pumping costs were very low for the entire systems (collection and treatment).

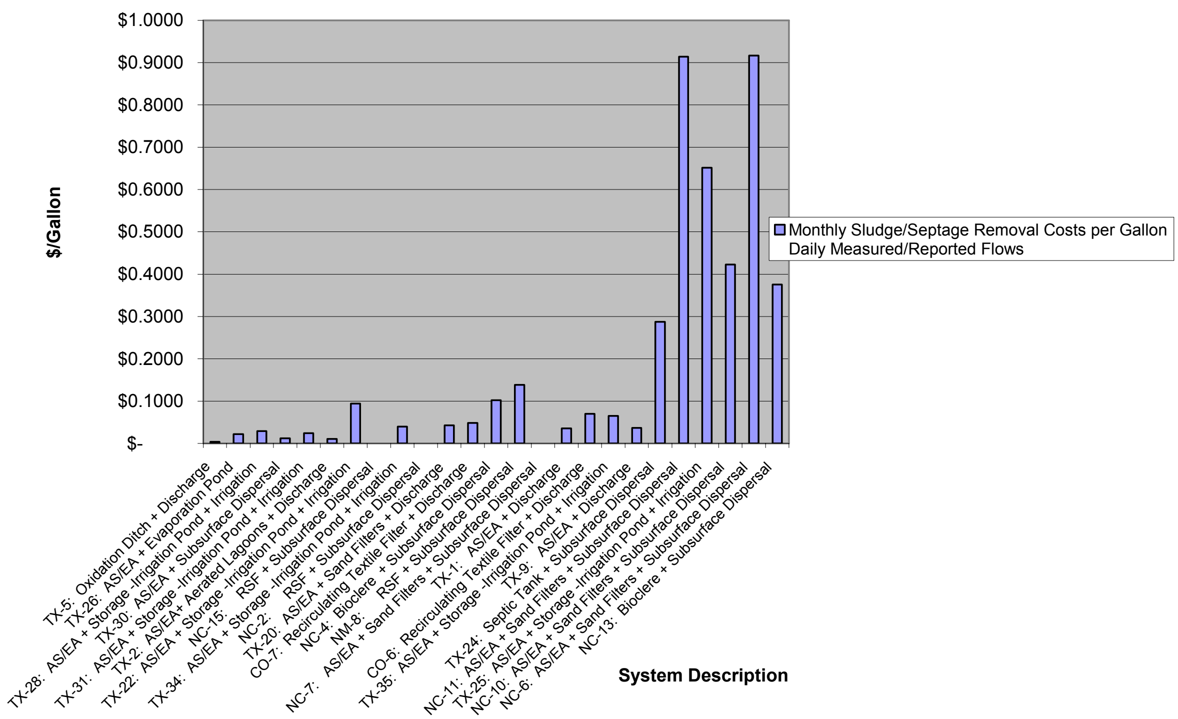
As seen for the capital costs reviewed, actual flows for systems may be much lower on average than designed/permitted flows. Monthly sludge removal/pumping costs were tracked based again on both design and average reported flows, as shown in Figures 5-8 and 5-9. For Figure 5-9, the systems order has been left the same as for Figure 5-8, though the vertical axis has changed five-fold to accommodate the higher cost per gallon range reflected in Figure 5-9. Flow data was not reported for some of the systems on the list, so no plot is included for those.

Figure 5-8. Monthly Reported Sludge/Septage Pumping/Hauling Costs Per Gallon Daily Design Flow.



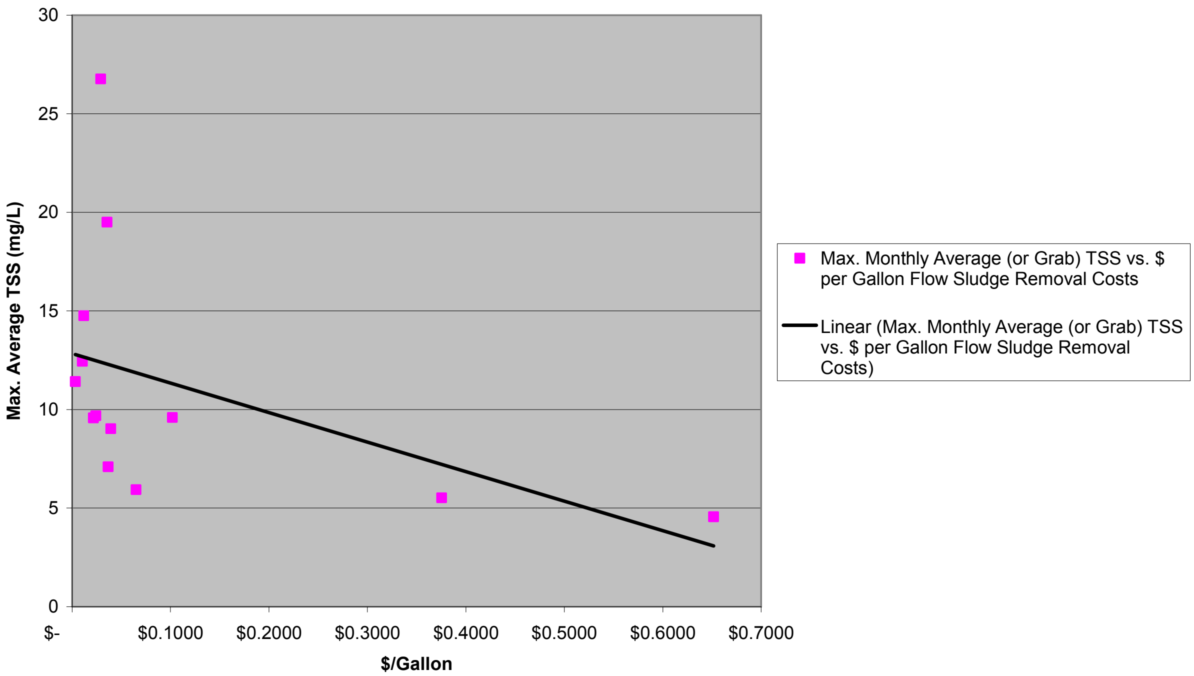
In general, the activated sludge/extended aeration treatment systems tended to have higher sludge removal/hauling costs as compared with packed media processes, particularly when considering the following: It appears that costs for systems using extended aeration treatment tended to be higher when they were followed by either a unit process (e.g. sand filtration which would have tended to show signs of the system's needing sludge wasting) or final effluent disposition processes that would not tend to visually obscure the need for pumping (e.g., subsurface dispersal systems as contrasted with holding ponds prior to irrigation, evaporation ponds, etc.). Five of the 6 systems with by far the highest sludge pumping costs per gallon of average reported flow used some type of subsurface dispersal method. Three of those 6 systems were extended aeration (EA) systems using sand filters following the EA process. TX-25 is a relatively new (recently replaced) publicly owned system serving a park and recreational area, with reportedly fairly intense maintenance practices (approximately 20 hours per week for regular operation and maintenance activities associated with that 7,311 gpd – design capacity plant). That plant also operates well below its design capacity (on average about 13% of the plant’s design flow).

Figure 5-9. Monthly Reported Sludge/Septage Pumping/Hauling Costs Per Gallon Average Daily Measured Flow.



As mentioned above, it was generally observed from the sludge/septage cost data that on average, less money was spent on sludge removal per gallon of wastewater treated for those treatment systems which do not include any type of filtration process or subsurface dispersal system that would tend to alert operators of the need to waste sludge from the system (i.e., that would precipitate sludge removal expenditures). Those plants were instead followed by either direct discharge, or were by some type of pond system followed either by irrigation or direct discharge. It was therefore hypothesized that such systems are likely accumulating sludge in their ponds, or may simply be discharging excess suspended solids. Maximum TSS monthly averages (or grab sample values if no reported averages) were plotted, and a trend line added to the charts to identify a potential trend based on the sludge removal cost data gathered for the facilities for which both sets of data (sludge costs and TSS data) were available. Those results are shown in Figure 5-10.

Figure 5-10. Maximum Monthly Average TSS vs Monthly Sludge Removal Costs Per Average Gallon Flow.



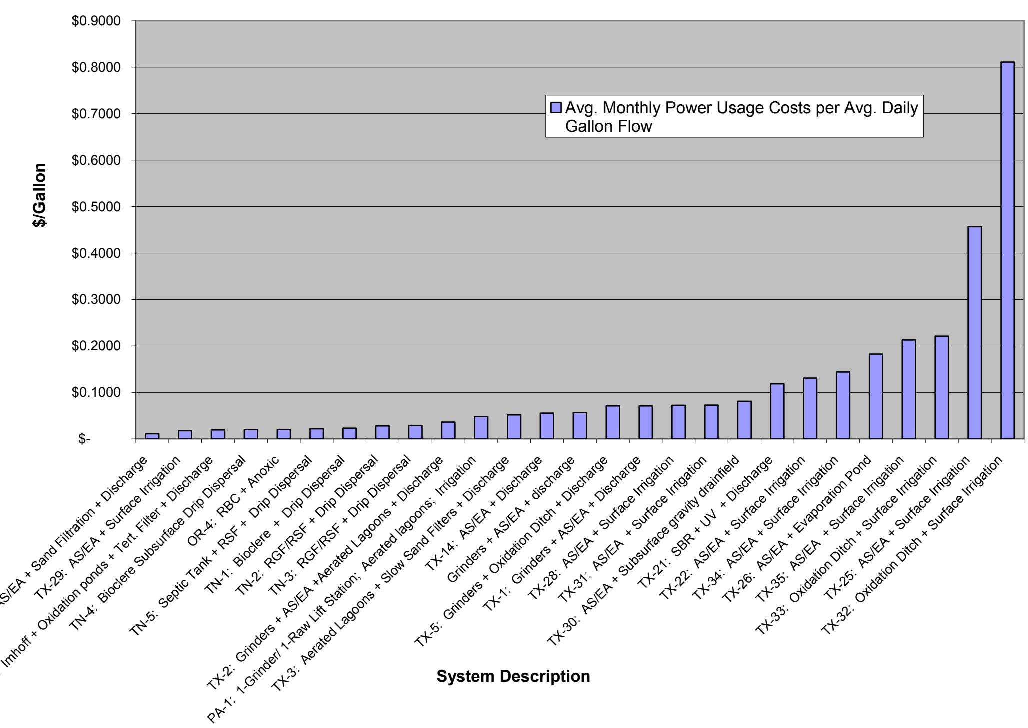
Although both sludge removal costs and TSS data were only available for a total of 13 systems, there appears to be a tendency for higher suspended solid measurements to occur for effluent quality in cases where less is spent for sludge removal per gallon treated. In some cases the higher expenditures may simply be a result of better management practices, while in others the presence of certain units processes such as filtration are necessitating more frequent sludge wasting to prevent filter clogging. Although those trending results may seem intuitively obvious, they point to some possible management issues of concern for systems in this size range, as related to sludge-wasting practices and system performance.

5.1.4 Systems Power Usage Costs

Power usage/cost data was obtained for a total of 29 systems as reported in Table 5-1. At least three years of power cost data were requested from systems operators/owners (most recent years), and costs were averaged over those periods and recorded on a monthly basis. Flow data was available for 28 of those systems, for evaluating costs per gallon of treated wastewater for the systems. Most of the systems for which power usage data was obtained are in Texas, and are mostly activated sludge facilities. Fortunately however power usage data was available for most of the Tennessee systems, which all use either recirculating sand/gravel filter or Bioclere treatment systems, thus affording some comparisons by method of treatment. Data was also available for an Oregon RBC system that includes an anoxic/denitrification process, and a Pennsylvania aerated lagoon system (three aerated lagoons in series).

Figure 5-11 shows plots of power usage by system type. For systems where system descriptions included a grinder lift station in association with (and obviously integral to the treatment system in terms of comminution), and for which the reported power usage costs included the lift station, those are combined. In other cases power usage for lift stations not adjacent to the treatment facility were most often not reported. Where lift station (typically grinder) costs are believed to be included in the reported power costs, that process is listed in the brief system descriptions. Listing systems by state and number enables consideration to regional power costs for any comparisons made.

Figure 5-11. Average Monthly Reported Power Usage Costs Per Gallon of Reported Average Daily Flow.



Power usage costs range from $0.0112 per gallon to a high of $0.8111 per gallon of average reported measured flows. All of the systems on the right side of the chart use some type of extended aeration process, clearly indicating the higher power usage costs associated with those systems. The fixed film and pond treatment processes tended to cost the least by far relative to power usage costs.

5.2 Systems Costs as Related to Performance

In considering systems costs, an important question is obviously whether extra dollars that may be spent for the construction and operation of a system are warranted based on better and/or more reliable performance achieved on average by that system. The data for systems included in Figures 5-2 (capital cost data) and 5-7 (all available operation and maintenance cost data) were reviewed to explore that question. A list of all those systems for which both capital costs and all major operation costs were reported was compiled, and is included in Table 5-2. The table includes capital and operating categories of expenses, and performance data for key effluent parameters including BOD_5, TSS, NH_3-N, and NO_3-N for systems from which that data was available. NH_3-N and TSS data were available for only a few of those systems, and no TKN or Total Nitrogen data were available for any.

Costs are shown in the table on a per treated gallon basis, based on reported flow data for the systems. Both types of cost data were available for a total of only twelve systems, however they represent a fairly good cross section of system types. Monitoring data was only included in the table for those systems having at least 12 data points for a specific parameter. Based on the data obtained for that limited number of systems, there is no observable trend to suggest that increased expenditures resulted in better system performance. Unfortunately no cost information was obtained for the Massachusetts systems, since those tended to be subject to lower total nitrogen limits than elsewhere (10 mg/L or less). However, AWM's residential user charges for systems in Massachusetts are approximately double the reported residential charges for systems managed by Adenus, which operates in the Southeast. "End of pipe" nitrate and total nitrogen limits (prior to final soil treatment through subsurface drip dispersal) tended to be significantly higher for Tennessee systems as compared with most of the Massachusetts systems studied. So the higher per user charges for the New England RME to build and operate those systems are consistent with the higher level of pretreatment required for those systems.

Table 5-2. Systems Performance As Compared with Capital and Operating Costs.

System & Treatment Method	Reported Capital Cost per Gallon Daily Flow ($/Gallon)	Avg. Monthly Operating Cost/Gallon Daily Flow ($/Gallon)	Average Reported BOD_5/COD_5 (mg/L)	Average Reported TSS (mg/L)	Average Reported NH_3-N (mg/L)	Average Reported NO_3-N (mg/L)	Comments
STEP/STEG; RSF/RGF; Drip Dispersal (TN-5)	$18.31	$0.0216	3.4		1.26	9.47	No sludge/septage removal costs included; Those costs reportedly very low over past few years.
Extended aeration (TX-9)	$18.45	$0.1326	4.61	7.09			
STEP/STEG ; RSF/RGF; Drip Dispersal (TN-3)	$25.60	$0.0288	1.94		2.86	10.75	No sludge/septage removal costs included; Those costs reportedly very low over past few years.
STEP/STEG; Bioclere; Drip Dispersal (TN-4)	$27.72	$0.0198	12.99		20.39	6.63	No sludge/septage removal costs included; Those costs reportedly very low over past few years.
STEP; Bioclere Drip Dispersal (TN-1)	$43.75	$0.0233	19.55		22.13	3.56	No sludge/septage removal costs included; Those costs reportedly very low over past few years.
Extended Aeration (TX-1)	$44.32	$0.0792	5.07	10.63			
STEP; RSF/RGF; Drip Dispersal (TN-2)	$46.38	$0.0278	3.82		10.4	10.01	No sludge/septage removal costs included; Those costs reportedly very low over past few years.
Extended Aeration (TX-31)	$205.82	$0.0912	3.66	9.69			
Recirculating Textile Media Filters (CO-6)	$208.83	$0.0517	11.24	7.87	2.47		
Extended aeration (TX-22)	$368.00	$0.1459	6.79				
Recirculating Textile Media Filters (CO-7)	$479.84	$0.1104	9.57	7.46			
Extended Aeration (TX-25)	$494.26	$0.5569	2.86	4.58			

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CO	1	34,000	Conv. Gravity Sewers; Rotating Biological Contactors (two); UV Disinfection.	Discharge	HOA (residential subdivision, store and restaurant)	Private	NR	$63	NR	NR	NR	NR	NR	In 2003, 55 connections were in use (130 commitments); Monthly User Charges were $63/month. A 2003 financial statement reported: Total income: $41,656; Total expenses: $42,472; Amount withheld in sewer reserve: $25,113; Total Connections: 130; Total Connections in Use: 55.35 Source: County records
CO	2	30,000	Conv. Gravity Sewers; Grinder pumps to treatment facilities; SBR; Cl Disinfection.	Discharge	Middle School with some overnight housing units	Private	NR	NA	$1700 +	NR	NR	NR	NR	Records indicate a 2001 service agreement with O&M company to make a service call to the WWTP 30 times per month for a fee of $1,700/month, & not including repairs costs. Source: County records
CO	3	35,000	Conv. Gravity Sewers; Package extended aeration WWTP; Polishing Filter (down-flow walnut shell filter); UV Disinfection.	Discharge	Residential homes and law enforcement center (with overnight capacity)	Private	NR	NR	$625 +	NR	NR	NR	NR	Owner contracts with operator for $7,500 per year plus $40/hour for each hour operator works on WWTF; Operator maintains and operates facilities, with owner responsible for providing all materials necessary for operation, maintenance and repair of the wastewater facilities. Source: Communications with operator.
CO	5	13,300	Septic tank pretreatment; Recirculating Sand/Gravel Filter; UV disinfection.	Discharge	Residential homes	Private	$301,000	NR	NR	NR	NR	NR	NR	Engineer's cost estimate (preliminary) was $301,000, including engineering & surveying; The engineering report estimated $15,000/year for the treatment system's costs, including O&M and debt service (does not report debt service period or details). Source: State/local records

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CO	6	5,300	Septic tank pretreatment; Recirculating Textile Media Filters; Stack feed Cl disinfection.	Discharge	Restaurant and Lodge	Private	$300,000	NA	$600 +	NR	$100	$125	NR	Capital costs estimated by operator, who also reported that cast-in-place concrete tanks added significantly to overall costs of system. For non-scheduled O&M, $45/hour. Grease traps, septic tanks are pumped once annually; Recirculation & secondary settling tanks pumped less often. Source: Communications with operator.
CO	7	5,000	Septic tank pretreatment; Recirculating Textile Media Filters; UV disinfection.	Discharge	Highway Rest Stop	Private	$700,000	NA	$300	NR	$71	$135	NR	State Project Manager recalls construction costs were approximately $700,000 (state project); Sludge pumping costs reportedly likely about $700-1000 annually, based on size of tank and pumping frequency. Source: Communications with design engineer.
CO	8	12,000	Septic tank pretreatment; Recirculating Sand/Gravel Filter; UV disinfection.	Discharge	Summer recreational camp	Private	$137,371	NA	NR	NR	NR	NR	NR	System is an upgrade. Unknown if reported capital costs include any collection and primary settling components. Source: Communications with design engineer and contractor.
CO	9	27,000	Septic tank pretreatment; Recirculating Sand/Gravel Filter; UV disinfection.	Discharge	Resort	Private	$400,000	NA	NR	NR	NR	NR	NR	Reported capital costs include: $150,000 for collection system; $250,000 for treatment system. Source: Communications with design engineer.
IN	1	10,645	Septic tanks (w/ effluent filters); Recirculating sand/gravel media filters.	Suburface Drip Dispersal	Residential Apartments	Private	$234,695	NR	NR	NR	NR	NR	NR	Loading rate to RSF 4.8 gpd/ft^2; Loading rate to drip field 0.3 gpd/ft^2. Source: ICCMODS and State records.
IN	2	19,080	Each home has a septic tank & recirculating media filter. STEP Collection system conveys to dispersal site.	Suburface Drip Dispersal	Residential Duplexes	Private	NR	$45 per living unit	NR	NR	NR	NR	NR	User charges are based on un-metered flows (each lot has a private well). Flow monitoring shows approx. 160 gpd/dwelling. Drip field loading rate 0.2 gpd/ft^2. Source: ICCMODS and State records.

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IN	NA	10,080	STEG collection system; Recirculating sand/gravel filter.	Suburface Drip Dispersal	Residential Subdivision	Private	$200,000	$50	NR	NR	NR	NR	NR	Monthly user charges reportedly cover both current/on-going management of the system and a fund for equipment repairs/replacements over time. Drip field loading rate 0.45 gpd/ft^2; RSF loading rate 3.9 gpd/ft^2. Source: ICCMODS & State records.
IN	NA	15,700	STEG collection system; Septic tanks; Elevated sand mound treatment.	Mound dispersal	Campground & Residential Living Units	Private	NR	$0.0451 per gallon	NR	NR	NR	NR	NR	Mound loading rate 0.3 gpd/ft$^{2.}$ Source: ICCMODS & State records.
IN	NA	7,200	STEP collection system; Septic tanks; Elevated sand mound treatment.	Mound dispersal	Residential Subdivision	Private	NR	Approx. $50 to $75	NR	NR	NR	NR	NR	Wastewater system is paid for via annual HOA dues, which vary (per connection) from $800 to $1500 per year, depending upon what needs to be done that year. Those dues cover everything from roads to lawn care, to lights, the wastewater system, etc. Loading rate to mounds 0.325 gpd/ft^2, based on design flow and mound area Source: ICCMODS & State records.
IN	NA	38 homes	STEG collection system & lift station to WWTP	NA	Community	Public	$289,900	NR	NR	NR	NR	NR	NR	STEG system installed to serve existing WWTP. Source: ICCMODS & State records.
IN	NA	15,000	STEP collection system; Septic tank pretreatment.	Subsurface Pressure Dispersal	Community	Public	$520,000	$35	NR	NR	NR	NR	NR	Capital costs include engineering. Monthly rates based on based on unmetered & avg. estimated flow of 4,000 gallons per month per dwelling unit (private wells); Loading rate to field 0.625 gpd/ft2, based on design flow and field area. Source: ICCMODS & State records.

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NC	2	27,600	Conventional gravity collection system; Septic tank pretreatment; Recirculating sand filter treatment; UV Disinfection.	LPP Subsurface dispersal	High School	Public	$280,000	NA	$1,360	NR	$280	$250	$750	O&M costs include: Routine weekly O&M; Annual jetting of LPP lines; and Generator maintenance/servicing. Lab costs include: Quarterly testing of monitoring wells, and effluent sampling. Repair costs include pump replacements (approx. $3,000 every 4 years).
NC	4	10,232	Septic tank pretreatment; Bioclere treatment system.	LPP Subsurface dispersal	Shopping Center	Private	NR	NA	$900	NR	$146	NR	NR	Reportedly average of 15 hours/month for O&M. Sludge costs based on 2006 data.
NC	6	25,000	Gravity sewers with grinder lift stations to plant; Extended aeration package plant; Rapid sand filters; Cl disinfection	LPP Subsurface dispersal	Condos and Marina	Private	See comment	NR	$4,000	NR	$3,500	NR	NR	WWTP capacity is 50,000. The plant has had many problems including structural ones, and it is estimated that replacement costs will be approximately $1,000,000. O&M costs include labor & chemicals ($1,500 labor, $2,500 chemicals).
NC	7	15,840	Gravity sewers with grinder lift stations to plant; Extended aeration package plant; Rapid sand filters; Cl disinfection	LPP Subsurface dispersal	Residential Subdivision	Private (HOA)	NR	NR	$1,550	NR	$250	NR	NR	Total 2007 budget for water/wastewater: $37,000 (Approx. 20% water/80% wastewater) O&M for both water/wastewater reportedly $17,000/year. Materials and labor vary year-to-year: $5,000 for 2007 Sludge removal: Approx. $3,000/year. Remainder of budget goes into fund for capital improvements. Service fees rolled into HOA fees.
NC	9	9,600	Conventional gravity collection; Septic tank pretreatment; Bioclere treatment system.	Conventional subsurface drainfield	Restaurant	Private	NR	NA	$480	NR	NR	NR	NR	Approximately 8 hours labor per month for O&M services amount ($480/month).

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NC	10	20,000	Conventional gravity sewer and lift station; Extended aeration package treatment plant with equalization; Tertiary sand filters; Tablet chlorinator with chlorine contact chamber.	LPP Subsurface dispersal	Residential Inn	Private	NR	NA	NR	NR	See Comment	See Comment	NR	It was reported that sludge hauling/removal, lab costs, etc. cost approximately $2,000-2,500 per month. It is unclear the extent of what is included in that amount.
NC	11	17,000	Conventional gravity sewer and lift station; Extended aeration package treatment plant with equalization; Tertiary sand filters.	LPP Subsurface dispersal	Outlet Mall	Private	NR	NA	$1,980	NR	$1,320	NR	NR	Reported O&M costs cover 33 hours of labor per month. Reported sludge hauling costs are based on 2006 figures.
NC	12	10,800	Conventional gravity collection; Septic tank pretreatment; Recirculating sand/gravel filter.	Pressure manifold to conventional subsurface trenches.	Rest Home	Private	$350,000	NA	NR	NR	NR	$167	NR	Reported O&M activities include periodic raking of filter surface, and recording elapsed time meters, cycle counters, etc.
NC	13	7,200	Conventional gravity collection; Septic tank pretreatment; Bioclere treatment system.	LPP Subsurface dispersal	Elementary School	Public	NR	NA	$780	NR	$1,280	NR	NR	O&M costs are for 13 hours of labor per month. Sludge hauling costs based on 2006 records.

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NC	15	11,400	Septic tanks & grease trap pretreatment; Recirculating sand/gravel filter; UV Disinfection.	LPP Subsurface dispersal	Elementary School	Public	$500,000 (See comment)	NA	See comments	See comment	$83	NR	NR	It was reported that, with respect to initial capital costs: ~$200,000 initial costs + ~$500,000 to replace the system due to almost immediate failures. Reported O&M activities: Approximately 1 hour per day checking system; Add 10 lbs of sodium bicarbonate per day, and 50 lbs to septic tank once weekly; UV lights changed once per year; Bushes trimmed once annually. Very little maintenance except for above, plus small plumbing items. Power costs "negligible". Source: School district staff.
NM	7	9,000	Septic Tanks; FAST Treatment Unit; Subsurface Wetland	Subsurface Drainfield	Mobile Home Park	Private	NR	$45.95 per month per connection	NR	NR	NR	NR	NR	The system's managing company reported a replacement system was estimated to be $800,000, which would cause user charges to likely increase to approx. $100/month. Source: Current Mgmt. Entity.
NM	9	30,000	Septic Tanks; RSF	Subsurface Drainfield	Middle School	Public	$213,435	NA	$167	NR	$433	$26	NR	Capital costs based on pre-construction est., incl. surveying/engnrg.; Not clear whether sludge pumping is based on sludge/scum level checks, or regularly scheduled trips. Source: State files/records.
OR	4	19,500	Septic tank pretreatment; RBC with methanol addition, and followed by anoxic unit process	Subsurface Drainfield	Mobile Home Park	Private	NR	NR	NR	$150	NR	NR	NR	Weekly cleaning and servicing reported for O&M activities. Source: State files/records.
OR	5	6,000	Septic tank pretreatment; Recirculating Sand/Gravel Filter	Subsurface Drainfield	Mobile Home Park	Private	NR	NR	$103	NR	NR	See Comment	NR	Monthly user charges shown cover lab costs. Source: System service provider.

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PA	1	40,000	1 Raw WW Lift Station + 1 Grinder Lift Station; Aerated Lagoons (4) treatment system.	Surface irrigation.	Residential community system	Public	NR	$44	$29	$1,958	NR	$819	NR	User charges include debt servicing & capital reserve. The town would reportedly need to charge about $63.50/month/user-LUE to cover all costs associated with this system. (Users of all township wastewater treatment systems charged same rate). $10,000 new user connection fee. Power costs for pump stations & treatment facilities. Laboratory costs include $7,500/year for quarterly well monitoring, plus 12 influent & 20 effluent sample collection & analyses per year. Total on-going costs reportedly $6.21 per 1,000 gallons treated. Source: Town operator and records.
TN	1	30,000	STEP Collection System; Bioclere Treatment System.	Subsurface Drip Dispersal	Rental Cabins	Privately Owned Public Utility	$300,000	$35.54 - $100 (see comments)	$1,127 (See Comment)	$159.57	See comment	NR	NR	Capital costs include engineering and construction of collection system (except for interceptor tanks at buildings). Residential customers pay flat rate statewide of $35.54 per month. Commercial (which will include this project) units pay a graduated rate based on flow ($75 without food, and $100 with food) for up to 300 gpd average and up. O&M reported as 2 hours per week total + travel time which was reported to average two hours per visit, though this was said to vary. Sludge pumping costs $250 per residential tank (1,500 gallons), but very few tanks pumped to date for these systems. Source: Private operations company

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TN	2	18,000	STEP Collection; Recirculating Sand/Gravel Treatment System.	Subsurface Drip Dispersal	Rental Cabins	Privately Owned Public Utility	$227,000	$35.54 - $100 (see comments)	$1,127 (See Comment)	$136.05	See comment	NR	NR	Capital costs include engineering and construction of collection system (except for interceptor tanks at buildings). Residential customers pay flat rate statewide of $35.54 per month. Commercial (which will include this project) units pay a graduated rate based on flow ($75 without food, and $100 with food) for up to 300 gpd average and up. O&M reported as 2 hours per week + travel time which was reported to average two hours per visit, though this was said to vary. Sludge pumping costs $250 per residential tank (1,500 gallons), but very few tanks pumped to date for these systems. Source: Private operations company
TN	3	15,750	STEP/STEG Collection System; Recirculating Sand/Gravel Treatment System.	Subsurface Drip Dispersal	Rental Cabins	Privately Owned Public Utility	$179,000	$35.54 - $100 (see comments)	$1,127 (See Comment)	$201.19	See comment	NR	NR	Capital costs include engineering and construction of collection system (except for interceptor tanks at buildings). Residential customers pay flat rate statewide of $35.54 per month. Commercial (which will include this project) units pay a graduated rate based on flow ($75 without food, and $100 with food) for up to 300 gpd average and up. O&M reported as 2 hours per week + travel time which was reported to average two hours per visit, though this was said to vary. Sludge pumping costs $250 per residential tank (1,500 gallons), but very few tanks pumped to date for these systems. Source: Private operations company

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TN	4	30,000	STEP/STEG Collection System; Bioclere Treatment System.	Subsurface Drip Dispersal	Rental Cabins	Privately Owned Public Utility	$300,000	$35.54 - $100 (see comments)	$1,127 (See Comment)	$214.71	See comment	NR	NR	Capital costs include engineering and construction of collection system (except for interceptor tanks at buildings). Residential customers pay flat rate statewide of $35.54 per month. Commercial (which will include this project) units pay a graduated rate based on flow ($75 without food, and $100 with food) for up to 300 gpd average and up. O&M reported as 2 hours per week + travel time which was reported to average two hours per visit, though this was said to vary. Sludge pumping costs $250 per residential tank (1,500 gallons), but very few tanks pumped to date for these systems. Source: Private operations company
TN	5	23,100	STEP/STEG Collection; Recirculating Sand/Gravel Treatment System.	Subsurface Drip Dispersal	Residential Subdivision	Privately Owned Public Utility	$144,000	$35.54 - $100 (see comments)	$1,127 (See Comment)	$170.16	See comment	NR	NR	Capital costs include engineering and construction of collection system (except for interceptor tanks at buildings). Residential customers pay flat rate statewide of $35.54 per month. Commercial (which will include this project) units pay a graduated rate based on flow ($75 without food, and $100 with food) for up to 300 gpd average and up. O&M reported as 40-60 hours per week + travel time which was reported to average two hours per visit, though this was said to vary. Sludge pumping costs $250 per residential tank (1,500 gallons), but very few tanks pumped to date for these systems. Source: Private operations company

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TX	1	12,000	Grinders; Extended Aeration; Cl Disinfection	Discharge	Community System	Private	$250,000	NR	$200	$400	$200	$150	NR	Estimated WWTP capital costs only, as provided by City Clerk; Power costs for WWTP, not including lift stations. Source: City staff.
TX	2	30,000	Grinders; Extended Aeration; Cl Disinfection	Discharge	Elementary & Secondary Schools	Private	NR	NA	$833.33	$518	$150	NR	NR	Source: School staff.
TX	3	40,000	Grinders; Aerated Lagoons; Clarifier; Slow Sand Filters; Cl Disinfection	Discharge	Recreation Parks (RV's and Campsites)	Public	$1,037,685	NA	$2,851	$1,716.00	NR	NR	NR	Capital costs include approx. 3 miles of collection lines, 5 lift stations & WWTP; Average power costs for FY's 2004-2006. Source: Park staff.
TX	5	49,000	Conventional gravity sewers; Grinders; Oxidation Ditch ("Racetrack") & Clarifiers; Cl Disinfection.	Discharge	Community System	Public	NR	$15	$1,825	$1,700	$83	$450	NR	Source: City staff.
TX	9	25,000	Extended aeration (package plant); Cl Disinfection	Discharge	Community System	Private	$290,000	NR	$1,850	$890	$575	See Comment	NR	Capital costs: $250,000 WWTP & $40,000 Grinder Lift Station; Power usage: $850/mo. WWTP & $40/mo. Lift station; O&M costs include lab services. Source: City staff.
TX	10	36,000	Imhoff tank; Oxidation ponds (1 aerated); Tertiary filter	Discharge	Community System	Public	NR	NR	$400	$125	NR	$150	NR	1998 capital costs for tertiary filter: $100,000; Costs for ponds & Imhoff not known (very old); Source: City staff.
TX	11	40,000	Oxidation Ditch & Clarifier; Cl Disinfection; Lift station to creek discharge.	Discharge	Community System	Private	NR	NR	$675	NR	NR	NR	NR	Source: Private operator.
TX	14	35,000	Grinder collection system; Extended aeration (package plant); Cl Disinfection.	Discharge	Recreation Parks (RV's and Campsites)	Public	NR	NA	$1,440	$301.36	NR	NR	$11,400	Repair costs reported for past 5 years. Source: Park staff.

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TX	15	8,000	Grinder collection system; Extended aeration (package plant); Cl Disinfection.	Discharge	Recreation Parks (RV's and Campsites)	Public	$377,625	NA	NR	NR	NR	NR	NR	2004 Capital costs for treatment system replacement. Source: Park staff.
TX	20	35,000	Grinder collection system; Extended Aeration (package plant); Sand Filtration; Cl Disinfection	Discharge	Recreation Parks (RV's and Campsites)	Public	$246,027	NA	$2,947	$119	$452	NR	$606	Capital costs for 1977-78 construction per files, including survey/engineering; Repair costs are for average of past 5 years. Source: Park staff.
TX	21	40,000	SBR; UV Disinfection	Discharge	Recreation Parks & Visitor's Center	Public	$1,200,000	NA	$4,592.50	$1,550			NR	2001 Capital costs for system; Staff report sludge not yet hauled from plant (possibly just accumulating in digester); Est. $200,000-400,000 to bring new plant into compliance, and correct problems. Source: Park staff.
TX	22	22,715	Grinder collection; system; Extended aeration (package plant); Cl Disinfection;	Spray Irrigation	Recreation Parks (RV's and Campsites)	Public	$508,949	NA	$2,825	$181	$130	$177	NR	Source: Park staff.
TX	23	5,000	Grinder Collection System; Aerated Lagoon; Stabilization Ponds;	Spray Irrigation	Recreation Parks (RV's and Campsites)	Public	$875,500 +	NA	$832	$227.61	NR	$30	See system summary document.	In 1976-77, approx. $269,000 in capital costs (may have been for most or all of system); $875,500 capital repairs/rehabilitation costs for system in 2005-2006 (incl. replacement of several lift stations, storage pond rehabilitation (sludge removal and liner replacement), sections of sewer line, valves, etc.; Power costs for FY 2004-2006; Sludge removed once in 29 years. Source: Park staff.

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TX	24	8,200	Septic tanks/effluent collection system	Low pressure dosed subsurface dispersal	Recreation Parks (RV's and Campsites); Amphitheatre.	Public	$211,500	NA	$1,473	NR	$400	NR		Capital costs include engineering (2000); Flow meter installed 2005 ($4,900); O&M staffing and sludge hauling costs shown are for multiple systems at park; Power usage for system very low (periodic activation of effluent pumps). Source: Park staff.
TX	25	7,311	Grinder collection system; Extended Aeration (package plant); Cl Disinfection.	Holding pond; Spray Irrigation.	Recreation Parks (RV's and Campsites)	Public	$474,000 +	NA	$2,828.26	$438	$625	$180	$219	Original EA WWTP & 2 lift stations constructed in 1971-1972 ($124,200). In 2001-2002 new/replacement WWTP & replacement of irrigation system distribution lines/headers (excluding collection and conveyance system(s) components) installed at a cost of approximately $474,000. [Approximately $221,200 for WWTP; Approx. $99,500 for pond; and remainder for piping & irrigation system improvements.] Costs do not include collection/conveyance system and lift stations. Source: Park staff.
TX	26	16,000	Grinder collection; system; Extended aeration (package plant); Cl Disinfection;	Evaporation Pond	Recreation Parks (RV's and Campsites)	Public	NR	NA	$1,147	$355	$42	$65	NR	Avg. sludge hauling costs during recent years; Source: Park staff.
TX	27	14,000	Grinder collection system; Facultative lagoon, stabilization/ holding pond.	Holding pond; Spray Irrigation.	Recreation Parks (RV's and Campsites)	Public	NR	NA	$2,925	NR	NR	NR	$3,000	Source: Park staff.
TX	28	7,500	Grinder collection system; Extended Aeration (package plant); Cl Disinfection.	Holding pond; Spray Irrigation.	Recreation Parks (RV's and Campsites)	Public	NR	NA	$1,047	$50	$20	NR	$2,243	Monthly sludge hauling costs based on 1 trip in past 3 years. Source: Park staff.

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TX	29	10,000	Grinder collection system; Extended Aeration (package plant); Cl Disinfection.	Holding pond; Spray Irrigation.	Recreation Parks (RV's and Campsites)	Public	NR	NA	$1,047	$60	NR	NR	$2,243	Source: Park staff.
TX	30	50,000	Grinder collection system; Extended Aeration (package plant); Cl Disinfection.	Subsurface Conventional Drainfield	Recreation Parks (RV's and Campsites)	Public	$252,253 (see comments)	NA	$1,800	$1,151	$170	NR	$4,218	Initial capital costs are 1970's figures, and were taken from old card files obtained for the system. Accuracy of those figures is unknown relative to system capital costs. Repair costs are based on reported repairs for recent 2-year period. $2,220/year was for wastewater treatment plant, and $1,998/yr. was for collection system. Source: Park staff.
TX	31	50,000	Grinder collection system; Extended Aeration (package plant); Cl Disinfection.	Holding pond; Spray Irrigation.	RecreationParks (RV's and Campsites)	Public	$1,704,614	NA	$3,700	$600	$200	$60	NR	Permitted flow shown is for maximum seasonal design capacity & flow; Reported initial capital costs are for 1996 improvements (lift stations and treatment plant --- and **not** including collection system & force main, and engineering/surveying). Power & lab costs estimated from other plants of same size operated by the same public entity in this region of the state. Source: Park staff.
TX	32	22,000	Grinder collection system; Oxidation ditch; Cl Disinfection.	Holding pond; Spray Irrigation.	RecreationParks (RV's and Campsites)	Public	$142,902	NA	$1,804	$249	NR	$43	$328	Estimated initial capital costs are based on archived 1976 project card file records, with accuracy unknown relative to what is included in those costs. Repair costs are average of most recent 3 years. Source: Park staff.

Table 5-1. Summary of Systems Cost Data Gathered.

State	System Number (Effluent Quality Data Tables)	Design/ Permitted Flow (gpd)	Treatment Method	Dispersal Method	Facilities Served	Public or Private Mgmt.	Initial Capital Costs	Monthly User Charges (If Appl.)	Average Estimated Monthly Operation/ Maintenance Labor & Materials Costs	Average Monthly Power Costs	Average Monthly Sludge Hauling Costs	Average Monthly Lab Costs	Average Annual Repair Costs	Comments
TX	33	40,000	Grinder collection system; Oxidation ditch; Cl Disinfection.	Holding pond; Spray Irrigation.	RecreationParks (RV's and Campsites)	Public	$259,822	NA	$1,804	$279	NR	$49	$312	Estimated initial capital costs are based on archived 1976 project card file records, with accuracy unknown relative to what is included in those costs. Repair costs are average of most recent 3 years. Source: Park staff.
TX	34	10,000	Grinder collection system; Extended Aeration (package plant); Cl Disinfection.	Holding pond; Spray Irrigation.	RecreationParks (RV's and Campsites)	Public	$170,281	NA	$2,579	$360	$98.15	NR	$2,510	Initial estimated costs from early 1970's, and taken from archived card file records. Power costs are for both treatment & irrigation systems ($330/month WWTP & $30/month irrigation system). Sludge hauling costs averaged for most recent 3-year period. Repair costs are averaged over most recent 5-year period. Source: Park staff.
TX	35	10,050	Grinder collection system; Extended Aeration (package plant); Cl Disinfection.	Holding pond; Spray Irrigation.	RecreationParks (RV's and Campsites)	Public	$340,561	NA	$2,579	$655	$200	NR	$2,359	Initial estimated costs from early 1970's, and taken from archived card file records. Power costs are for both treatment & irrigation systems ($633/month for WWTP & $22/month for irrigation system). Sludge hauling costs averaged for most recent 3-year period. Repair costs are averaged over most recent 5-year period. Source: Park staff.
NJ, PA, DE, CT, RI, & MA	NA	Systems 5,000 to 250,000 gpd	Approx. 60-70% MBR's; 20-30% SBR's; Approx. 5% Extended Aeration.	Low Pressure Dosing and Infiltration Ponds	Residential & Commercial Facilities	Private	NA	$80	NA	NA	NA	NA	NA	The monthly user charges include design/construction, operation and maintenance, repairs, and replacement(s) over time. Web-based controls and monitoring are used for unit processes Source: Design/Build/Operate Firm in New England

Table 5-1. Summary of Systems Cost Data Gathered.

State	System Number (Effluent Quality Data Tables)	Design/ Permitted Flow (gpd)	Treatment Method	Dispersal Method	Facilities Served	Public or Private Mgmt.	Initial Capital Costs	Monthly User Charges (If Appl.)	Average Estimated Monthly Operation/ Maintenance Labor & Materials Costs	Average Monthly Power Costs	Average Monthly Sludge Hauling Costs	Average Monthly Lab Costs	Average Annual Repair Costs	Comments
KY, TN, AL & GA	TN Systems No.'s 6 through 8	Systems up to 2 MGD	For systems with flows < 50,000 gpd, primarily fixed film (sand filters, geotextile filters, RBC's, trickling filters, wetlands etc.)	Primarily drip dispersal systems	Residential & Commercial Facilities	Private	NA	$40 - $50	NA	NA	NA	NA	NA	Typical user charges by this Level 4/5 RME are flat rate charges of $40 to $50 per month for residential properties. (Charges are generally flat rate for residential and commercial customers.) Monthly user charges cover operation and maintenance, repairs, and replacement(s) over time. Escrow accounts are established for replacement of system components. All billing and administration is handled through the home office. Source: SE U.S. Design/Build/Operate firm.

CHAPTER 6.0

DISCUSSION OF OVERALL FINDINGS AND OBSERVATIONS

6.1 Summary of Findings and Observations from Data Gathering Process

As discussed in Chapter 2.0, data obtained from regulatory sources was considered to be the most valuable to the study because of opportunities to review a wide range of system types, as well as differing methods and materials that may be used in different states and geographic conditions. While an effort was made to pick a range of systems types and sizes, the selection of specific systems for inclusion in the study was for the most part random, with the availability of data tending to be the biggest factor in the selection process. Regulators were very helpful however in assisting with the identification of examples of systems using a range of treatment categories, as well as flows and types of facilities served. The array of system types and sizes resulting from the approach taken for which data was subsequently gathered are believed to represent a good cross section of large/community scale decentralized wastewater systems in service today.

One of the principle obstacles encountered with data gathering for systems found (based on permitting file information) to be applicable to the study was that very few states were found to maintain electronic databases containing sufficient descriptive information about systems. Where databases were found to exist, most did not specify the collection method used; oftentimes the treatment process(es) was(were) only partially or minimally described; and most often there was little to no information about the details of the final dispersal method if some type of subsurface soil dispersal method was used. Gathering such detailed information entailed detailed reviews of specific systems files in permitting offices where access to those files was agreed to by regulatory staff, and so tended to limit greatly the numbers of systems for which such searches could be done. That in turn tended to limit the ability to clearly profile and categorize statistically valid numbers of systems for subsequent evaluations.

Because of the greater availability of data fro NPDES-permitted systems, many of these were included in the study from several states. A number of states require NPDES permits for surface irrigation systems, so data from on a fairly large number of those was obtained along with direct discharge systems. However, a limitation in the reliability of this data in terms of the ability to categorize these systems based on specific treatment and dispersal methods and other critical characteristics for comparative evaluations with other systems of the same type, was again the paucity of descriptive information available in these electronic database to make that possible.

The data gathering process therefore occurred at essentially two levels of activity: 1) compliance monitoring data gathering, and 2) detailed information gathering for a certain number of systems in each major U.S. region. Below are the numbers of systems in each region for which regulatory compliance monitoring data in some amount was obtained:

- New England States: <u>67 Systems</u>

- Mid-Atlantic States: 86 Systems
- Southeastern States: 112 Systems
- South-Southwestern States: 44 Systems
- Midwest and Upper Midwestern States: 5 Systems
- Central and Western Mountain States: 11 Systems
- West Coast States: 16 Systems.

Clearly the largest amount of systems data was found to be available for states in the eastern U.S. where more state regulatory authorities overseeing systems in the size range and types covered under this study tend to maintain electronic databases for those systems. Still in several eastern states it was necessary to review paper files individually, or request copies of scanned or PDF file documents for review. The least data was obtained for systems in the Midwest and Upper Midwestern States. While several of those states were in the process of developing databases to track systems, they were not yet available for use in this study.

An effort was made to obtain at least three years of monitoring data for systems, but due to a variety of factors this was often not possible. In some cases the results of only four to six sampling events might be found in an electronic or paper file for a system, although this data was still included in the datasets for each state. Most of the compliance monitoring data obtained has been provided in spreadsheet format in the appendices to this study report. In the case of Massachusetts, an Access database of information from the Groundwater Division of DEP in MA contains that "raw" data. Depending on specific permit requirements for systems, monitoring results tend to vary widely in terms of reported parameters. Very little nitrogen data, for example was available from some states while other states tended to place considerable attention on the tracking and enforcement of permit-specific nitrogen limits.

With respect to the more detailed data/information gathering for systems, the amount of descriptive, operational, cost and other information found to be available for systems (or which owners or operators were willing to share) varied greatly. Approximately 15-20 systems were targeted for detailed information gathering from each major U.S. region, but resultant numbers were less for some areas of the U.S. due to the obstacles encountered with obtaining that information. For those systems from which at least a certain amount of detailed information was obtained, the types and extent of that information differed greatly, largely depending on the owners'/operators' ability and/or willingness to provide requested information. Some amount detailed information that was considered somehow relevant to the system's overall performance was gathered for a total of about 75 systems nationwide. Such information might include for certain systems operation and maintenance practices; repairs over the past few years; certain observations relative to performance; and various types of cost information that was requested.

Some of that detailed information has been included as comments related to the data discussed for certain systems, with cost information obtained for all systems presented and discussed in Chapter 5.0. Summaries of some of the detailed information provided by engineers, operators and/or owners of systems are included in the appendices for that particular state, and identified by system number.

6.2 Summary of Discussions with Regulators and Systems Managers and Operators

In an effort to "flesh out" systems' performance information and observations from states and regions around the country that might not be evident from the data obtained, discussions with regulators and systems managers/operations companies were conducted to invite their comments. Discussions were held with staff from eleven state regulatory programs overseeing systems in the size range applicable to this study, and two regional operations companies that design/build and operate systems in the applicable size range. Section 3.3 of the report summarizes those discussions, along with some general performance-related comments from systems' operators around the U.S. that were communicated during the detailed systems' data-gathering process.

6.2.1 Highlights of Discussions with Regulators

In general, comments and observations from regulators across the country tended to support and be consistent with the data and information gathered for systems. The following summarizes observations communicated to project team members by key regulatory staff with state programs on the performance and issues of concern associated with large/community scale wastewater systems.

6.2.1.1 Highlights of Comments on Systems Design/Performance Issues and Considerations

- The types of collection systems that tended to be used predominantly in states varied greatly. In several states, the selection of collection systems used (e.g., STEP, STEG, conventional gravity, or other collection alternative) was reportedly based on the terrain along with cost and environmental considerations, whereas in other states it was reported that conventional gravity collection was used almost exclusively regardless of geophysical conditions or cost considerations.
- In some states where STEP/STEG systems were reportedly used some but not commonly used, problems with design review and permitting were reported. Those issues were reportedly due to uncertainties by regulators in those states about long term operation and maintenance considerations. In other states, STEP/STEG systems were reported to be by far the most common method of collection for large/community scale decentralized systems, with no particular concerns voiced about their use.
- Flow equalization and control was repeatedly mentioned by regulators across the U.S. as a major area of concern relative to systems designs and proper performance. Schools and hotels in particular were mentioned as observed to have problems when insufficient flow equalization was incorporated into designs.
- Regulators in some states expressed concern about the use of activated sludge treatment for large scale decentralized and small community systems due to operational vulnerabilities and instabilities, whereas in other states there appeared to be little active concern in that regard based on the numbers of activated sludge systems in those states. One state reported that activated sludge systems would not be permitted for systems with flows less than 30,000 gpd, and that for systems up to 100,000 gpd specific system approval would be needed. Aerated tank units are reportedly no longer used for single family residences in that state.
- Start-up problems were noted for seasonal use treatment facilities in one state where there tend to be a fairly large number of activated sludge-based package treatment systems.

- Regulators in several states commented that attached growth/fixed film systems seemed to perform the best for decentralized wastewater systems, with recirculating sand/gravel systems mentioned several times as a method of treatment that seemed to perform very well on average. However, RSF/RGFs were reported in one state as having problems with high nitrates in at least some cases where they served schools.
- Regulators in one state who seemed comfortable with the use of drip irrigation said that typically some type of attached growth/fixed film treatment process is used prior to subsurface drip dispersal in their state. If space is not a constraint for a site where drip dispersal is to be used, RSF/RGFs are typically employed, and otherwise AdvanTex or Bioclere treatment systems tend to be used.
- In some states concerns were expressed about, and limitations placed upon the use of subsurface drip irrigation systems, while in certain states such as Georgia and Tennessee no such concerns were expressed by regulators, presumably due to the successful use of that method of dispersal in those states.
- Problems with drip installations in rocky soils were noted by regulators in one state.
- Low pressure pipe dispersal was said in several states to be the preferred method of subsurface dispersal used for large/community scale decentralized systems. In at least one state, areal reductions (increased soil loading rates) were reportedly allowed for low pressure pipe/dosing systems, but not allowed for drip irrigation systems due to various concerns.
- The need was identified for establishing appropriate upper limits for soil loading rates allowed for subsurface drip irrigation systems.
- One state reported allowing up to 40% areal reductions for systems using chambers for subsurface effluent disposition.
- Sufficient UV disinfection systems' maintenance was reported to be a problem in some states.
- Concerns were expressed by regulators from at least two states about the reliability of telemetry systems.
- Regulators conveyed concerns voiced by the public about potential public and environmental health impacts associated with the use of spray/surface irrigation systems.
- Repeated interest was expressed by regulators in the development and application of more consistent and scientifically-based design approaches that better consider things such as subsurface fate and transport of pollutants, and use of appropriate hydraulic and organic loading rates based on the specific type of treatment system. Questions were raised about the long-term performance of systems loaded at design capacity. A specific question posed by one regulator about systems' performance and planning was "How well and how long will systems operate when loaded at design capacity?".
- The need was expressed by one regulator for there to be a better definition of "working" for systems, rather than reliance on the more superficial and easily monitored systems aspects. Another regulator commented that there seems to be a widespread absence of understanding and/or agreement about what "success" really means.
- Regulators from one state described a "disconnect" between soil scientists and engineers/designers. They expressed concern about the use of hydro-geological assessments to determine loading rates due to site heterogeneity, but said that they could be used to supplement a soil evaluation.

- Regulators from one state commented that very few engineers were able and willing to effectively design large/community scale decentralized systems, and that they tended to only design the more conventional types of systems with which they're familiar.

6.2.1.2 Highlights of Comments on Systems Management and Regulatory Oversight

- More effective systems management was repeatedly identified by regulators as a major challenge and problem with the performance of large/community scale decentralized systems.
- The lack of funding for these programs was also repeatedly cited as an obstacle for ensuring compliance and effective oversight of systems.
- Regulators from several states expressed a preference for RMEs to be public entities such as a city or county, though in some cases it might be an entity with a more vested interest such as a homeowners association or the developer.
- Problems were reported to occur when residents pay private developers directly for their wastewater service, if those services are not regulated by a public utility commission. The public complains that developers may be charging excessively. However, developers must also charge enough to pay for costs of service to ensure adequate care of the systems.
- Regulators from another state expressed concern about the long-term viability and presence of private utilities.
- Regulators indicated the need for greater involvement in systems operation by vendors/manufacturers of treatment systems.
- The more advanced treatment technologies were observed to need more "proactive" and "motivated" operation and maintenance than tends to be specified by vendors, and that operation and maintenance practices instead tend to be regulation-driven.
- Consideration to development density was mentioned by multiple regulators as needed with regard to the planning and permitting of systems.
- The need for renewable operating permits was stated.
- The need for better trained engineers, operators and installers was noted.
- Better oversight and quality control of systems installations was said to be needed.
- Systems costs were repeatedly mentioned as a concern for the public.
- A regulator commented that standards and policies (regulations) should be developed to accommodate and facilitate a systematic process of problem-solving and effective wastewater service implementation, rather than such solutions being limited by regulations.

6.2.2 Highlights of Discussions with Regional RMEs

Detailed information was obtained from two regional RMEs that design, build, and operate/manage decentralized wastewater systems including the size range covered in this study (Adenus and AWM). Both companies manage systems in multi-state regional areas, managing from 100-200 systems and employing from 75-200 persons. Representatives for each firm offered very valuable insights into a variety of performance and management aspects of large scale decentralized systems, as detailed in Chapter 3.0 of this report. Highlights from the information provided include the following:

- Both companies operate as Level IV or V RMEs (EPA's management model levels) for their customers.

- AWM operates mostly in the Northeastern U.S. and also Nevada, while Adenus operates in the Southeastern U.S. AWM-managed systems would therefore on average likely be subject to somewhat lower total nitrogen limits, especially for systems in Massachusetts and some other New England coastal states.
- Adenus charges flat rates of $40-50 per month per residential property, with commercial customers also charged a flat rate that depends on the specific system. Most of Adenus' systems use STEP/STEG collection systems, which they prefer exclusively, with most of their treatment systems employing fixed film processes (e.g., sand filters, geotextile filters, RBCs, and trickling filters), with some wetlands also used. Adenus reports that their use of fixed film/natural treatment processes results in easily operated and maintained systems with very low 40-year lift cycle costs.
- AWM bills its residential customers flat rate charges of $75-80 per property, and is exploring the use of flow metering as a part of rate setting, but this is not yet occurring.
- AWM uses mostly conventional gravity collection systems, though they prefer STEP systems from an O&M standpoint. They use mostly activated sludge-based treatment processes, with about 70% MBRs and about 20-30% SBRs, with extended aeration systems making up the balance. AWM reports that their MBR systems are easily automated and controlled remotely, and in general are less subject to upsets from changing influent characteristics.
- Neither firm is a vendor of proprietary treatment systems used for their projects, with the choice of systems types based on permitting requirements and site conditions.
- Most of Adenus' systems use mostly subsurface drip effluent dispersal, while AWM uses mostly low pressure dosing and infiltration ponds (along with some other methods associated with their reuse projects).
- Both firms use web-based telemetry monitoring and controls, however, because NPDES compliance reporting requires that samples be tested in a certified laboratory, AWM reports that it does not do remote monitoring of regulated parameters. Adenus monitors unit processes and does QA/QC verification through its in-house web-based telemetry monitoring.
- AWM maintains its records mostly in paper format, while Adenus' regulatory compliance records are mainly in electronic format.
- Both firms report very successful overall performance results with the systems they manage (and/or own), though AWM reports that "start-ups" can be a challenge for small plants. Addition of equalization capacity has proven to be of significant benefit to performance.

6.3 Summary of Findings and Observations Relative to Systems Performance

The analyses and evaluations that were done with the data gathered for systems in the various U.S. states/regions are not intended to provide a definitive assessment of their individual performance, but instead to elucidate trends with the performance of systems nationwide. Such trending may be helpful in guiding practices and for encouraging more investigation into certain observations for specific types of systems. A thorough evaluation of numerous individual systems is beyond the scope of this nationwide study, due to both time and budget constraints and the ability to gather sufficient information about specific systems to assure the accuracy of detailed analyses.

While it continued to be considered important to segregate data by state due to the variety of factors including permitting requirements and regional geographic and climatic variations, the few numbers of specific types/categories of systems in each state database repeatedly challenged the comparative systems' data analysis process. With often only two to three systems of a specific type, numerical and/or graphical averages of those combined systems datasets could easily be misinterpreted if the detailed data for each system was not reviewed and considered.

Of the 13 states from which data was gathered for systems, Massachusetts, Kentucky, and Virginia offered by far the largest bodies of data, and thus greater numbers of systems using certain treatment types for making performance comparisons. A limitation however was that only a limited amount of descriptive information was provided in the electronic databases for unit processes and systems configurations, thus raising questions at points in the analyses about the actual treatment processes used by certain systems. Of those three states, the large Massachusetts ACCESS database included the most information about each system.

Due to the relatively low total nitrogen limits for most of the Massachusetts systems studied (10 mg/L or less total nitrogen for most of those systems), data gathered from that state also offered a good opportunity to review systems for their nitrogen reduction capabilities. Of the 57 systems in the state for which total nitrogen data was obtained, 72% reportedly averaged 10 mg/L or less for the period reviewed, with about 29% of those having no excursions above 10 mg/L during that period. Of that 29%, two of the three treatment types used were fixed film/attached growth processes with anoxic components (RBCs and Biocleres), with the third being a proprietary hybrid fixed film and suspended growth treatment process (Amphidrome). The largest portion of the systems making up that 29% were RBCs having an anoxic/denitrification unit process component.

Of the 67 Massachusetts systems studied, ten reported averages of less than 5 mg/L for total nitrogen, with eight of those having an RBC in some process configuration. Only one of those ten systems consistently maintained effluent total nitrogen levels of less than 5 mg/L for the period reviewed, with influent TN levels averaging just under 40 mg/L. Those residential condominiums are served by a 44,700 gpd activated sludge plant with denitrification process treatment, and was averaging about 83% of its hydraulic loading capacity for the period reviewed. One other system that averaged less than 5 mg/L and exceeded that value for TN only once over the sampling events reviewed was an RBC system serving a retail store, and operating on average at just over half of its design hydraulic capacity.

Observations relative to total nitrogen treatment performance were consistent with the findings of two other studies done in recent years: A 2005 study done by Tighe and Bond for the Town of Yarmouth and Barnstable County Wastewater Implementation Committee in

Massachusetts (“Small Community-Size Wastewater Treatment Technologies Evaluation”); and a 2006 Massachusetts study done by Susan Peterson on the nitrogen removal capabilities of treatment facilities in larger flow categories than covered under this study, but still considered small community (“Nitrogen Removal in Small Flows Wastewater Facilities in Massachusetts”, Small Flows Quarterly, Vol. 7, No. 3, pages 29 to 35). The latter study found that most of the systems with flows less than 1 MGD had difficulty consistently meeting effluent TN limits of 10 mg/l, with most out of compliance 2 or 3 months of the year. That study also found that for systems with flows less than 50,000 GPD, meeting total nitrogen limits was more difficult, though still possible. The use of instrumentation that allowed for fine-tuning of operations to manage conditions remotely tended to help in that respect.

With regard to secondary treatment and nitrification performance, fixed film processes also tended to perform the best on average. It appeared that most of the processes reviewed were capable of treating applicable secondary treatment limits on average. Of the fixed film systems with the exception of those studied in Oregon, RSF/RGFs performed the best on average for BOD_5 reduction and nitrification as compared with the RBC’s and Bioclere systems reviewed within those respective states and datasets. Maximum reported values also tended to be significantly lower on average for RSF’s/RGF’s as compared with RBC’s or Biocleres, and as compared with activated sludge systems. Unfortunately those states with the largest data sets did not have significant numbers of RSF/RGFs for which performance could be compared in that state with activated sludge processes or even other fixed film system types. Regulators interviewed in states where large numbers of RSF/RGFs are used seemed very comfortable with their performance, at least with regard to meeting the applicable treatment limits in those states.

One of the fixed film processes that showed very mixed performance for the limited data available was the AdvanTex recirculating textile media filter systems, a relatively new proprietary treatment system as compared with others reviewed in this study. There were a very limited number of these systems of the size range applicable to the study and that had been in service for at least about five years. The number of sampling events for those systems tended to be fairly limited also. Those datasets would not therefore be considered sufficient for a meaningful evaluation of the performance of those systems. A number of larger AdvanTex systems have gone into service around the U.S. during the past few years, making possible a much better evaluation of their overall performance in upcoming years.

There was a relatively large amount of data from different regions for extended aeration plants, with some opportunity to review data for certain process variations with those systems. The use of sand/media filtration following extended aeration/activated sludge treatment plants appeared to reduce BOD_5 and TSS on average for at least one state (Texas), while also significantly reducing the maximum values reported for those parameters in that dataset. For the large Kentucky and Virginia databases however, there was again very little detailed descriptive information about the specific treatment processes used for those systems, and it is likely that some systems labeled simply “activated sludge” or “extended aeration” may also have a media polishing filter of some kind.

Schools and other seasonal use facilities tended to be the most challenging types of facilities to serve in terms of treatment performance. Consistent with regulators comments throughout the U.S., proper management was found to be critical to achieving good performance for those systems. Of the RSF’s/RGF’s and other fixed-film systems that were found to have relatively poor performance, a large percentage served schools or were located in relatively remote settings and likely receiving significantly fewer service calls and less overall attention. The use of remote sensing systems to monitor conditions remotely appears to be an important element of the regional management operations reviewed.

Flow equalization and/or flow control were repeatedly pointed to by both regulators and operators of systems as very important to achieving good performance for systems in the size range studied for this project. Sufficient flow equalization was deemed as particularly important for schools, hotels, and other seasonal use or systems with large flow fluctuations. Average measured flow for most of the systems studied tended to be less than 50% of the design capacity, which emphasizes one of the questions raised by a state regulator regarding the long-term performance of many of these systems if/when they are operating at their permitted flow limits. Data from Kentucky's 76 systems showed that privately owned and managed systems tended to operate closer to their design/permitted flows than public systems.

6.4 Summary of Observations from Cost Data

To the extent that public and private systems owners and operators were able and willing to share cost data, such information was gathered for systems across the U.S. Some amount of cost information was obtained for over 60 systems in eight states. Requests were made for both capital and operating costs, including where available at least about three years of sludge removal, power usage, laboratory services, and labor associated with on-going operation and maintenance activities. The information obtained is summarized in Table 5-1.

Capital cost information was obtained for 29 systems, with those found to range from $6.23 per gallon daily design flow up to $140 per gallon. Along with two AdvanTex treatment systems located in mountainous areas of Colorado, publicly owned activated sludge systems in Texas serving campgrounds and recreational areas tended to be the most costly per gallon of design flow. Eight of the nine publicly and privately owned systems for which capital costs were reported to be less than $20 per gallon design flow used some type of fixed film treatment process (six RSF/RGF's and two Biocleres). Costs for the two Bioclere systems and three of the seven RSF/RGF systems included drip dispersal fields and the STEP/STEG collection systems serving those facilities (excluding interceptor tanks serving residences or cabins). In general, the RSF/RGF's in the states of Tennessee, New Mexico and Colorado were the least expensive to construct per gallon of design flow.

When costs were based on averaged measured/reported daily flows, they ranged from a low of $18.31 to $494.26 per treated gallon. Based on reported flows, the publicly owned systems serving recreational areas in Texas were the most costly, and the Tennessee fixed film systems the least costly per treated gallon. Although the Tennessee systems are categorized as "public", they are owned by a privately owned public utility (publicly regulated utility).

In general publicly owned systems tended to cost more per design or treated gallon as compared with privately owned systems, with the exception of the five Tennessee design/build/operate systems (two Bioclere and three RSF/RGF systems, all STEP/STEG and subsurface drip dispersal). And costs per average measured daily flow tended to be much higher than cost per gallon of design flow, given that most systems were operating well below their design hydraulic capacities. That circumstance emphasizes the cost benefits of phasing-in wastewater systems as possible, if development and use of the system are expected to occur increasingly over extended periods of time. Flow and performance tracking of these systems can then become a basis for adding treatment capacity as needed, as tends to occur with larger centralized wastewater facilities.

Operation and maintenance costs were reviewed first by considering only the reported labor costs for routine/on-going operation and maintenance activities. The majority of that cost information obtained was for Texas systems, with most of those being for some type of activated sludge treatment process. However, sufficient information was obtained from elsewhere and for other treatment processes to offer some comparisons. The labor component of reported operations costs was charted for systems in Figures 5-3 and 5-4, and was found to vary by a factor of over 500, ranging from \$0.0007 to \$0.39. For monthly labor costs per gallon daily design flow, again the publicly owned and operated systems serving recreational campgrounds in Texas and the activated sludge systems tended to have the highest costs.

As with capital costs, substantially increased monthly operations labor costs per gallon were found when considering actual measured flows for systems. For just the labor category of operational expenses, monthly costs per gallon of average measured flow ranged from about \$0.0007 to just under \$6.00 per gallon. The system with the lowest costs was an aerated lagoon system serving a small community in Pennsylvania. The two systems having by far the highest per gallon costs were two oxidation ditch treatment systems serving publicly owned parks and recreational areas in Texas.

Sludge/septage removal cost data was obtained and reviewed for 26 of the systems studied, and for which data had been requested for at least three of the most recent years of the systems operation. Of those there were eight fixed film systems (either Biocleres or RSF/RGF's) with the remainder some type of activated sludge system. Based on system design flows, costs ranged from a low of \$0.0017 for a Texas publicly owned oxidation ditch (NPDES discharge system) up to a high of \$0.1778 for a North Carolina Bioclere system having final effluent dispersal in a subsurface dispersal field. No sludge removal cost data was available for any of the five Tennessee systems for which other cost data was available, although the operations manager of those systems reported that very few of the STEP/STEG interceptor or other tanks had required pumping over the past five years, and so sludge/septage removal costs for those systems were reportedly very low (based either on design or actual flows).

When reported sludge pumping costs were examined based on actual average measured flow, those costs ranged from \$0.0034 (for the same TX oxidation ditch system) to a high of \$0.9167 for a North Carolina extended aeration + filtration system with final effluent dispersal in a subsurface dispersal field. A potential trend was observed for this dataset that seemed of particular interest as related to systems management. It was generally observed that on average (for monthly sludge costs per average daily treated gallon flow), *less* money was spent on sludge removal for those treatment systems that included neither some type of filtration process nor were served by a subsurface effluent dispersal system. It therefore appeared that more was spent on sludge removal, and in general residuals management, for systems having some type of process that would tend to alert operators of problems: That is, treatment filter or dispersal field clogging concerns or problems. Other than that pattern observed for activated sludge plants that either did or did not include a subsequent filtration process, no particular cost pattern was observed for sludge removal costs for that category of treatment system

At least about three years of power usage cost data (most recent years) was obtained for a total of 29 systems, and is included in Table 5-1. In cases where reported costs were understood to include raw or grinder lift stations associated with those treatment plants/sites, those were identified as a part of the brief system descriptions included in Figure 5-11. Surface irrigation and subsurface effluent dispersal systems would both of course include effluent lift stations and associated power costs. Average monthly reported power costs were only charted based only on average daily measured flow for systems.

Power usage costs were found to range from a low of $0.0112/gallon (Texas extended aeration + filtration system, discharging to surface waters) to a high of $0.8111/gallon for a Texas oxidation ditch followed by surface irrigation of treated effluent. Systems were sorted and charted based on per gallon costs, with lower to higher costs shown from left to right. All of the systems on the right half of the chart (higher costs) used some type of extended aeration treatment process. Two publicly owned Texas extended aeration systems serving parks and recreational areas (one discharging and the other using surface irrigation) were inexplicably reporting the lowest power costs per gallon of flow for the charted systems. On balance however, the pond and fixed film/attached growth treatment processes tended to have significantly lower power usage costs per gallon of average daily flow.

When all monthly reported operation and maintenance costs were combined and charted based on gallon of average daily measured flow for systems, those costs ranged from $0.07/gallon for a Pennsylvania aerated lagoon system to a high of $4.25/gallon for one of the Texas extended aeration systems serving a publicly owned park/recreational area. Of those twenty systems, the most costly systems are either publicly owned or use an activated sludge treatment process. Of those more costly systems the only non-activated sludge treatment system is a publicly owned AdvanTex system serving a highway rest stop in Colorado.

In terms of nationwide trends from the combined cost and systems performance data, there was no evidence that performance for the size range of systems studied in this project correlates with the capital and operating expenses associated with those systems. It appeared in many cases that, in terms of initial capital costs of systems designed and built, the chosen type of system was often based on the familiarity of local engineers with certain types of systems, rather than on a long-term cost-effectiveness evaluation for the specific project. The Tennessee systems managed by RMEs (and owned by a utility) were an exception to that based on the performance data and the reported costs for those systems. Those systems appeared on average to be performing well for pretreatment prior to final treatment in subsurface drip dispersal systems, and all tended to be among the least costly of those evaluated nationwide.

The five fixed film Tennessee systems for which cost data was available appeared to have several important elements in common that were not typically observed elsewhere for the systems studied:

- ♦ Long-term cost assessments appeared to have been considered as a part of the planning process;
- ♦ The systems were designed, built and subsequently operated by the same company;
- ♦ The design/build/operate firm was not a vendor of any particular proprietary treatment system (which would tend to offer greater flexibility in system selection);
- ♦ The privately owned public utility that owns the systems is state-regulated.

The approach taken with the Tennessee systems seems to be consistent with a number of the conclusions voiced by a number of state regulators across the U.S., in terms of ways that systems performance and management could be improved in their state.

6.5 Conclusions and Recommendations from Study Findings

Much was learned from the systems identification and data gathering processes themselves about the state-of-the-industry for the size range of decentralized domestic wastewater systems studied in this project. The absence of cohesive electronic statewide databases in the U.S. containing not only detailed systems descriptions, but which would enable the tracking of systems' performance, was somewhat surprising given computing and electronic record-keeping capabilities today. Without such databanks, it is not realistically possible to obtain and review data for large enough populations of systems of certain types and sizes to offer statistically valid observations relative to performance trends. Such performance evaluations are needed to constantly update and inform the industry and help guide its practices. Therefore, a principal recommendation from this study is to encourage statewide regulatory programs throughout the U.S. to work alongside of counties and local programs to further develop and make systems information available electronically. Databases containing the following would be very useful for performance tracking:

- Owner information;
- Type of operation/management (public versus private);
- Permitted and/or design flow;
- Date the system went into service;
- Type of facilities served (e.g., church, youth/recreational camp, subdivision/homes, grocery store, etc.);
- Geographic location;
- Method of collection (e.g., STEP/STEG, conventional gravity, grinder pressure sewers, vacuum, etc.);
- Method(s) of treatment used, and specific configuration;
- Unit process sizing information (including loading rates, media type/sizing for filters, etc.);
- Method of final effluent disposition (discharge, surface application, or some method of subsurface dispersal);
- Performance/effluent quality requirements ("limits") and reporting requirements;
- All reported compliance monitoring data in spreadsheet format.

Other recommendations and areas of likely interest or concern to the decentralized wastewater industry that have come to the fore during the study based on both the data gathering process and the findings from that data gathered are summarized below.

- ♦ The development and implementation of technologies and approaches that can cost-effectively and reliably meet applicable nitrogen limits for systems appears badly needed. While data from some states such as Massachusetts indicate that some types of systems are capable of meeting relatively low total nitrogen limits on average, the reliability and consistency of those processes in doing so was observed to be an issue, as well as the costs associated with those systems.

- For decentralized systems to be evaluated alongside of centralized wastewater options for providing “permanent” wastewater service, system selection and design need to be based on long-term (30-40 year minimum) cost analyses that include the use of realistic capital and operations costs.

- Based on comments by regulators and observations from the data gathered, there appears to be a strong correlation between better overall management practices and good system performance. There is an opportunity for much better systems management by the decentralized wastewater industry through the use of telemetry systems and other state-of-the-art approaches, along with a higher level of long-term involvement by manufacturers to ensure that systems are performing as intended.

- Tracking of systems flows and performance could be used to support the phasing-in of wastewater systems infrastructure where possible so that more cost-effective service can be achieved. Legal/institutional obstacles to this should be reviewed for policy changes that would overcome current hurdles, such as funding programs requiring that all funds allocated to a community be expended during a period of time that would preclude such phasing if found to be appropriate.

- A principle comment repeatedly conveyed by regulators was the public’s concern about costs of systems and service, and is an area of great importance to the industry.

- The importance and need for integrating land use planning and appropriate densities with the planning of decentralized wastewater systems was voiced by regulators and the public (through discussions with regulators).

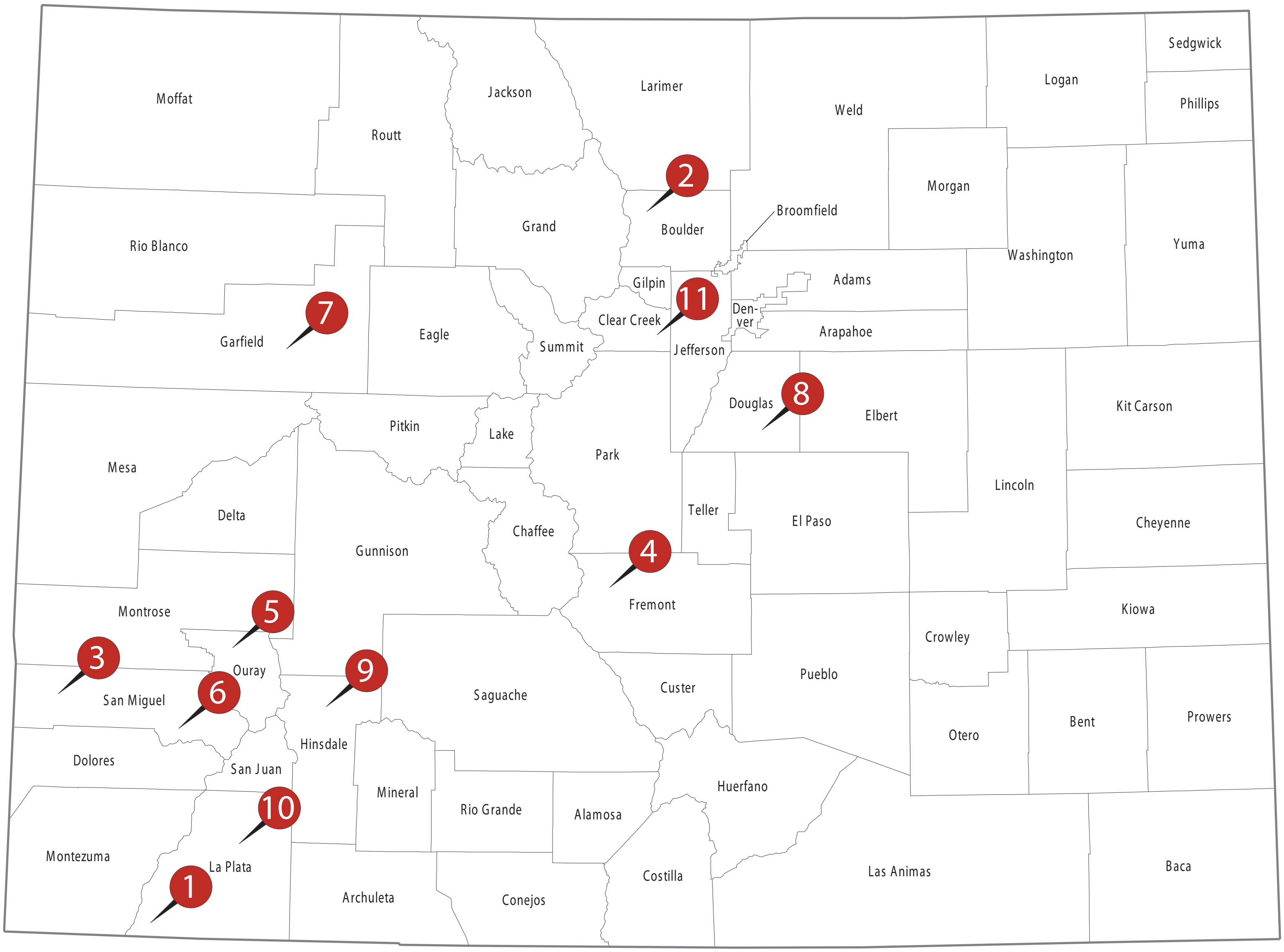
- A need was emphasized for the development and implementation of progressive billing/rate systems for large/community scale decentralized wastewater systems that can effectively accommodate “split systems”: That is, management programs that include both individual onsite systems and clustered/collective systems. Regardless of cost-effectiveness and the use of the most appropriate type of service for specific properties, the application of such split systems management programs was not allowed in some states despite an interest by regulators in those states for that to occur.

- Statewide education/training and certification is needed for engineers, installers and operators of systems that are based on up-to-date industry-accepted practices nationwide.

- The management of systems must be based on sound training and experience and appropriate to the specific processes, rather than on arbitrary timetables and regulatory requirements assigned to broad categories of systems, and which may not be applicable to specific systems.

APPENDICES

Appendix 1.A
By-County Locations of Colorado Systems



1. Durango County; Community System; Bar Screen, Parshall flume; Grit settling channels; Lift station; Mechanical fine screen; Equalization basin; Rotating Biological Contactors (Two); Final clarifier; UV disinfection (later changed to chlorine tablet disinfection); Tertiary clarification via a 12,000 gallon septic tank; Aerobic digester. Into service 1984; 34,000 gpd; Privately Managed.

2. Boulder County; School; Bar screen; Distribution box leading to two flow equalization tanks (@ 10,000 gallons); Grinder pumps; SBR (fine-bubble diffusers, floating decant system, and operating volume of 41,000 gallons); Sodium hypochlorite disinfection; Aerobic digester. Into service Early 1970's with plant changes made & online in 1997; Design flow 30,000 gpd; Privately Managed.

3.San Miguel County; Community System; Muffin Monster grinder; Grit chamber where lime is added for pH control; Parshall flume with ultrasonic level recorder; AeroMod package activated sludge plant; Polishing Filter (down-flow walnut shell filter); UV disinfection. Into service 1997; Design flow 35,000 gpd; Privately Managed.

4. Fremont County; Visitor Park with Food Service; Activated sludge/extended aeration treatment plant (Equalization Tank; Aeration Basin; Secondary Clarifier; Disinfection with calcium hypochlorite; Stream Discharge. Into service 1968, with upgrades/repairs between 1998 & 2001; Design flow 18,000 gpd; Privately Managed.

5. Ouray County; Residential Community System; Septic tank pretreatment; Recirculating Sand/Gravel Filter; UV Disinfection; Stream Discharge.

Into service 2001 (replaced older system); Design flow 13,300 gpd; Privately Managed.

6. San Miguel County; Lodge and Café; Septic tank pretreatment; Recirulating Textile Media Filters (AdvanTex); Stack-Feed Chlorination Disinfection; Stream
Discharge. Into service 003; Design flow 5,300 gpd; Privately Managed.

7. Garfield County; Highway Rest Stop; Septic tank pretreatment; Recirulating Textile Media Filters (AdvanTex); UV Disinfection; Stream Discharge. Into service 2002; Design flow 5,000 gpd; Privately Managed.

8. Douglas County; Recreational Camp; Septic tank pretreatment; Recirulating Sand/Gravel Filter; UV Disinfection; Stream Discharge. Into service 2001; Design flow
12,000 gpd; Privately Managed.

9. Hinsdale County; Resort; Septic tank pretreatment; Recirulating Sand/Gravel Filter; UV Disinfection; Stream Discharge. Into service 2000; Design flow 27,000 gpd; Privately Managed.

10. La Plata County; Summer Youth Camp; Septic tank pretreatment; Recirulating Sand/Gravel Filter; UV Disinfection; Stream Discharge in summer; Subsurface drainfield
dispersal in winter. Into service 2000; Design flow 20,000 gpd; Privately Managed.

11. Clear Creek County; Summer Camp; Septic tank pretreatment; Recirulating Sand/Gravel Filter; UV Disinfection; Stream Discharge. Into service 1994; Design flow
9,000 gpd; Privately Managed.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System CO-1

A. Basic Information

- State/County where system is located; La Plata County, Colorado
- Date permit was issued; 1984, and again in 1991. As of 2004, facility was continuing to operate under an "Administrative Extension".
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). October 1984.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Residential and commercial customers, including:
  - Store;
  - Café;
  - Townhomes;
  - 3 Subdivisions;
- Design Flow; 34,000 gallons per day.
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system; Approximately 1700 L.F. of 8-inch PVC gravity sewer lines.
  2. Pretreatment system (primary, secondary, disinfection); Bar screen; Parshall flume; Grit settling channels; Lift station; Mechanical fine screen; Equalization basin; Rotating Biological Contactor; Final clarifier; UV disinfection (later changed to chlorine tablet disinfection); Tertiary clarification via a 12,000 gallon septic tank; Aerobic digester.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Subsurface leach field.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). Appears to be state design criteria/requirements.
  (3) Loading rates to unit processes;
    - Flow Equalization: 9,000 gallon aerated basin (1-1/3 hp submersible pump);
    - RBC's: Two 12' diameter air driven units in series, 9,400 ft^2 each, with a loading rate of 2.26 gallons per day per ft^2 @ 50 degrees F;

- Secondary Clarification: One circular center feed clarifier, 10' diameter, 8'7" water depth, 5,280 gallons, Surface Overflow Rate (SOR) = 800 gpd/ft^2, and Detention = 1-4 hours;
- Disinfection: Two 5' UV lamps, 16,000 mv/sec., 30 gpm;
- Effluent Flow Measuring: 45 degree V-notch weir with recorder;
- Tertiary Clarification: 12,000 gallon septic tank;
- Leach Field: 600 ft^2, min. percolation rate = 15 min./inch.

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
(5) Soil/land loading rate.
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; Colorado Dept. of Health, Water Quality Control Division.
- Effluent quality limits (regulatory performance standards/limits for system);
  - BOD_5: 30 mg/L;
  - TSS: 30 mg/L;
  - Fecal Coliform: 2,000/4,000 Col./100 ml (30-day geometric mean/7-day geometric mean)
  - pH: 6-9
  - Oil & Grease: 10 mg/L (daily maximum).
- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Homeowner's association treatment plant operator; If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system?
- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers?
- Regularly scheduled operation and maintenance activities;
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
- Are there inspection or other "walkover" photos of the system that may be available to us? No.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees

- Connection fees (if applicable); Records from County indicate that in 2003, there were 55 connections in use (130 commitments); and Monthly User Charges were $63/month.
- Service fee structure and user fees charged
  A 2003 financial statement submitted to the County gave the following information:

Total income:	$41,656;
Total expenses:	$42,472;
Amount withheld in sewer reserve:	$25,113;
Total Connections:	130;
Total Connections in Use:	55.35

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System CO-2

A. Basic Information

- State/County where system is located; CO/Boulder Co.
- Date permit was issued; 1995
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). Early 70s package plant; conversion in 1995; start-up Dec. 1997

B. Design Information

Basic Design Information

- Type(s) of facilities served; Private middle/high school with some onsite housing facilties
- Design Flow; 30,000 gpd
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? Extended aeration package plant discharge to Boulder Creek installed in 1971. Removal of discharge to non-discharging lagoon unlined infiltration pond/basin in mid 70s. replacement/expansion of plant to SBR in 1995.
- Type of System
  1. Collection system: Conventional
  2. Pretreatment system (primary, secondary, disinfection) Bar screen (hand cleaned); Distribution box leading to two flow equalization tanks (@ 10,000 gallons); Pumping from equalization by two 7-hp non-clog grinder pumps; SBR (concrete box, fine-bubble diffusers, floating decant system, waste sludge pumping system to an aerobic digester, and operating volume of 41,000 gallons); Sodium hypochlorite disinfection; Aerobic digester.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) non-discharging infiltration lagoon/pond

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study); Influent BOD 196 mg/L (design basis).
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
  (5) Soil/land loading rate.
  (6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info;
- Effluent quality limits (regulatory performance standards/limits for system);
  - pH: 6.5-8.5;
  - Fecal coliform: 200/400 (30-day geometric mean/7-day geometric mean);
  - BOD_5 30/45 mg/L;
  - Nitrate + Nitrite: 10 mg/L (Daily max.);
  - Flow: 30,000 GPD.
- Are there periodic regulatory inspections of the system?

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system?
- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers?
- Regularly scheduled operation and maintenance activities;
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
- Are there inspection or other "walkover" photos of the system that may be available to us?

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Instantaneous recorder & totalizer - 4" Bailey Fisher Magnetic Meter – factory calibrated.
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Records show that in 1995 the operations service was charging $450 per month for the following:

- Four site visits per month for the following; Sample collection for one set of Influent & Effluent BOD, TSS, NH3-N and two MLSS samples per month; Sample preservation and chain of custody procedures; mileage to/from the lab; two trip reports and normal correspondence to the state; Laboratory costs by an outside lab were billed separately;
- Two un-scheduled trips per month, with additional trips to be billed at $50/hour, with a 2-hour minimum;
- Unlimited phone calls for guidance/questions.

Records show that in 2001 the operations company entered into an agreement with the school to perform a service call to the wastewater treatment plant 30 times per month. The monthly fee for this was $1700, and did not include repair costs.

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System CO-3

A. Basic Information

- State/County where system is located; CO/San Miguel
- Date permit was issued; 6/17/05; 10/12/99; 12/13/96
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). Appears to have gone into service in 1997.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Currently 50 residential homes, and a law enforcement center.
- Design Flow; 35,000 gpd. (current high average flow is approx. 7,000 gpd).
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system: Conventional collection system.
  2. Pretreatment system (primary, secondary, disinfection) Lift station; Muffin Monster grinder; grit chamber where lime is added for pH control; 3-inch parshall flume with ultrasonic level recorder; AeroMod package activated sludge plant (includes aerated selector tank; aeration tank with subsurface coarse bubble diffusers, unaerated overflow surge tank; W-bottom non-mechanical clarifier; and aerated digester); Polishing Filter (down-flow walnut shell filter); UV disinfection.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) NA. Discharge to San Miguel River.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
  (3) Loading rates to unit processes; (Design loading rates);
    - Aeration Basin: t_d = 24 hours (volume = 35,062 gallons);
    - Aerators: FTR = 1.5 lbs O_2/hp-hr; 249.4 cfm, coarse bubble diffusers; Capacity = 73 lbs. BOD_5/day.
    - Split Clarifier: Surface Area = 96 ft^2; SOR = 365 gal/day; t_d = 6.0 hrs.
    - Radial Filter: Surface Area = 9.2 ft^2;

- UV Disinfection: Volume = 59.7 gallons; t_d = 59 minutes; Capacity = 0.087 MGD peak flow.

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
(5) Soil/land loading rate. NA.
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; Colorado Dept. of Health; Water Quality Control Division; 4300 Cherry Creek Drive South; Denver, CO 80222-1530.
- Effluent quality limits (regulatory performance standards/limits for system);
  - TSS: 30/45 mg/L (30-day/7-day average);
  - BOD5: 30/45 mg/L (30-day/7-day average);
  - Fecal Coliform: 12,000/6,000 #/100 ml (7-day/30-day average);
  - Oil & Grease: 10 mg/L daily max.;
  - pH: 6.0-9.0 Standard units.
- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Privately owned (PUD). If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Treatment plant is operated by a licensed operator under contract with the PUD.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system?
- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers?
- Regularly scheduled operation and maintenance activities;
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
  - Operator reports that the skimmer & clarifier often plug up and need to be cleared of paper that makes it's way past the Muffin Monster;
  - The polishing filter (walnut shell filter) currently has a stuck valve needed for back-flushing the filter, and so the filter is being by-passed.

- Are there inspection or other "walkover" photos of the system that may be available to us?

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged

PUD contracts with the operator for $7,500 per year plus $40/hour for each hour the operator works on behalf of the Treatment Facility. The operator maintains and operators the facilities, with the PUD responsible for providing all materials necessary for operation, maintenance and repair of the facilities.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System CO-4

A. Basic Information

- State/County where system is located; CO/Freemont County
- Date permit was issued; 10/1/03;
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1968, with modifications/upgrades sometime between 1998 and 2001 (as result of an inspection that revealed certain deficiencies).

B. Design Information

Basic Design Information

- Type(s) of facilities served; Tourist/recreational park with restaurants/food service facilities, shopping, rides, park staff residences, etc. (30 permanent residents and 200 summer residents).
- Design Flow; 18,000 gpd.
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system: Conventional collection system.
  2. Pretreatment system (primary, secondary, disinfection. Activated sludge/extended aeration treatment plant (Equalization Tank; Aeration Basin; Secondary Clarifier, with return activated sludge lines back to aeration basin; Disinfection with calcium hypochlorite; Waste activated sludge storage tank).
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) NA. Discharge upstream of the stream's confluence with the Arkansas River.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). State design criteria.
  (3) Loading rates to unit processes;
    - Flow equalization basin: 9,100 gallons;
    - Blower: 5 hp; 125 cfm; 4 coarse bubble diffusers.
    - Grinder Transfer Pump: 2 hp, 26 gpm @ 12' TDH.

- Aeration Basin: 22'-6" x 11'-6"; 10'-6" side water depth; Volume = 2,700 ft^3, and 20,300 gallons; @ 18,000 gpd, 27 hours detention. Volumetric BOD_5 loading @ 397 mg/L = 22.1 lbs/day/1000ft^3.
- Blowers: (two) 9.7 bhp, 179 acfm; 14 coarse bubble diffusers.
- Secondary Clarifier: Surface area = 69 ft^2; Surface overflow rate = 260 gal/ft^2; Solids loading (MLSS = 4,500 mg/L, Q_{RAS} = 100%) = 19.6 lbs/ft^2/day.
- RAS/WAS pumps: 2 membrane, variable speed 1.5 hp pumps.
- Disinfection: 57 ft^3, with 30 minutes contact time.

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
(5) Soil/land loading rate. NA.
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; Colorado Dept. of Health; Water Quality Control Division; 4300 Cherry Creek Drive South; Denver, CO 80222-1530.
- Effluent quality limits (regulatory performance standards/limits for system);
    - TSS: 30/45 mg/L (30-day/7-day average);
    - BOD5: 30/45 mg/L (30-day/7-day average);
    - Fecal Coliform: 200/400 #/100 ml (30-day/7-day average);
    - Oil & Grease: 10 mg/L daily max.;
    - pH: 6.5-9.0 Standard units;
    - Total residual chlorine: 0.5 mg/L.
- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Privately owned (PUD). If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Treatment plant is operated by a licensed operator under contract with the Company.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system?
- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers?
- Regularly scheduled operation and maintenance activities;
- Man-hours per week or month routinely committed to O&M activities;

- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.); A June 2001 memorandum describes the following plant modifications/upgrades/repairs following a 1998 performance evaluation of the treatment plant:
  - Existing blowers were removed & replaced with 2 new blowers, each with 9.7 brake horsepower, and 179 cubic feet per minute capacity;
  - The entire existing air distribution piping and diffusers were removed & replaced with all new piping and coarse bubble diffusers. The new drop pipes were designed so that they could be removed to service the diffusers without turning the air system off or draining the basin.
  - The entire existing air lift return activated sludge/waste activated sludge (RAS/WAS) system, that was interconnected with the blowers, was removed and replaced with membrane type pumps with the capacity of returning or wasting flows from 4.5 gpm to 45 gpm. The prior air lift system was seen as a major factor limiting performance of the plant.

- Are there inspection or other "walkover" photos of the system that may be available to us?

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Palmer Bowlus 6" Bubble Tube, and for effluent, V-notch weir and ultrasonic meter/recorder.
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System CO-5

A. Basic Information

- State/County where system is located; Ouray County, Colorado
- Date permit was issued; 2000 and 2005.
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 2001

B. Design Information

Basic Design Information

- Type(s) of facilities served; Residential community system: Up to 65 single family homes.
- Design Flow; 13,300 gallons per day.
- History of systems on site: Is this system a replacement? Yes. The system replaced a lagoon treatment system. If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system;
  2. Pretreatment system (primary, secondary, disinfection); Septic tank pretreatment; Recirculating sand/gravel filter; UV disinfection; Discharge.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Discharge.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
    - Organic loading = 175 persons x 0.2 lbs/day/person = 35 lbs./day
    - Waste strength = 35 lbs/day/0.0133 MGD/8.34 = 316 mg/L BOD_5.

  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). Orenco Systems, Inc. design information is cited by the design engineer in the file.
  (3) Loading rates to unit processes;
    - Septic tank size of 25,000 gallons based on (1.5 peaking factor) x (1.25 day retention time) = 24,118 gallons. (75 gpd x 3.5 persons/home x 49 homes).
    - Per Orenco's recommendation, recirculation tank sized in accordance with daily average flow volume = 14,000.
    - Gravel filter sized for 5 gpd/ft^2 = 3990 ft^2; A 50' x 80' filter.
    - Two Sanitron Model S2400B UV disinfection units in series were specified, and sized to handle 15.4 gpm discharge (based on pumping rate to

recirculation tank and splitter valve maximum discharge rate of 20% of flow); The model specified is rated for up to 17 gpm and below 200 colonies/100 ml.

According to design engineer, system continues to operate at well below it's design capacity.

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
(5) Soil/land loading rate.
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; Colorado Dept. of Health, Water Quality Control Division.
- Effluent quality limits (regulatory performance standards/limits for system);
  - BOD_5: 30/45 mg/L (30/7 day average)
  - TSS: 75/110 mg/L (30/7 day average);
  - Fecal Coliform: 2,000/4,000 Col./100 ml (30-day geometric mean/7-day geometric mean)
  - pH: 6.5-9
  - Oil & Grease: 10 mg/L (daily maximum), and no visible sheen.
  - Total Residual Chlorine: Daily max of 0.5 mg/L.
- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Homeowner's association treatment plant operator; If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system?
- Is the system owned and managed by a public or private entity? Privately managed. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers?
- Regularly scheduled operation and maintenance activities;
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
- Are there inspection or other "walkover" photos of the system that may be available to us? No.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Badger 2000 Ultrasonic – 4" Manhole Flume.
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); The engineer's cost estimate (preliminary) was $301,000, including engineering & surveying.

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

  The engineering report estimated $15,000/year cost for the treatment system, including debt service (does not report debt service period).

Fees

- Connection fees (if applicable)
- Service fee structure and user fees charged

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System CO-6

A. Basic Information

- State/County where system is located; San Miguel County, Colorado
- Date permit was issued; 2000
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 2003

B. Design Information

Basic Design Information

- Type(s) of facilities served; Restaurant and lodge.
- Design Flow; Records/reports indicate both 4,800 and 8,540 gallons per day. ? The discrepancy may be in reported disagreement about acceptable loading rates to the AX20 units (Orenco appears to have requested using 25 gpd/ft2, and the CO Health Dept. has reportedly specified 15 gpd/ft2.)
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system;
  2. Pretreatment system (primary, secondary, disinfection);
     - Septic tank size of 9,000 gallons, and 9,000 secondary compartment;
     - Recirculation tank about 6,000 gallons, per Orenco's recommendation;
     - 16 AX20 treatment units;
     - Stack feed chlorination
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Discharge.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). Orenco Systems, Inc. .
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
  (5) Soil/land loading rate.
  (6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System CO-6

C. Regulatory Information

- Regulatory authority and contact info; Colorado Dept. of Health, Water Quality Control Division.
- Effluent quality limits (regulatory performance standards/limits for system);
  - BOD_5: 30/45 mg/L (30/7 day average)
  - TSS: 30/45 mg/L (30/7 day average);
  - Fecal Coliform: 6,000/12,000 Col./100 ml (30-day geometric mean/7-day geometric mean)
  - pH: 6.5-9
  - Total Residual Chlorine: Daily max of 0.5 mg/L.
- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Private treatment plant operator; If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers?
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system?
- Is the system owned and managed by a public or private entity? Privately managed. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers?
- Regularly scheduled operation and maintenance activities;
  - TCOMM panel check – approx. 1 hour per week;
  - 1/week check pH, temp. & Cl in effluent;
  - Total of 2 hours per week for above, plus 8 hours per month for DMR reporting;
  - Intercept grease tank out of lodge (cafeteria & 14 hotel rooms) gets pumped 1/year; Primary septic tank pumped 1/year, & occasionally the 2ndary settling and recirculation tank is pumped; (Pump total of 9,000 gallons, 1/year, plus grease);
- Man-hours per week or month routinely committed to O&M activities; See above.
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);

  Stacked feed tablet chlorinator has had problems according to the operator, and he much prefers UV disinfection.

- Are there inspection or other "walkover" photos of the system that may be available to us? No.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Flow measurement via Badger Ultrasonic electronic sensor & flow meter 4 inch "manhole flume". (Location of meter critical due to problems when it catches fecal matter, due to size of meter).
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); $300,000 estimated costs, per operator. [Note: Operator reported that the custom cast-in-place concrete tanks installed contributed greatly to overall costs of system.]

OM&M

- Hourly rates for personnel along with hours spent. $600 per month ($45/hour when hourly);
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
    - $125-150/month lab costs;
    - Intercept grease tank out of lodge (cafeteria & 14 hotel rooms), gets pumped 1/year; Primary septic tank pumped 1/year, & occasionally the 2ndary settling and recirculation tank; Pump 9,000 gallons, 1/year, plus grease**;** **$1200/year approx. for sludge/septage pumping.**

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System CO-7

A. Basic Information

- State/County where system is located; Garfield County, Colorado
- Date permit was issued; ?
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 2002

B. Design Information

Basic Design Information

- Type(s) of facilities served; Highway Rest Stop.
- Design Flow; 5,000 gpd.
- History of systems on site: Is this system a replacement? Yes. If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? System was designed to replace composting toilets, due to increased visitation at the rest stop. The site conditions were steep & rocky, and surface discharge of effluent was necessary, so advanced treatment was required.
- Type of System
  1. Collection system;
  2. Pretreatment system (primary, secondary, disinfection);
     - Septic tank size of 15,000 gallons (Old septic tank left in place as a pre-settling/grit removal tank);
     - Recirculation tank about 5,000 gallons, per Orenco's recommendation;
     - AX20 treatment units;
     - UV Disinfection.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Discharge.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). Orenco Systems, Inc. .
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
  (5) Soil/land loading rate.
  (6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; Colorado Dept. of Health, Water Quality Control Division.
- Effluent quality limits (regulatory performance standards/limits for system);
  - BOD_5:
  - TSS:
  - Fecal Coliform:
  - NH3 25 mg/L Max. monthly grab limit;
  - pH:
  - Total Residual Chlorine:
- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Private treatment plant operator; If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system?
- Is the system owned and managed by a public or private entity? Privately managed. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers?
- Regularly scheduled operation and maintenance activities;
  - Daily check and wiping of UV disinfection unit (tends to need solids wiped from it regularly);
  - Flush AX20's (manually operating pumps & flushing extra effluent through units);
  - Clean Biotube effluent filters twice seasonally (once at beginning & end of visitor season);
  - Pump old smaller (approx. 2000 gallon) septic tank twice seasonally – beginning & end of visitor season);
  - Flush field laterals once annually;
  - Sample collection weekly & monthly;
  - Data recording/reporting.
- Man-hours per week or month routinely committed to O&M activities; Average, including sample collection, approximately 5 hours/month.
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
  - UV unit needs regular attention to prevent solids accumulation & make sure continues to function properly;
  - Difficult to meet ammonia limits, due to temperature according to operator.

- Are there inspection or other "walkover" photos of the system that may be available to us? No.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet data.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); State Project Manager recalls that the construction costs were approximately $700,000.

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

O&M company currently charges approx. $300 monthly for labor;
Lab costs are estimated at $135 monthly;

Sludge pumping & power costs unknown, though sludge pumping costs likely approximately $700-1000 annually, based on size of tank and pumping frequency.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System CO-8

A. Basic Information

- State/County where system is located; Douglas County, Colorado
- Date permit was issued; ?
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 2001

B. Design Information

Basic Design Information

- Type(s) of facilities served; 240-person camp.
- Design Flow; 12,000 gpd
- History of systems on site: Is this system a replacement? Yes. If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system;
  2. Pretreatment system (primary, secondary, disinfection);
     - Grease trap (1,500 gallons)
     - Septic tank pretreatment with effluent filters (two 12,000 gallon tanks - 24,000 gallons total capacity).
     - Recirculation tank (12,000 gallons);
     - Recirculating sand filter (reportedly a 6,000 ft^2 filter);
     - UV disinfection (Sanitron).
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Discharge.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). Orenco Systems, Inc. .
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
  (5) Soil/land loading rate.
  (6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; Colorado Dept. of Health, Water Quality Control Division.
- Effluent quality limits (regulatory performance standards/limits for system);
  - BOD_5:
  - TSS:
  - Fecal Coliform:
  - pH:
  - Total Residual Chlorine:
- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Private treatment plant operator; If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system?
- Is the system owned and managed by a public or private entity? Privately managed. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers?
- Regularly scheduled operation and maintenance activities;
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
- Are there inspection or other "walkover" photos of the system that may be available to us?

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); $137,371.30 reported costs, per Contractor/Installer.

OM&M

- Hourly rates for personnel along with hours spent;
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System CO-9

A. Basic Information

- State/County where system is located; Hinsdale County, Colorado
- Date permit was issued; ?
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 2000

B. Design Information

Basic Design Information

- Type(s) of facilities served; Resort.
- Design Flow; 27,000 gpd.
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system;
  2. Pretreatment system (primary, secondary, disinfection); Recirculating sand filter treatment;
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Discharge.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). Orenco Systems, Inc. .
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
  (5) Soil/land loading rate.
  (6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; Colorado Dept. of Health, Water Quality Control Division.
- Effluent quality limits (regulatory performance standards/limits for system);
  - BOD_5:
  - TSS:

  - Fecal Coliform:
  - pH:
  - Total Residual Chlorine: .
- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Private treatment plant operator; If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system?
- Is the system owned and managed by a public or private entity? Privately managed. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers?
- Regularly scheduled operation and maintenance activities;
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
- Are there inspection or other "walkover" photos of the system that may be available to us? No.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); Collection system: $150,000; Treatment system: $250,000.

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System CO-10

A. Basic Information

- State/County where system is located; La Plata County, Colorado
- Date permit was issued; ?
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 2000

B. Design Information

Basic Design Information

- Type(s) of facilities served; Camp – summer use only.
- Design Flow; 20,000 gpd (summer);
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system;
  2. Pretreatment system (primary, secondary, disinfection);
  - Septic tank (25,000 gallon tank);
  - Recirculation tank (15,000 gallon tank);
  - Recirculating sand filter (4,000 ft2 filter);
  - UV disinfection (Sanitron);
  - Stream discharge.

  In summer months, RSF is off-line, and septic tank pretreatment followed by dispersal in subsurface drainfield is used (low flows).

  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Discharge in summer; subsurface dispersal field in non-summer months.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). Orenco Systems, Inc. .
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
  (5) Soil/land loading rate.

(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; Colorado Dept. of Health, Water Quality Control Division.
- Effluent quality limits (regulatory performance standards/limits for system);
    - BOD_5: 30 mg/L Monthly Avg.; 45 mg/L Max.
    - TSS: 30 mg/L Monthly Avg.; 45 mg/L Max.
    - Fecal Coliform: 6,000 Col./100 ml Avg.; 12,000 Col./100 ml. Max.
    - pH: 6.5-9.0 S.U.
    - Total Residual Chlorine: 0.5 mg/L
- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Private treatment plant operator; If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers?
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system?
- Is the system owned and managed by a public or private entity? Privately managed. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers?
- Regularly scheduled operation and maintenance activities;
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
- Are there inspection or other “walkover” photos of the system that may be available to us? No.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System CO-10

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System CO-11

A. Basic Information

- State/County where system is located; Clear Creek County, Colorado
- Date permit was issued; ?
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1994

B. Design Information

Basic Design Information

- Type(s) of facilities served; Camp.
- Design Flow; 9,000 gpd.
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system;
  2. Pretreatment system (primary, secondary, disinfection);
     - Septic tank size of ________ gallons;
     - Recirculation tank about _______ gallons;
     - Recirculating sand filter;
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system);

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). Orenco.
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
  (5) Soil/land loading rate.
  (6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; Colorado Dept. of Health, Water Quality Control Division.
- Effluent quality limits (regulatory performance standards/limits for system);
    - BOD_5: 30 mg/L Monthly Avg.; 45 mg/L Max.

- TSS: 30 mg/L Monthly Avg.; 45 mg/L Max.
- Fecal Coliform: 6,000 Col./100 ml Avg.; 12,000 Col./100 ml. Max.
- pH: 6.5-9.0 S.U.
- Total Residual Chlorine: 0.5 mg/L

- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Private treatment plant operator; If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system?
- Is the system owned and managed by a public or private entity? Privately managed. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers?
- Regularly scheduled operation and maintenance activities;
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
- Are there inspection or other "walkover" photos of the system that may be available to us? No.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System CO-12

A. Basic Information

- State/County where system is located; CO/Garfield
- Date permit was issued; 2-1-00/7-26-05
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). Appears to have gone in service in 2000

B. Design Information

Basic Design Information

- Type(s) of facilities served; Residential dwellings (56 single houses), tree farm, horse boarding
- Design Flow; 20,000 gpd
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? Appears to be new
- Type of System
  1. Collection system; Appears to be STEP or STEG
  2. Pretreatment system (primary, secondary, disinfection) Individual septic tanks into RSF, then UV
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) Discharge to Roaring Fork River

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following: No plans in file, but there are application forms that have some of this information that are being copied
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
  (5) Soil/land loading rate.
  (6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; Colorado Dept. of Health; Water Quality Control Division; 4300 Cherry Creek Drive South; Denver, CO 80222-1530.
- Effluent quality limits (regulatory performance standards/limits for system); in permit, being copied

- Are there periodic regulatory inspections of the system? Yes, inspection reports being copied

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Looks like private ownership with operator.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? No - surface discharge
- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers?
- Regularly scheduled operation and maintenance activities; in permit and application
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
- Are there inspection or other "walkover" photos of the system that may be available to us?

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.) – estimates in file, being copied

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System CO-13
NOTE: Reported Monitoring Data Obtained Jan. '08

A. Basic Information

- State/County where system is located; Park County, Colorado
- Date permit was issued; 2000
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1999

B. Design Information

Basic Design Information

- Type(s) of facilities served; Youth Camp.
- Design Flow; 18,000 gpd.
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system;
  2. Pretreatment system (primary, secondary, disinfection);
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Discharge.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). Orenco Systems, Inc. .
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
  (5) Soil/land loading rate.
  (6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; Colorado Dept. of Health, Water Quality Control Division.
- Effluent quality limits (regulatory performance standards/limits for system);
  - BOD_5:

   - TSS:
   - Fecal Coliform:
   - pH:
   - Total Residual Chlorine:
- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Private treatment plant operator; If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system?
- Is the system owned and managed by a public or private entity? Privately managed. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers?
- Regularly scheduled operation and maintenance activities;
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
- Are there inspection or other "walkover" photos of the system that may be available to us? No.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); $600,000 estimated costs, per design firm

OM&M

- Hourly rates for personnel along with hours spent.

- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
NO MONITORING DATA AVAILABLE FOR THIS SYSTEM
CO-ND1

A. Basic Information

- State/County where system is located; Saguache County, Colorado
- Date permit was issued; ?
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1996

B. Design Information

Basic Design Information

- Type(s) of facilities served; K-12 Public School.
- Design Flow; 6,000 gpd.
- History of systems on site: Is this system a replacement? Yes. If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? Shallow groundwater conditions at site.
- Type of System
  1. Collection system;
  2. Pretreatment system (primary, secondary, disinfection);
     - Septic tank (9,000 gallons)
     - Recirculation tank (4,500 gallons);
     - Recirculating sand filter (1,200 ft2 filter);
     - Mounded dispersal bed.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Mound dispersal, 6,500 ft2 of dispersal area.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). Orenco Systems, Inc. .
  (3) Loading rates to unit processes; 5 gpd/ft2 to RSF (design flow); 0.77 gpd/ft2 to mound dispersal bed/field.
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
  (5) Soil/land loading rate.
  (6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
NO MONITORING DATA AVAILABLE FOR THIS SYSTEM
CO-ND1

- Regulatory authority and contact info; Colorado Dept. of Health, Water Quality Control Division.
- Effluent quality limits (regulatory performance standards/limits for system);
  - BOD_5:
  - TSS:
  - Fecal Coliform:
  - pH:
  - Total Residual Chlorine:
- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Public (school district) treatment plant operator; If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. School district.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system?
- Is the system owned and managed by a public or private entity? Publicly managed. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers?
- Regularly scheduled operation and maintenance activities;
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
- Are there inspection or other “walkover” photos of the system that may be available to us?

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
NO MONITORING DATA AVAILABLE FOR THIS SYSTEM
CO-ND1

- Initial construction costs for the system (including design and permitting costs if available); Contractor recalls that constructed costs were approximately $80,000 to $100,000.

OM&M

- Hourly rates for personnel along with hours spent;
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
NO MONITORING DATA AVAILABLE FOR THIS SYSTEM
System CO-ND2

A. Basic Information

- State/County where system is located; CO/Kit Carson Co.
- Date permit was issued; General permit: 4-26-96; 5-23-2000; 9-9-05
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). Appears to have gone into service in 1996.

B. Design Information

Basic Design Information

- Type(s) of facilities served; 80 residential units, four commercial units, one school
- Design Flow; 21,200 gpd
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system; Conventional
  2. Pretreatment system (primary, secondary, disinfection); Lagoon
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) Non-discharge (evaporation).

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following: in permit application which will be copied
  - (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  - (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
  - (3) Loading rates to unit processes;
  - (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
  - (5) Soil/land loading rate.
  - (6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; Colorado Dept. of Health; Water Quality Control Division; 4300 Cherry Creek Drive South; Denver, CO 80222-1530.
- Effluent quality limits (regulatory performance standards/limits for system);
- Are there periodic regulatory inspections of the system?

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
NO MONITORING DATA AVAILABLE FOR THIS SYSTEM
System CO-ND2

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
  Public/town.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system?
- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers?
- Regularly scheduled operation and maintenance activities;
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);

    In one inspection report, it was noted that trees & weeds needed to be cleaned from in and around the lagoon, to protect the integrity of the liner. It was also noted that the integrity of the liner needed to be confirmed in terms of identifying any adverse impacts to groundwater (Ogallala Aquifer, 150' deep at that location), and the town was asked to send a summary of the flow monitoring data from drinking water wells during the winter months.
- Are there inspection or other "walkover" photos of the system that may be available to us? There is one qualitative inspection report which is being copied.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.

- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees
- Connection fees (if applicable);
- Service fee structure and user fees charged

Appendix 2.A
By-County Locations of Florida Systems

1. Holmes County, Florida; Extended Aeration (Activated Sludge); Filtration; Discharge: Approximate Start-up Date: 1993.; Design flow 25,000 gpd; Publicly Managed.

2. Putnam County, Florida; Extended Aeration (Activated Sludge); Anoxic Zone with recirculation; Filtration (3 sand filters @ 21 ft2); Discharge: Permit Issuance Date: 2001. Design flow 36,000 gpd; Privately Managed.

3. St. Johns County, Florida; Extended Aeration (Activated Sludge); Discharge. Permit issued 2003. Design flow 7,500 gpd; Privately Managed.

4. Putnam County, Florida; Extended Aeration (Activated Sludge); Chlorination; Dechlorination; Discharge; Permit Issued 2003; Design flow 5,000 gpd; Publicly Managed.

5. Taylor County, Florida; Extended Aeration (Activated Sludge); Chlorination; Dechlorination; Discharge. Design Flow 5,000 gpd; Privately Managed.

6. Palm Beach County, Florida; Extended Aeration (Activated Sludge); Discharge to Inland Waterway. Initial permit 1975. Design flow 10,000 gpd. Privately Managed.

7. Palm Beach County, Florida; Extended Aeration (Activated Sludge); Discharge to Intercoastal Waterway. Initial permit Date 1975. Design flow 15,000 gpd; Privately Managed.

8. Palm Beach County, Florida; Extended Aeration (Activated Sludge); Discharge to Intercoastal Waterway. Initial permit Date 2002. Design flow 15,000 gpd; Privately Managed.

9. Duval County, Florida; Extended Aeration (Activated Sludge); Chlorination; Discharge to river. Initial permit Date 2001. Design flow 20,000 gpd; Privately Managed.

10. Nassau County, Florida; Activated Sludge, Contact Stabilization; Chlorination; Discharge to Constructed Wetland. Initial permit Date 1996. Design Flow 23,000 gpd; Privately Managed.

11. Putnam County, Florida; Extended Aeration (Activated Sludge); Anoxic Tank; Reaeration Tank; 2 Secondary Clarifiers; Chlorination; Rapid infiltation (percolation ponds). Into Service Approx. 1988. Design flow 7,000 gpd; Privately Managed.

12. Columbia County, Florida; Activated Sludge - Bardenpho Process [Influent pumping station; Dual static screens; 3 surge tanks; Two pre-anoxic basins; Two aeration basins; Two post-anoxic basins; One post-aeration basin; 3 secondary clarifiers; One aerobic digester; Two sand filters; Two clear wells; Two Chlorine contact chambers (Sodium Hypochlorite)]; One effluent dosing tank; Effluent is discharged by gravity to one of two drain fields. Design flow 20,000 gpd; Publicly Managed.

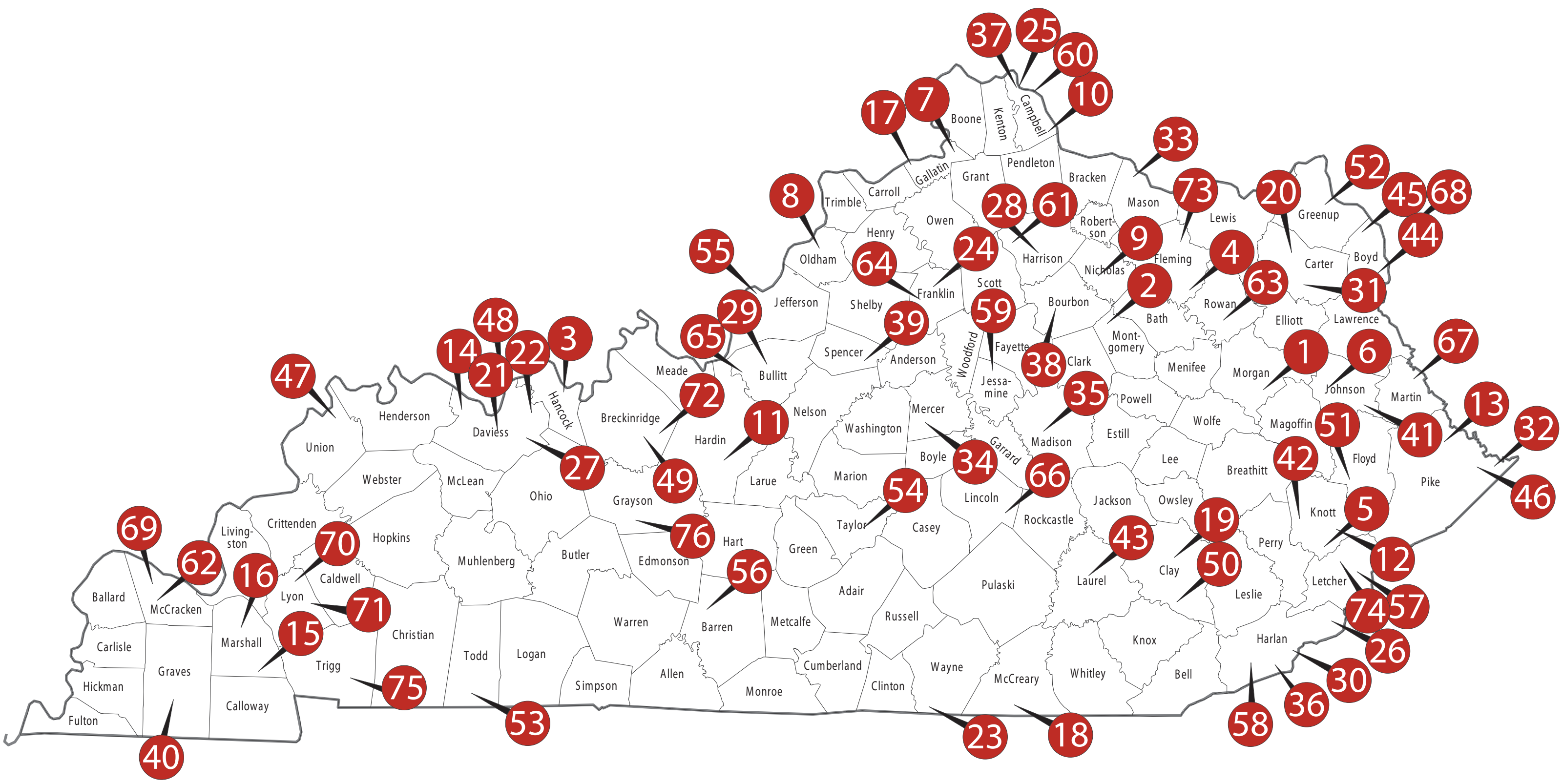
13. Columbia County, Florida; Activated Sludge - Extended Aeration System One influent screen; Four Surge tanks; Three Anoxic tanks; Seven Aeration tanks; Two Secondary Clarifiers; Four Filters; Two Chlorine contact tanks; and Three Aerobic digesters]; Effluent has previously been discharged to a Rapid Infiltation Bed, but is now permitted for a new Surface Irrigation System (26.5 acres); (Percolation/Infiltation ponds will be used as back-up); Design flow 20,000 gpd; Publicly Managed.

Appendix 3.A
By-County Locations of Indiana Systems

1. Owen County, Indian; Cluster system with Septic tank pretreatment; Recirculating Sand Filter; Drip Irrigation field. Into service 1999; Permitted flow 10,645 gpd; Privately Managed; Residential apartments.

2. Lake County, Indiana; Septic Tanks pretreatment; Recirculating Media Filters at Each Residence; Treated Effluent Collection/Conveyance System; Drip Irrigation Field; Into service 2001; Permitted flow 19,080 gpd; Privately managed; Residential duplexes

Appendix 4.A
By-County Locations of Kentucky Systems



1. Morgan County; Grinding/Comminutors, Activated Sludge; Discharge System. Permitted 12/19/1975; Permitted flow 5,000 gpd; Privately Managed; Youth Camp.

2. Montgomery County; Grinding/Comminutors, Activated Sludge, Chlorination; Discharge System. Permitted 5/6/1985; Permitted flow 5,000 gpd; Privately Managed; Children's Home/Day Care.

3. Hancock County; Grinding/Comminutors, Activated Sludge, Chlorination; Discharge System. Permitted 5/9/1987; Permitted flow 5,000 gpd; Privately Managed; Mobile Home Park.

4. Fleming County; Grinding/Comminutors, Activated Sludge, Chlorination; Discharge System. Permitted 7/20/1984; Permitted flow 7,500 gpd; Publicly Managed; Recreation Area/Campground.

5. Knott County; Grinding/Comminutors, Activated Sludge, Chlorination; Discharge System. Permitted 7/30/1986; Permitted flow 10,000 gpd; Privately Managed; Nursing Home.

6. Johnson County; Grinding/Comminutors, Activated Sludge, Chlorination; Discharge System. Permitted 10/29/1984; Permitted flow 13,000 gpd; Privately Managed; Subdivision.

7. Gallatin County; Activated Sludge, Chlorination; Discharge System. Permitted 7/26/1988; Permitted flow 6,000 gpd; Privately managed; Campground.

8. Oldham County; Activated Sludge, Chlorination; Discharge System. Permitted 11/21/1984; Permitted flow 7,500 gpd; Privately managed; Apartments/Condos/ Townhouses.

9. Nicholas County; Activated Sludge, Chlorination; Discharge System. Permitted 9/29/1992; Permitted flow 7,500 gpd; Privately managed; Mobile Home Park.

10. Campbell County; Activated Sludge, Chlorination; Discharge System. Permitted 11/19/1997; Permitted flow 10,000 gpd; Privately managed; Subdivision.

11. Hardin County; Grinding/Comminutors, Activated Sludge, Chlorination; Discharge System. Permitted 3/12/1976; Permitted flow 15,000 gpd; Privately managed; Truck Stop.

12. Knott County; Grinding/Comminutors, Activated Sludge, Chlorination; Discharge System. Permitted 9/26/1975; Permitted flow 25,000 gpd; Publicly Managed; Recreation Area/ Campground.

13. Pike County; Grinding/Comminutors, Activated Sludge, Chlorination; Discharge System. Permitted 8/19/1980; Permitted flow 24,000 gpd; Privately managed; Apartments/Condos/ Townhouses.

14. Daviess County; Grease Removal, Screening, Grinding/Comminutors, Activated Sludge, Chlorination; Discharge System. Permitted 12/18/1985; Permitted flow 12,000 gpd; Privately managed; Church and School.

15. Marshall County; Grease Removal, Screening, Grinding/Comminutors, Activated Sludge, Chlorination; Discharge System. Permitted 8/19/1980; Permitted flow 19,500 gpd; Privately managed; Motel/Resort.

16. Marshall County; Activated Sludge Treatment with Chlorination; Discharge System. Permit issued 4/18/1988; Permitted flow 5,000 gpd; Privately managed; Campground.

17. Gallatin County; Activated Sludge Treatment with Chlorination; Discharge System. Permit issued 10/29/1984; Permitted flow 30,000 gpd; Privately managed; Subdivision.

18. McCreary County; Screening, Activated Sludge, Chlorination; Discharge System. Permitted 12/19/1975; Permitted flow 5,000 gpd; Privately managed; Nursing Home.

19. Clay County; Activated Sludge, Chlorination; Discharge System. Permitted 2/29/1996; Permitted flow 29,500 gpd; Publicly managed; School.

20. Carter County; Activated Sludge Treatment with Chlorination; Discharge System. Permit issued 8/19/1980; Permitted flow 15,000 gpd; Publicly managed; Recreation Area/Campground.

21. Daviess County; Screening, Activated Sludge, Chlorination; Discharge System. Permit issued 9/13/1983; Permitted flow 5,000 gpd; Privately managed; Campground.

22. Daviess County; Screening, Activated Sludge, Chlorination; Discharge System; Permit issued 10/13/1978; Permitted flow 5,000 gpd; Privately managed; Mobile Home Park.

23. Wayne County; Screening, Activated Sludge, Chlorination; Discharge System. Permit issued 11/21/1984; Permitted flow 10,000 gpd; Privately Managed; Youth Camp.

24. Franklin County; Screening, Activated Sludge, Chlorination; Discharge System. Permit issued 11/21/1984; Permitted flow 10,500 gpd; Privately managed; Mobile Home Park.

25. Campbell County; Screening, Activated Sludge, Chlorination; Discharge System. Permit issued 5/12/1976; Permitted flow 40,000 gpd; Privately managed; Subdivision.

26. Harlan County; Screening, Grinders/Comminutors, Activated Sludge, Chlorination; Discharge System. Permit issued 7/5/1989; Permitted flow 5,000 gpd; Privately managed; Motel/Resort.

27. Daviess County; Screening, Grinders/Comminutors, Activated Sludge, Chlorination; Discharge System. Permit issued 6/30/1975; Permitted flow 6,000 gpd; Privately managed; Mobile Home Park.

28. Harrison County; Screening, Grinding/Comminutors, Activated Sludge, Chlorination; Discharge System. Permit issued 11/7/1984; Permitted flow 12,000 gpd; Privately managed; Mobile Home Park.

29. Bullitt County; Screening, Grinding/Comminutors, Activated Sludge, Chlorination; Discharge System. Permit issued 1/11/1985; Permitted flow 12,000 gpd; Privately managed; Subdivision.

30. Harlan County; Screening, Grinding/Comminutors, Activated Sludge, Chlorination; Discharge System. Permit issued 5/9/1975; Permitted flow 12,000 gpd; Publicly Managed; RecreationArea/ Campground.

31. Carter County; Screening, Grinding/Comminutors, Activated Sludge, Chlorination; Discharge System. Permit issued 8/19/1980; Permitted flow 15,000 gpd; Publicly managed; Recreation Area/ Campground.

32. Pike County; Screening, Grinding/Comminutors, Activated Sludge, Chlorination; Discharge System. Permit issued 3/30/1990; Permitted flow 15,000 gpd; Privately managed; Apartments/Condos/ Townhouses.

33. Mason County; Screening, Grinding/Comminutors, Activated Sludge, Chlorination; Discharge System. Permit issued 8/23/1994; Permitted flow 15,000 gpd; Privately managed; Subdivision.

34. Mercer County; Screening, Grinding/Comminutors, Activated Sludge, Chlorination; Discharge System. Permit issued 11/18/1986; Permitted flow 26,000 gpd; Privately managed; Apartments/Condos/Townhouses.

35. Madison County; Screening, Grinding/Comminutors, Activated Sludge, Chlorination; Discharge System. Permit issued 9/26/1980; Permitted flow 30,000 gpd; Publicly managed; Subdivision.

36. Harlan County; Screening, Grinding/Comminutors, Activated Sludge, Chlorination; Discharge System. Permit issued 4/5/1985; Permitted flow 30,000 gpd; Privately managed; Motel/Resort.

37. Campbell County; Grinding/Comminutors, Activated Sludge, Sedimentation, Chlorination; Discharge System. Permitted 11/21/1984; Permitted flow 5,000 gpd; Privately managed; Apartments/Condos/Townhouses.

38. Bourbon County; Equalization, Activated Sludge, Post-Aeration Treatment, with Chlorination; Discharge System. Permitted 11/7/1984; Permitted flow 20,000 gpd; Privately managed; Mobile Home Park.

39. Spencer County; Equalization, Activated Sludge, Sedimentation, Post-Aeration, with Chlorination; Discharge System. Permitted 7/26/1988; Permitted flow 25,000 gpd; Privately managed; Motel/Resort.

40. Graves County; Screening, Grinding/Comminutors, Activated Sludge, Intermittent Sand Filters, Chlorination; Discharge System. Permit issued 4/24/1981; Permitted flow 6,000 gpd; Privately managed; Subdivision.

41. Johnson County; Grinding/Comminutors, Activated Sludge, Intermittent Sand Filters, Chlorination; Discharge System. Permitted 3/26/1987; Permitted flow 5,000 gpd; Privately managed; Subdivision.

42. Knott County; Screening, Grinding/Comminutors, Activated Sludge, Intermittent Sand Filters, Chlorination; Discharge System. Permit issued 9/6/1974; Permitted flow 45,000 gpd; Publicly managed; Recreation Area/Campground.

43. Laurel County; Screening, Grinding/Comminutors, Activated Sludge, Intermittent Sand Filters, Chlorination, Aerobic Digestion (Sludge); Discharge System. Permit issued 11/5/1979; Permitted flow 31,000 gpd; Publicly managed; Recreation Area/Campground.

44. Boyd County; Screening, Grinding/Comminutors, Activated Sludge, Intermittent Sand Filtration, Chlorination; Discharge System. Permit issued 8/20/1984; Permitted flow 9,000 gpd; Privately managed; Recreation Area/Campground.

45. Boyd County; Screening, Grinders/Comminutors, Activated Sludge, Intermittent Sand Filters, Post-Aeration, Chlorination; Discharge System. Permit issued 12/19/1984; Permitted flow 5,000 gpd; Privately managed; Apartments/Condos/Townhouses.

46. Pike County; Screening, Activated Sludge, Intermittent Sand Filtration, Chlorination; Discharge System. Permitted 10/19/1989; Permitted flow 9,000 gpd; Privately managed; Mobile Home Park.

47. Union County; Screening, Grinding/Comminutors, Equalization, Activated Sludge, Intermittent Sand Filters, Post-Aeration, Chlorination; Discharge System. Permit issued 8/19/1980; Permitted flow 34,000 gpd; Publicly managed; School.

48. Daviess County; Screening, Grinding/Comminutors, Activated Sludge, Rapid Sand Filtration, Chlorination; Discharge System. Permit issued 6/30/1975; Permitted flow 10,000 gpd; Privately managed; Mobile Home Park.

49. Breckinridge County; Screening, Grinding/Comminutors, Activated Sludge, Rapid Sand Filtration, Chlorination; Discharge System. Permit issued 6/30/1975; Permitted flow 11,000 gpd; Publicly managed; Recreation Area/Campground.

50. Clay County; Screening, Grinding/Comminutors, Activated Sludge, Rapid Sand Filtration, Chlorination; Discharge System. Permit issued 8/22/1986; Permitted flow 13,000 gpd; Privately managed; Medical/Health Care Center.

51. Floyd County; Screening, Grinding/Comminutors, Activated Sludge, Rapid Sand Filtration, Chlorination; Discharge System. Permit issued 2/28/1986. Permitted flow 15,000 gpd; Publicly managed; Apartments/Condos/Townhouses.

52. Greenup County; Grinding/Comminutors, Activated Sludge, Rapid Sand Filtration, Post Aeration, Chlorination; Discharge System. Permitted 4/8/1986; Permitted flow 22,000 gpd; Publicly managed; Subdivision.

53. Todd County; Equalization, Activated Sludge, Sedimentation, Rapid Sand Filtration, Post-Aeration, with Chlorination; Discharge System. Permitted 12/4/1987; Permitted flow 7,500 gpd; Publicly managed; School.

54. Taylor County; Grit Removal, Grinding, Activated Sludge, Rapid Sand Filtration, Chlorination; Discharge System. Permitted 1/31/1974; Permitted flow 16,000 gpd; Publicly managed; Campground/RV Park.

55. Jefferson County; Grinding/Comminutors, Activated Sludge, Multi-media Filtration, Chlorination; Discharge System. Permitted 12/9/1977; Permitted flow 10,000 gpd; Publicly managed; Subdivision.

56. Barren County; Screening, Grinding/Comminutors, Activated Sludge, Multimedia Filtration, Chlorination; Discharge System. Permit issued 7/13/1981; Permitted flow 8,000 gpd; Publicly managed; Recreation Area/Campground.

57. Letcher County; Screening, Grinding/Comminutors, Activated Sludge, Multimedia Filtration, Chlorination; Discharge System. Permit issued 12/8/1989; Permitted flow 9,000 gpd; Privately managed; Motel/Resort.

58. Harlan County; Screening, Grinding/Comminutors, Activated Sludge, Polishing Lagoons, Chlorination; Discharge System. Permit issued 5/23/1989; Permitted flow 5,000 gpd; Privately managed; Mobile Home Park.

59. Jessamine County; Screening, Grinding/Comminutors, Activated Sludge, Polishing Lagoons, Chlorination; Discharge System. Permit issued 3/24/1978; Permitted flow 5,000 gpd; Privately managed; Youth Camp.

60. Campbell County; Screening, Grinding/Comminutors, Activated Sludge, Polishing Lagoons, Chlorination; Discharge System. Permit issued 3/9/1988; Permitted flow 25,000 gpd; Privately managed; Apartments/Condos/Townhouses.

61. Harrison County; Grease Removal, Screening, Grinding/Comminutors, Activated Sludge, Aerated Lagoons, Chlorination; Discharge System. Permitted 1/23/1986; Permitted flow 6,000 gpd; Publicly managed; Elementary School.

62. McCracken County; Grinding/Comminutors, Activated Sludge, Polishing Lagoons, Chlorination; Discharge System. Permitted 3/24/1978; Permitted flow 30,000 gpd; Privately managed; Subdivision.

63. Rowan County; GrindingGrinding/Comminutors, Activated Sludge, Polishing Lagoons, Chlorination, Aerobic Digestion (Sludge); Discharge System. Permitted 9/6/1974; Permitted flow 49,500 gpd; Publicly managed; RecreationArea/ Campground.

64. Franklin County; Grinding/Comminutors, Activated Sludge, Polishing Lagoons, Post-Aeration, Chlorination; Discharge System. Permitted 9/23/1985; Permitted flow 25,000 gpd; Privately managed; School.

65. Bullitt County; Grinding/Comminutors, Activated Sludge, Sedimentation, Aerated Pond/Lagoon, Chlorination; Discharge System. Permitted 1/11/1985; Permitted flow 5,000 gpd; Privately managed; Golf Course/Country Club.

66. Lincoln County; Screening, Grinding/Comminutors, Extended Aeration, [Secondary Treatment], Chlorination; Discharge System. Permit issued 6/20/1996; Permitted flow 20,000 gpd; Publicly managed; School.

67. Martin County; Screening, Grinding/Comminutors, Extended Aeration, Intermittent Sand Filters, Chlorination; Discharge System. Permit issued 3/22/1996; Permitted flow 12,000 gpd; Publicly managed; School.

68. Boyd County; Extended Aeration, Intermittent Sand Filters, Post-Aeration, with Chlorination; Discharge System. Permitted 3/10/1994; Permitted flow 6,000 gpd; Privately managed; Subdivision.

69. McCracken County; Grinding/Comminutors, Extended Aeration, Polishing Lagoons, Chlorination; Discharge System. Permitted 6/30/1987; Permitted flow 25,000 gpd; Privately managed; Subdivision.

70. Lyon County; Anaerobic Treatment followed by Intermittent Sand Filters; Discharge System. Permit issued 8/19/1980; Permitted flow 5,000 gpd; Privately managed; Mobile Home Park.

71. Lyon County; Anaerobic Treatment followed by Intermittent Sand Filters Treatment; Discharge System. Permit issued 8/19/1980; Permitted flow 8,000 gpd; Privately managed; Campground/RV Park.

72. Breckinridge County; Septic Tank Pretreatment, Intermittent Sand Filters, Chlorination; Discharge System. Permit issued 3/4/1996; Permitted flow 7,400 gpd; Publicly managed; School.

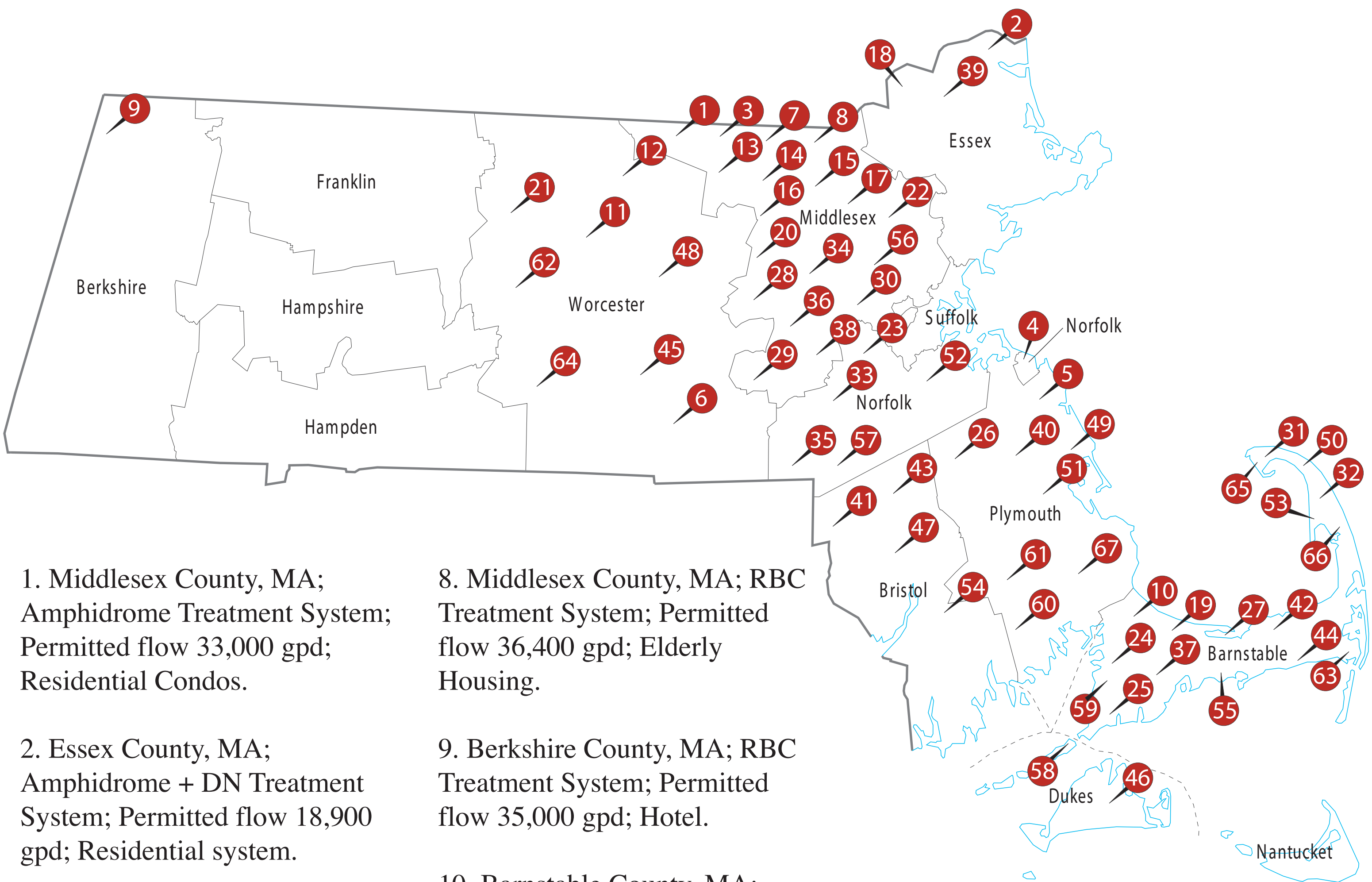
73. Fleming County; Septic Tank Pretreatment, Micro-screening/ Micro-straining (probably effluent filters/screens); Equalization, Mixing, Rapid Sand Filtration, Chlorination, Dechlorination; Discharge System. Permit issued 7/10/2001; Permitted flow 12,800 gpd; Privately managed; Subdivision.

74. Letcher County; Septic Tanks, Vegetative Filter, Slow Sand Filtration, Ultraviolet Irradiation; Discharge System. Permit issued 9/23/1999. Permtted flow 9,000 gpd; Publicly managed; Subdivision.

75. Trigg County; Grease Removal, Septic Tanks, Sedimentation/Settling, Vegetative Filter, Trickling Filter, Chlorination, Aerobic Digestion (sludge); Discharge System. Permitted 9/22/1986; Permitted flow 19,200 gpd; Privately managed; Nursing Home.

76. Grayson County; Stabilization Ponds, Intermittent Sand Filters, Post-Aeration, Ultraviolet Irradiation; Discharge System. Permit issued 3/13/1989; Permitted flow 45,000 gpd; Publicly managed; Community System

Appendix 5.A
By-County Locations of Massachusetts Systems



1. Middlesex County, MA; Amphidrome Treatment System; Permitted flow 33,000 gpd; Residential Condos.

2. Essex County, MA; Amphidrome + DN Treatment System; Permitted flow 18,900 gpd; Residential system.

3. Middlesex County, MA; Activated Sludge + DN; Permitted flow 26,000 gpd; Residential system.

4. Norfolk County, MA; DN treatment system (?); Permitted flow 9,500 gpd; Health Club/gym (Athletic complex).

5. Plymouth County, MA; FAST Treatment System; Permitted flow 23,500 gpd; Retail store.

6. Worcester County, MA; RBC Treatment System; Permitted flow 37,000 gpd; Restaurant.

7, Middlesex County, MA; RBC Treatment System; Permitted flow 27,134 gpd; Retail Store.

8. Middlesex County, MA; RBC Treatment System; Permitted flow 36,400 gpd; Elderly Housing.

9. Berkshire County, MA; RBC Treatment System; Permitted flow 35,000 gpd; Hotel.

10. Barnstable County, MA; RBC Treatment System; Permitted flow 25,000 gpd; Residential condos.

11. Worcester County, MA; RBC Treatment System; Permitted flow 31,680 gpd; Residential condos.

12. Worcester County, MA; RBC Treatment System; Permitted flow 35,000 gpd; School.

13. Middlesex County, MA; RBC + DN Treatment System; Permitted flow 18,750 gpd; Office complex.

14. Middlesex County, MA; RBC + DN Treatment System; Permitted flow 40,000 gpd; Hotel.

15. Middlesex County, MA; RBC + DN Treatment System; Permitted flow 15,840 gpd;
Residential system.

16. Middlesex County, MA; RBC + DN Treatment System; Permitted flow 39,750 gpd; Residential condos.

17. Middlesex County, MA; RBC + DN Treatment System; Permit ted flow 24,000 gpd; School.

18. Essex County, MA; RBC + DN Treatment System; Permitted flow 37,548 gpd; School
.

19. Barnstable County, MA; RBC + FAST Treatment System; Permitted flow 28,500 gpd; Hotel.

20. Middlesex County, MA; Solar Aquatic Treatment System; Permitted flow 7,000 gpd; Business.

21. Worcester County, MA; Zenon (MBR) Treatment System; Permitted flow 12,000 gpd; School.

22. Middlesex County, MA; Zenon (MBR)/RU Treatment System; Permitted flow 35,000 gpd; Office/Retail Complex.

23. Norfolk County, MA; Amphidrome Treatment System; Permitted flow 18,000 gpd; Elderly housing.

24. Barnstable County, MA; Amphidrome Treatment System; Permitted flow 24,000 gpd; Hotel.

25. Barnstable County, MA; Amphidrome Treatment System; Permitted flow 35,000 gpd; Hotel.

26. Plymouth County, MA; Amphidrome + DN Treatment System; Permitted flow 13,500 gpd; Elderly housing.

27. Barnstable County, MA; Amphidrome/Tetr. Treatment System; Permitted flow 35,500 gpd; Residential condos.

28. Middlesex County, MA; Activated Sludge Treatment System; Permitted flow 26,000 gpd; Residential system.

29. Middlesex County, MA; Activated Sludge Treatment System; Permitted flow 30,000 gpd; High school.

30. Middlesex County, MA; Activated Sludge + DN Treatment System; Permitted flow 44,700 gpd; Residential condos.

31. Barnstable County, MA; Primary/septic treatment; Two 30/24 Biocleres followed by two 30/32's (two parallel trains); Parshall flume; Tetra Bed Denitr.; LPD soil Dispersal; Permitted flow 17,000 gpd; Retails businesses; Into service 2000.

32. Barnstable County, MA; Primary settling (pre-conditioning/aeration chamber for grease, etc.); Two 24/30 Biocleres (recirc. To septic tank) in series; Equalization; Fixed Film Anoxic (Bioclere) reactor; Settling tank for clarification; Post-aeration chamber/tank; LPD soil dispersal; Permitted flow 6,250 gpd; Elderly Housing; Into service 2000.

33. Norfolk County, MA; Primary settling; Two 30/24 Biocleres followed by two 30/32's (two parallel trains); Equalization; (Aquapoint Anox reactor followed by fixed film anoxic reactor, which is a Bioclere unit with plastic media dosed with methanol); LPD soil dispersal; Permitted flow 11,218 gpd; Country Club; Into service 2000.

34. Middlesex County, MA; Primary/septic treatment; Four 30/32 Biocleres with recirculation back to septic tank; (Two parallel trains with 2 in series); Equalization; Bioclere denitr. Filters (Aquapoint Anox reactor followed by fixed film anoxic reactor, which is a Bioclere unit with plastic media dosed with methanol); LPD soil dispersal; Permitted flow 14,955 gpd; Country Club; Into service 2001.

35. Norfolk County, MA; Primary tanks; two 24/30's Biocleres in series (recirculation of effluent from nitrified to the septic tank for denitr); Equalization; (Aquapoint Anox reactor) followed by fixed film anoxic reactor, which is a Bioclere unit with plastic media dosed with methanol; LPD soil dispersal; Permitted flow 6,500 gpd; Elderly housing; Into service 1999.

36. Middlesex County, MA; Primary settling; Two 24/30 Biocleres (recirc. To septic tank); Equalization; Dynasand deep bed continuous flow sand filter; LPD soil dispersal; Permitted flow 16,000 gpd; Children's day camp; Into service 1998.

37. Barnstable County, MA; Primary tanks; two 30/32 Biocleres in series (recirculation of effluent from nitrified to the septic tank for denitr); Parshall flume; followed by tetra deep bed denitrification unit - media filter, anoxic biomass deep in bed; LPD soil dispersal; Permitted flow 16,100 gpd; Elem./Middle School; Into service 1998.

38. Middlesex County, MA; FAST Treatment System; Permitted flow 30,000 gpd; Business (Electronics corp.).

39. Essex County, MA; FAST Treatment System; Permitted flow 15,000 gpd; High school.

40. Plymouth County, MA; RBC Treatment System; Permitted flow 7,500 gpd; Retail store.

41. Bristol County, MA; RBC Treatment System; Permitted flow 26,500 gpd; Retail businesses.

42. Barnstable County, MA; RBC Treatment System; Permitted flow 12,800 gpd; Elderly housing.

43. Bristol County, MA; RBC Treatment System; Permitted flow 29,000 gpd; Hotel.

44. Barnstable County, MA; RBC Treatment System; Permitted flow 39,000 gpd; Hotel.

45. Worcester County, MA; RBC Treatment System; Permitted flow 12,500 gpd; Residential system.

46. Dukes County, MA; RBC Treatment System; Permitted flow 15,000 gpd; Residential system.

47. Bristol County, MA; RBC Treatment System; Permitted flow 31,000 gpd; Residential system.

48. Worcester County, MA; RBC Treatment System; Permitted flow 45,000 gpd; Residential system.

49. Plymouth County, MA; RBC Treatment System; Permitted flow 48,970 gpd; Residential system.

50. Barnstable County, MA; RBC Treatment System; Permitted flow 30,000 gpd; Residential condos.

51. Plymouth County, MA; RBC Treatment system; Permitted flow 30,000 gpd; Residential condos.

52. Norfolk County, MA; RBC Treatment System; Permitted flow 20,400 gpd; School.

53. Barnstable County, MA; RBC Treatment System; Permitted flow 32,000 gpd; School.

54. Bristol County, MA; RBC Treatment System; RBC + DN Treatment System; Permitted flow 39,779 gpd; School.

55. Barnstable County, MA; RBC + DN Treatment System; Permitted flow 32,000 gpd; Elderly housing.

56. Middlesex County, MA; RBC + DN Treatment System; Permitted flow 40,600 gpd; Hotel.

57. Norfolk County, MA; RBC + DN Treatment System; Permitted flow 35,000 gpd; Residential system.

58. Barnstable County, MA; RBC + DN Treatment System; Permitted flow 40,000 gpd; Residential system.

59. Barnstable County, MA; RBC + DN Treatment System; Permitted flow 35,400 gpd; School.

60. Plymouth County, MA; RBC + DN Treatment System; Permitted flow 40,000 gpd; School.

61. Plymouth County, MA; RBC + DN Treatment System; Permitted flow 50,000 gpd; School.

62. Worcester County, MA; RBC + Recirculating Sand Filter Treatment System; Permitted flow 40,000 gpd; Country Club.

63. Barnstable County, MA; SBR Treatment System; Permitted flow 18,000 gpd; Jr./Sr. High School.

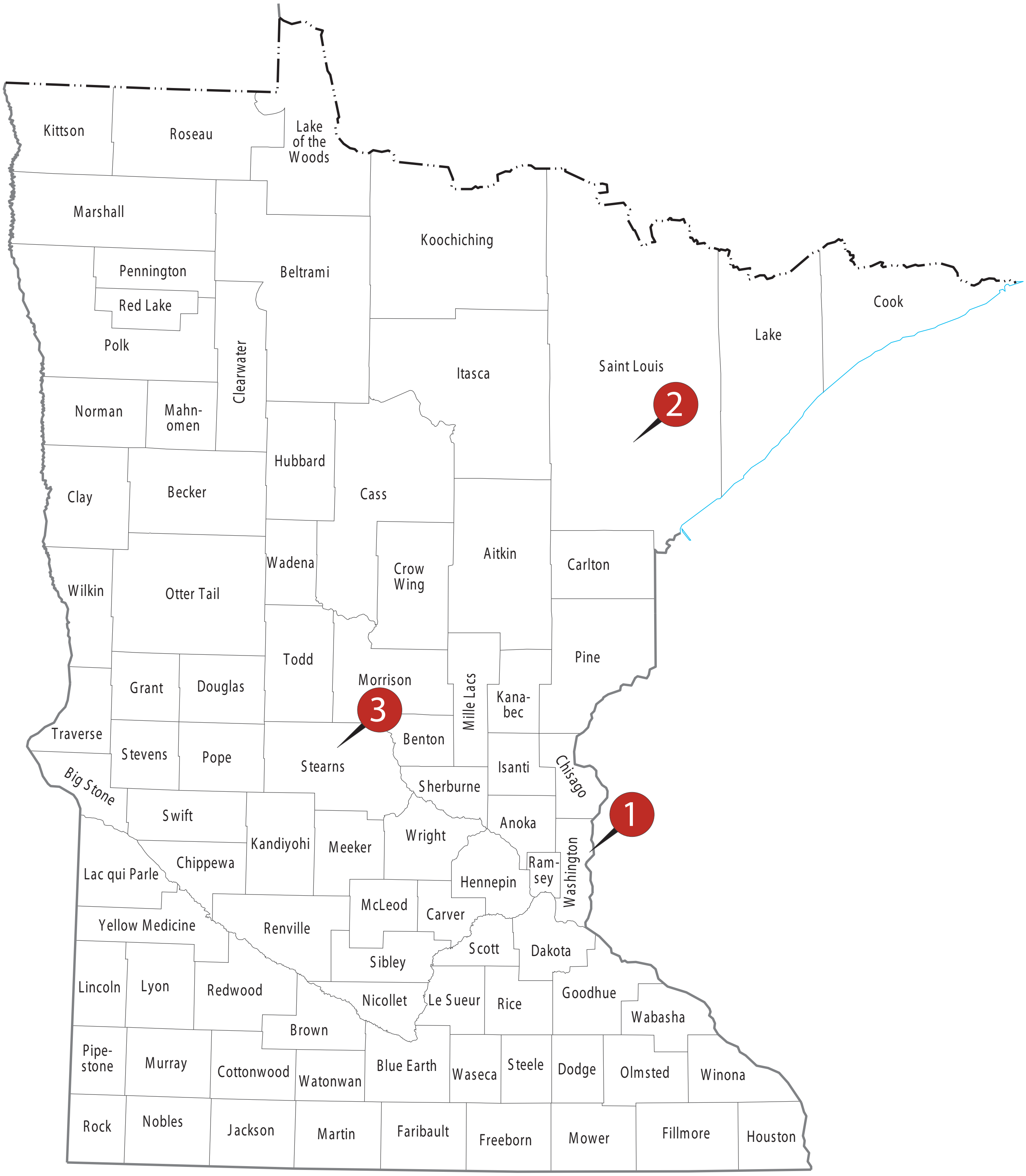
64. Worcester County, MA; Zenon (MBR) Treatment System; Permitted flow 25,000 gpd; Recreational Campground/RV Park.

65. Barnstable County, MA; RBC Treatment System; Permitted flow 20,000 gpd; School.

66. Barnstable County, MA; RBC Treatment System; Permitted flow 20,000 gpd; School.

67. Plymouth County, MA; RBC Treatment System; Permitted flow 30,000 gpd; High School.

Appendix 6.A
By-County Locations of Minnesota Systems

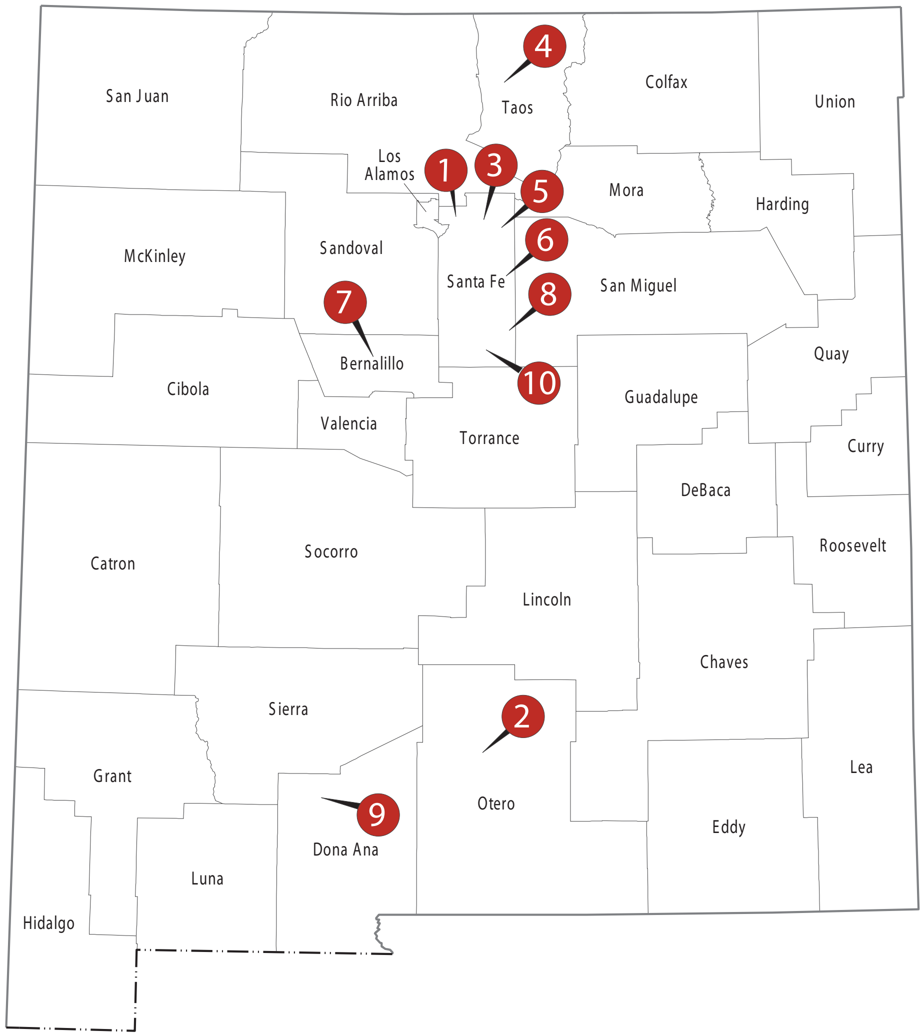


1. Washington County; STEP system; 7,800 sq. ft Recirculating Sand Filter; 4,000 sq. ft. of subsurface Drainfield trenches; 19,800 gpd; Publicly Managed; Residential System.

2. St. Louis County; Septic tank (12,000 Gallons); Recirculating gravel filter (3200 sq. ft); Subsurface Drainfield (176 sq ft trenches); 11,000 gpd; Privately Managed; Lodge/Cabins.

3. Stearns County; STEP Collection System (septic tank pretreatment); Recirculating gravel filter (3300 sq. ft); Subsurface Drainfield (3,600 L.F. of trenches); 17,000 gpd; Privately Managed; Residential Subdivision.

Appendix 7.A
By-County Locations of New Mexico Systems



1. Santa Fe County; Bar Screens, Grit Chamber, Sequencing Batch Reactor, Chlorine Contact Tanks, Lined Holding Ponds from which approximately 15 acres are irrigated. Into service 1988; Permitted flow 30,000 gpd; Publicly Managed; College.

2. Otero County; Screening, Primary Clarifier, Trickling Filter, Chlorine Contact Chamber, Drip Irrigation to approx. 4 acres. Into service sometime prior to 1995, and upgraded/modified 2004/2005; Permitted flow 10,000 gpd; Privately Managed; Research & Visitor Center.

3. Santa Fe County; Septic Tanks (4 total, with two parallel trains of 2 each); Two-Cell Wetland; Permitted flow 5,000 gpd; Privately Managed; School.

4. Taos County; Septic tank pretreatment; Package Plants and an SBR in Paralleltrains, leading to 3 drainfields (2 of them alternating annually). WW Plants #1 and #2; Permitted flow 6,000 gpd; Privately Managed; Mobile Home Park.

5. Santa Fe County; Septic tank pretreatment; Primary Settling; Trickling Filter w/Recirculation back to Primary Settling Tank and Equipped with Bio-filters; Secondary Settling; Pressure Dosing to Sand Filter Cells; Effluent storage in lagoons prior to land application to alfalfa field (0.87 acres); Permitted flow 12,000 gpd; Privately Managed; Resort.

6. Santa Fe County; Septic tank pretreatment; Primary Settling; Trickling Filter w/Recirculation back to Primary Settling Tank and Equipped with Bio-filters; Secondary Settling; Pressure Dosing to Sand Filter Cells; Effluent storage in lined lagoons prior to land application to alfalfa field (0.87 acres); Permitted flow 12,000 gpd; Privately Managed; Resort.

7. Bernalillo County; Septic tank pretreatment via Effluent Collection System; Additional Primary Settling in Community 10,000 Gallon Septic Tank; Nitrification via BioMicrobics FAST 9.0 Treatment Unit; Denitrification in Subsurface Flow Wetland Cells; Subsurface Dispersal Field ("Leachfield"); System went into service in 1997; Permitted flow 9,000 gpd; Privately Managed; Mobile Home Park.

8. Santa Fe County; Screening, Primary Clarifier, Trickling Filter, Subsurface Leachfield; Into service in 1995; Permitted flow 5,802 gpd; Privately Managed; Shopping Center.

9. Dona Ana County; Septic tank; Recirculating Sand Filter (w/ recirc. Tank); Subsurface Leachfield; Into service in 1997; Permitted flow 25,000 gpd (changed to 30,000 gpd March 2003); Publicly Managed; Middle School.

10. Santa Fe County; Bar Screen; Surge Tanks; Two Sequencing Batch Reactors in Parallel; UV Disinfection; Storage tank; Subsurface Drip Irrigation; Into service in 1996; Permitted flow 8,000 gpd (changed to 5,220); Privately Managed; RV Park.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NM-1

A. Basic Information

- State/County where system is located; Santa Fe County, NM
- Date permit was issued; Most recently: October 5, 2005.
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1988

B. Design Information

Basic Design Information

- Type(s) of facilities served; School (College);
- Design Flow; 30,000 gpd.
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system Conventional gravity (all on-site sewer lines);
  2. Pretreatment system (primary, secondary, disinfection) SBR/chlorination;
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) Surface Irrigation.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following: A key element of the design is reportedly nitrogen removal.

  System consists of:
  - Manually operated bar screen, grit chamber, and 3" influent Parshall flume and ISCO bubbler flow meter/recorder; the flow meter is recorded twice daily. [Bubbler type head level transmitter and electronic chart recorder]
  - ICEAS (intermittent cycle extended aeration system) Sequencing Batch Reactor: Wastewater flows into primary (pre-react zone) compartment, prior to entering main treatment compartment. 3-stage process (aeration/treatment, settling, and decanting). Entire cycle is about 4 hours.
  - Supernatant flows through effluent line to a lift station, which transfers supernatant to the chlorination chamber, and then the holding ponds.
  - Lagoon 1 is 3 million gallons (plastic lined); Lagoon 2 is 1 million gallons (also plastic lined);
  - Chlorination is provided by calcium hypochlorite tablets.
  - Effluent is pumped into the campus surface irrigation system. The irrigated area is about 15 acres.

  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);

(2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
(3) Loading rates to unit processes;
(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
(5) Soil/land loading rate.
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; New Mexico Department of the Environment; Ground Water Quality Division.
- Effluent quality limits (regulatory performance standards/limits for system); Monitoring requirements:
    1. Weekly fecal coliform samples from chlorine contact chamber effluent; Results submitted quarterly.
    2. Semi-annual reporting of wastewater volume flowing into plant (daily).
    3. Quarterly monitoring of NO3-N and TKN from west lagoon;
    4. Land application data sheets used to calculate nitrogen loading to irrigated areas. Quarterly reports submitted to NMED.
    5. Monthly measurement & recording of flow meter installed at outlets of lagoons to measure volume of wastewater irrigated. Records submitted semi-annually.
    6. BOD, TSS & TDS monitored twice monthly, and reported to NMED.
    7. Other tests done by SFCC to confirm proper operation of plant include settlement test, DO and chlorine tests. These records are maintained by operators.

- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Two College staff persons monitor and maintain the treatment plant and auxiliary operations; Both are certified by the New Mexico Environment Department as Level III Waste Water Treatment Operators.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system?
- Regularly scheduled operation and maintenance activities;

- Bar screens cleaned manually 1st thing each morning, then twice again during the day;
- The grit chamber is cleaned twice per day.
- Flow meter reading is taken 1st thing each morning, and if recalibration is needed then it is done.
- SBR plant has 3 compartments with diffusers. An annual inspection is performed on these diffusers.
- Two 25 hp motors and two root blowers supplying air to the main aeration chamber and pre-react chamber, and 2 more 7-1/2 hp motors and 2 root blowers supplying air to sludge holding tank, are given a weekly maintenance check and belt tension on the motors & blowers. A weekly check is done on the intake filters.
- Other pumps in the main aeration chamber and sludge holding chamber there are pumps that are given annual maintenance checks (impeller and oil casting);
- Decanter mechanism in main aeration chamber is checked daily.
- The two pumps in the lift station (that pumps to chlorination system and irrigation holding ponds) are pulled out annually and checked.

- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
- Are there inspection or other "walkover" photos of the system that may be available to us? Yes. Copies made of numerous inspection photos taken during WUTAP evaluation.

In November, 2002 the Water Utilities Technical Assistance Program (WUTAP) performed a diagnostic evaluation of the plant to assess its capacity and status. Those results included the following:

- The plant appeared able to be able to adequately handle current flows;
- WUTAP estimated that average daily flows were about 25,000 gpd, with peak daily flows as high as 35,000 gpd;
- Influent flow meter was found to be reading in error by about +25%, based on head readings for the flume; [NOTE: NMED inspections on other occasions reported meter was reading zero, with flow clearly entering system.]
- Nitrogen sampling was being done in lagoon locations likely to slightly skew calculations for checking nitrogen loading in the irrigation system, though not enough to affect compliance with permit requirements;
- Some improvements to the process control testing program were recommended;
- It was noted that new sludge drying beds added to increase sludge handling capacity were not properly lined, and posed a potential threat to ground water quality. The beds were apparently not placed into service because of this.
- **The overall condition of the plant appeared to be good (due to good maintenance practices),** though certain conditions were noted that needed repair/attention, including:

- Aeration and diffuser piping showing serious corrosion, and several diffusers missing;
- Some aeration blower intake/discharge couplings were noted to be leaking slightly;
- 2-3 ft. grit deposits found in pre-react chamber, and some grit in SBR aeration basin (facility never taken off-line and cleaned since start-up);
- Holding lagoon liners exhibiting numerous tears. Vegetation roots appear to be penetrating liner in some areas.

NMED inspection reports included concerns about foam and grease in the SBR. SBCC staff reported foam was only present in the winter.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Flow is measured by a Parshall flume, and a flow meter with a totalizer (flow recorded twice daily);
  In 2002, over a 5 month period, there were 30 recorded flow violations (flows over the permitted 30,000 gpd, and in many cases approach double the permitted flow).
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. GW Depth reported to be 300'. GW monitoring wells are sampled.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NM-2

A. Basic Information

- State/County where system is located; Otero County, NM
- Date permit was issued;
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1990's (or earlier).

B. Design Information

Basic Design Information

- Type(s) of facilities served; Government owned research facility and employee housing.
- Design Flow; 10,000 gpd
- History of systems on site: Is this system a replacement? The trickling filter system was upgraded, including change from rock to plastic media. If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?

The following was observed during a June 1995 visit to the system by WUTAP, after which certain changes were made to the plant.

1. Primary clarifier full of septic sludge;
2. Trickling filter plugged with trash & solids;
3. Secondary clarifier full of septic sludge and no mechanical means to remove sludge;
4. Chlorine contact chamber full of septic sludge;
5. High nitrogen level noted in effluent.

- Type of System
  1. Collection system Conventional gravity 8-inch collection lines, and one lift station.
  2. Pretreatment system (primary, secondary, disinfection) Trickling Filter;
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) Subsurface drip dispersal.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:

  System consists of:

  - Screening, primary settling/clarifier (Spiragester); 10' diameter 15'10" depth to bottom of hopper (9300 gallons).
  - Trickling filter treatment unit (concrete) with radial arm distribution; [The original media was rock, and in October 2004, it was replaced with plastic media manufactured by NSW.] 10' diameter, 9' media depth (5300 gallons).
  - Secondary clarifier (concrete); 8' diameter 15'10" depth to bottom of hopper (6000 gallons).

- Disinfection (chlorine contact chamber); [Original system used gas chlorination, but in summer of 2005, this was replace with a liquid sodium hypochlorite chlorination system.] 5'x 5' x 8' depth (1500 gallons).
- Subsurface dispersal of effluent. (4 acres).

(1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
(2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
(3) Loading rates to unit processes; Hydraulic loading rate to trickling filter = +127 gpd/ft2; Volumetric organic loading rate = 18 lb. BOD/day per 1000 ft3;
(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
(5) Soil/land loading rate.
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; New Mexico Department of the Environment; Ground Water Quality Division.
- Effluent quality limits (regulatory performance standards/limits for system);

Monitoring requirements:

1. Flow measurement (effluent flow meter), continuously monitored and reported quarterly;
2. Effluent quality monitored quarterly (after chlorination basin & before pumping/dosing), for TKN, NO3, TDS and Chloride.

- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? GW monitoring.
- Regularly scheduled operation and maintenance activities;
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);

Are there inspection or other "walkover" photos of the system that may be available to us?

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); See spreadsheet.
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. GW Depth reported to be 50'. GW monitoring wells are sampled.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NM-3

A. Basic Information

- State/County where system is located; Santa Fe County, NM
- Date permit was issued;
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). Sometime prior to 1994.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Elementary School.
- Design Flow; 5,000 gpd
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?

- Type of System
  1. Collection system
  2. Pretreatment system (primary, secondary, disinfection) Septic tanks followed by a two-cell wetland treatment system;
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) Subsurface infiltration basin.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:

  System consists of:
    - A total of 4 septic tanks leading to a two-cell wetland system. Two 5,000 gallon septic tanks in series; and a 5,000 gallon tank and a 1,000 gallon tank in series. Effluent from these two parallel primary treatment trains flows to the 2-cell wetland.
    - Subsurface dispersal of effluent (infiltration basin)

  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
  (5) Soil/land loading rate.

(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; New Mexico Department of the Environment; Ground Water Quality Division.
- Effluent quality limits (regulatory performance standards/limits for system);
  - 45 mg/L Total Nitrogen was assumed for the effluent, and irrigated area to be limited to 200 lbs/acre/year of TN;
  - Total of 185 school days per year.

Monitoring requirements:

1. Flow measurement based on water usage at the school, reported semi-annually;
2. Wetland Effluent quality monitored semi-annually for TKN, NO3, and Chloride.

- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Private operations/inspection company. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? No.
- Regularly scheduled operation and maintenance activities;
  - Checking of sludge/scum levels in tanks bi-annually, and cleaning as needed/recommended.
  - Water levels in the wetland are to be maintained at 2” below the surface of the gravel.
  - Undesirable or excessive vegetation is to be removed, and a healthy population of desirable plants maintained.
  - Records maintained.

- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);

  Are there inspection or other “walkover” photos of the system that may be available to us? No.

General observations from the information available in the regulatory files/records for this system:

1. Based on the water usage records, the flow through the system appeared to be on average significantly less than the 5,000 gpd permitted flow (usually in range of 2,000-3,000 gpd);
2. On multiple occasions, the sample point at the wetland outlet was dry, and therefore no effluent sample could be collected;
3. Septage pumping records seem to indicate fairly good attention to the sludge and scum levels in the septic tanks.
4. For the few effluent samples collected, reported and copied from the file review, TKN levels in the wetland effluent were relatively high (greater than 75 mg/L), and for the one Nitrate-Nitrogen result available, the concentration was less than 1 mg/L.
5. In April 1994, an letter from NMED to the school stated that the entire system, including septic tank port, flow meter box, constructed wetlands, leak detection pipes, and infiltration basin should be inspected weekly to ensure discovery of malfunctions. It was reported in the letter that monitoring had consistently shown that the wetlands were not performing as well as expected, and that the effluent was consistently above permitted limits.
6. The system was re-configured in subsequent years – it appears re-routing flow from at least one of the wetland cells.
7. In 2002, a complaint was file regarding surfacing sewage around the school from a cleanout, which based on the notes appears to have possibly been associated with a piece of wood and rebar lodged in a pipe, perhaps from construction when that portion of the system was installed.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); See spreadsheet.
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. GW Depth reported to be 185'.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.

- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees
- Connection fees (if applicable);
- Service fee structure and user fees charged

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NM-4

A. Basic Information

- State/County where system is located; Taos County, NM
- Date permit was issued; Original permit, 1995.
- Date system went into service (confirm that there are at least 5 years of operation of the system before today).

B. Design Information

Basic Design Information

- Type(s) of facilities served; Mobile Home Park.
- Design Flow; 6,000 gpd total combined flow (2 systems);
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?

Note: This system layout and components of this system were not in the files. The original system appears from the records to have not been functioning adequately, and so another SBR unit was placed in parallel with one of the package plants serving the residential units.

- Type of System
  1. Collection system
  2. Pretreatment system (primary, secondary, disinfection) Two SBR's (Chromoglass) in tandem/parallel discharging to two alternating drainfields; A 2nd SBR package plant discharging to another drainfield.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) Mound Dispersal Bed/Field.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:

  System consists of:

  - Two Cromaglass package treatment plants in parallel (SBR's), with their discharge alternating annually between two adjacent drainfields; Another (lower) Cromaglass package plant discharges to a third drainfield.

  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
  (3) Loading rates to unit processes;

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
(5) Soil/land loading rate.
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; New Mexico Department of the Environment; Ground Water Quality Division.
- Effluent quality limits (regulatory performance standards/limits for system); 15 mg/L Total Nitrogen in treated effluent.

  Monitoring requirements:
  - Quarterly effluent quality samples for TKN, NO_3-N, TDS and Chloride.
  - Quarterly GW monitoring of water levels to nearest inch.
  - Quarterly GW samples taken for TKN, NO_3-N, TDS and Chloride.

- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? ; If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? Yes.
- Regularly scheduled operation and maintenance activities;
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
  Are there inspection or other "walkover" photos of the system that may be available to us? No.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); See spreadsheet.
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. GW Depth reported to be 15'.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NM-6

A. Basic Information

- State/County where system is located; Santa Fe County, NM
- Date permit was issued; Original permit, 1986.
- Date system went into service (confirm that there are at least 5 years of operation of the system before today).

B. Design Information

Basic Design Information

- Type(s) of facilities served; Guest units, offices, restaurant, swimming pool and hot tubs..
- Design Flow; 12,000 gpd;
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?

Grease interceptors and septic tank pretreatment, followed by equalization prior to being pumped from a lift station to the treatment plant. The treatment plant consists of a primary settling tank; a trickling filter unit with recirculation to the primary settling tank, a secondary settling tank equipped with bio-filters; and a pressure-dosed sand filter. The treatment plant receives flows from all of the above resort facilities. The effluent is disinfected (chlorine table disinfection chamber), and goes to two synthetically lined lagoons for evaporation and storage, prior to land application to 0.87 acres of alfalfa fields through gravity flood irrigation.

- Type of System
  1. Collection system; Effluent collection system (tanks adjacent to facilities served).
  2. Pretreatment system (primary, secondary, disinfection) See above
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) See above

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:

  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;

(5) Soil/land loading rate.
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; New Mexico Department of the Environment; Ground Water Quality Division.
- Effluent quality limits (regulatory performance standards/limits for system);
    - 15 mg/L Total Nitrogen.
    - 30 day average of 1000 CFU/100 ml Fecal Coliform;
    - 5,000 CFU/100 ml Maximum Fecal Coliform;
    - 30-Day Average BOD of 30 mg/L;
    - 45 mg/L Maximum BOD;
    - 30-day Average TSS of 75 mg/L;
    - 90 mg/L Maximum TSS.
    - Treated/disinfected effluent shall be land applied such that nitrogen loading does not exceed by 25% the reasonably expected nitrogen uptake per year for the .87 acres of alfalfa. Nitrogen content shall NOT be adjusted to account for volatilization and mineralization processes.

      BOD, TSS and Fecal Coliform are to be sampled monthly and reported quarterly, and TKN, NO3-N, TDS and Cl to be sampled and reported quarterly. Monitoring reports are to include discharge volumes to the treatment plant and land application area; monitoring well depth-to-water measurements; analytical results from wastewater and groundwater samples, grease interceptor and septic tank inspection records; and all treatment and holding facility pumping and disposal records. A totalizing flow meter is to be used to measure monthly volumes of wastewater pumped from the lift station to the WWTP, and results included in the quarterly reports.

- Are there periodic regulatory inspections of the system?

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Privately owned/managed; If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? Yes.
- Regularly scheduled operation and maintenance activities;
- Man-hours per week or month routinely committed to O&M activities;

- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
  Are there inspection or other "walkover" photos of the system that may be available to us? No.

Quantitative
- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); See spreadsheet.
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet (limited data).
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. GW Depth reported to be 10'.

E. Cost Information

Design/Construction
- Initial construction costs for the system (including design and permitting costs if available);

OM&M
- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees
- Connection fees (if applicable);
- Service fee structure and user fees charged

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NM-7

A. Basic Information

- State/County where system is located; Bernalillo County, NM
- Date permit was issued; 2004 (appears to be most recent at time of records review).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1997.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Mobile Home Park Subdivision(currently 42-44 connections)
- Design Flow; 9,000 gpd;
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system Effluent collection system
  2. Pretreatment system (primary, secondary, disinfection) Community 10,000 gallon septic tank for added settling; Bio-Microbics FAST 9.0 treatment unit for nitrification; Subsurface wetland treatment for denitrification;
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) Subsurface "leachfield".

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:

  See above.

  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
  (5) Soil/land loading rate.
  (6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; New Mexico Department of the Environment; Ground Water Quality Division.
- Effluent quality limits (regulatory performance standards/limits for system);

Quarterly average TN limits of 30 mg/L; Annual average TN limits of 20 mg/L

- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Private. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? Yes.
- Regularly scheduled operation and maintenance activities;
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
- Are there inspection or other "walkover" photos of the system that may be available to us? No.

  Note: An assessment was done of this system by Bio-Microbics, and a number of problems were found in several critical areas that appear to have significantly affected the systems performance. Those are discussed in the study report.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Yes, monthly averages. Flume/flow meter sensor.
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Yes, see spread sheet (influent to wetland following treatment via septic tanks and FAST unit).
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. Yes, see spread sheet (wetland effluent prior to subsurface dispersal).
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. GW Depth reported to be 53'. GW monitoring wells are sampled.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees

- Connection fees (if applicable); Currently $45.95 per connection. However, due to compliance problems, NMED is requiring system revisions/replacement to come into compliance. Estimates for new system are reportedly around $800,000, so fees would increase to approximately $100/month/connection.
- Service fee structure and user fees charged

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NM-8

A. Basic Information

- State/County where system is located; Santa Fe County, NM
- Date permit was issued;
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1995.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Shopping Center.
- Design Flow; 5,802 gpd
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?

- Type of System
  1. Collection system
  2. Pretreatment system (primary, secondary, disinfection) Septic tanks followed by a trickling filter treatment system;
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) Subsurface effluent dispersal.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
  (5) Soil/land loading rate. 4,200 square feet of subsurface dispersal field area. Loading rate of 1.38 gpd/ft2, based on design flow.
  (6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; New Mexico Department of the Environment; Ground Water Quality Division.
- Effluent quality limits (regulatory performance standards/limits for system); Total Nitrogen in treated effluent limited to 20 mg/L.

Monitoring requirements:

1. Monthly treated wastewater flow measurement based on metered water usage, reported quarterly with monitoring reports;
2. Quarterly effluent quality monitoring reports for NO_3-N, TKN, TDS and Cl.

- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Private company (Agora LLC and Enviro. Monitoring & Testing LLC/Link Summers, LLC). If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? No.
- Regularly scheduled operation and maintenance activities;
    - Measure depth to groundwater, and analyze GW samples from 3 monitoring wells for NO_3-N, TKN, TDS, and Cl. Submit quarterly monitoring reports.
    - Checking of sludge/scum levels in tanks, and cleaning as needed/recommended.
    - Monitor treatment plant effluent for NO_3-N, TKN, TDS and Cl.
    - Remove solids from treatment plant as needed based on process control testing. If scum layer is within 3 inches or the solids level is within 12 inches of the intake of the outlet tee, the contents of the tanks are to be pumped. Tank inspection and pumping records to be submitted to NMED quarterly.
    - Record monthly water supply meter readings, and deduct irrigation water usage to estimate discharge volumes from the treatment plant. Submit meter readings, calculations and discharge volumes in quarterly monitoring reports.
    - Inspect grease interceptor and pump as needed. Submit inspection and pumping records in quarterly reports.
    - Inspect lift stations and pump as needed. Submit inspection and pumping records in quarterly monitoring reports to NMED.
    - Inspect leachfield area; Keep log of inspection findings and repairs made.

- Man-hours per week or month routinely committed to O&M activities; Not reported.
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);

Are there inspection or other "walkover" photos of the system that may be available to us? No.

General observations from the information available in the regulatory files/records for this system:

The following sludge/septage pumping records were obtained:

10/18/2000:	5,000 gallons pumped; ($542.83)
1/9/2001:	2,500 gallons pumped; ($271.41)
3/30/2001:	5,000 gallons pumped; ($542.83)
7/6/2001:	5,000 gallons pumped; ($542.83)
8/27/2001:	7,500 gallons pumped; ($814.25)
1/10/02:	7,500 gallons pumped; ($814.24)
2/5/02:	8,000 gallons pumped; ($684.94)
4/4/02:	8,000 gallons pumped; ($684.94)
Aug. '02:	8,000 gallons pumped;
April '03:	8,000 gallons pumped;
July '03:	8,000 gallons pumped;
Oct. '03:	16,000 gallons pumped;
Jan. '04:	8,000 gallons pumped;
March '04:	8,000 gallons pumped;
May '04:	12,000 gallons pumped;
June '04:	8,000 gallons pumped.

Based on available invoices/costs, sludge pumping costs average approximately $101 per 1,000 gallons pumped. In 2004, septage pumping averaged 6,000 gallons per month. Therefore, most recent sludge/septage pumping records indicate those costs averaged $606 monthly ($7,272 annually).

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); See spreadsheet.
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. GW Depth reported to be 100'.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M
- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Sludge/septage pumping records indicate those costs averaged $606 monthly ($7,272 annually) for most recent year for which records were available.

Fees
- Connection fees (if applicable);
- Service fee structure and user fees charged

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NM-9

A. Basic Information

- State/County where system is located; Dona Ana County, NM
- Date permit was issued; 2002
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1997.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Middle School.
- Design Flow; 25,000 gpd (It appears that the permit was later modified for 30,000 gpd, possibly around 2002-2003)
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system
  2. Pretreatment system (primary, secondary, disinfection); 37,500 Gallon Septic tank; 25,000 Gal. Recirculation/Dosing Tank; 5,000 SF Recirculating Sand Filter; 5-acre Leachfield.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) Subsurface conventional leachfield.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
    - Metcalf & Eddy, Wastewater Treatment Disposal & Reuse, was used for projecting flows from the school;
    - Influent total nitrogen of 40 mg/L was assumed;
    - For sizing septic tank, "McGhee, Water Supply & Sewerage" was referenced for determining that 24 hours of hydraulic retention time was typically needed, with "enough additional capacity (1.5 times the average flow) to handle peak flows of short duration."
    - Nitrogen loading to the drainfield to be < 200 lbs/Acre/year.
  (3) Loading rates to unit processes;
    - Septic tank: 1.5 days hydraulic retention time for design flow;
    - Recirculation Tank: 1 day hydraulic retention time for design flow;

- Recirc. Sand Filter: 5 gpd/ft2/day, based on design flow of 25,000 gpd.

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
(5) Soil/land loading rate.
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; New Mexico Department of the Environment; Ground Water Quality Division.
- Effluent quality limits (regulatory performance standards/limits for system); Currently, treated effluent quality is not to exceed 20 mg/L Total Nitrogen. Prior to March 2003, the limit was 27 mg/L TN.

  Monitoring requirements:
  1. Monthly discharge volumes, reported quarterly;
  2. Quarterly sampling/analyses and reporting of influent and effluent samples for NO_3-N and TKN.
  3. Copies of septic tank inspection and pumping records.

- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Public school district wastewater operators/technicians; If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? Yes.
- Regularly scheduled operation and maintenance activities;
  - Inspect septic tanks semi-annually for accumulation of scum and solids. If scum layer is within 3 inches or solids level is within 12 inches of the intake of the outlet tee, the contents of the tanks shall be pumped.
  - Monitoring and record-keeping;

- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);

  Are there inspection or other "walkover" photos of the system that may be available to us? No.

General observations from the information available in the regulatory files/records for this system:

- In August 2000, a new recirculation pump was installed.
- In July 2002, concerns were noted regarding increasing concentrations of nitrate in one of the monitoring wells;
- In August 2002, a spill of treated wastewater from the RSF unit occurred due to a broken line. Approximately 7200 gallons were spilled.
- In March 2003, the permit was renewed and modified for treating 30,000 gpd.
- In March/April 2004, adjustments to the recycle pump timing were made which appeared to improve effluent nitrogen levels.
- Flow meter problems were noted as being the reason for such high recorded flows on a few days.
- In February 2005, a letter from the physical plant director indicates that there was bio-film buildup in the recirculation line; that TN levels were excessively high (over 20 mg/L); and that one of the pumps dosing the sand filters was inoperable.
- In May 2005, the New Mexico Environment Dept. noted in an inspection report that tire marks were observed over the leachfield, although there were no signs of surfacing effluent; Bio-film buildup in the recirculation line appeared to be eliminated by installation of a new pump; and that corrective action would be needed if effluent quality did not improve such nitrogen limits were met.
- In March 2006, it was noted that the flow meter was not working properly.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); See spreadsheet.
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. GW Depth reported to be 350’.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); Prior to construction, costs for entire system estimated to be $213,435, including engineering & surveying.

OM&M

- Hourly rates for personnel along with hours spent.

- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
    - Prior to construction, annual O&M costs for the system were estimated to be $2,000.
    - Records show that in 2005 the physical plant director requested quarterly pumping of the septic tank, estimated at 16,000 gallons pumped per quarter. At $100/1,000 gallons, that cost would be $6,400 per year just for sludge/septage pumping.
    - Quarterly lab services were typically $79 ($316 annually).

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NM-10

A. Basic Information

- State/County where system is located; Santa Fe County, NM
- Date permit was issued; Original permit, 1996 (Later modifications to permit).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1996

B. Design Information

Basic Design Information

- Type(s) of facilities served; RV Park.
- Design Flow; 8,000 gpd (previously 5,220 gpd).
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? Modifications were made to the system at some point, increasing the flow from 5,220 gpd to 8,000 gpd; Adding a 5,000 gallon capacity SBR; and increasing the land application (drip dispersal) area from 11.81 to 17 acres.
- Type of System
  1. Collection system; Conventional gravity sewer lines.
  2. Pretreatment system (primary, secondary, disinfection) Bar screen; Two surge tanks in series; Two sequencing batch reactors (SBR's) in parallel, with an 8,000 gallon capacity (one-3,000 gallon unit, and one-5,000 gallon unit); a settling basin, UV disinfection system, and storage tank.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) Subsurface drip irrigation (17 acres).

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
  (5) Soil/land loading rate.
  (6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; New Mexico Department of the Environment; Ground Water Quality Division.

- Effluent quality limits (regulatory performance standards/limits for system); Originally permit required 20 mg/L Total Nitrogen in treated effluent. It was later revised to require a total nitrogen loading limit of 200 lbs/acre/year of total nitrogen to the subsurface drip irrigation field.

  Monitoring requirements:
  - Quarterly effluent quality samples for TKN and NO_3-N.
  - Calculation of nitrogen loading to subsurface drip dispersal field, with quarterly reporting.
  - Quarterly reports on monthly discharge volumes (based on totalizer flow meter readings);
  - Maintain records for all activities.

- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? ; If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? Yes.
- Regularly scheduled operation and maintenance activities;
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);

  Are there inspection or other "walkover" photos of the system that may be available to us? No

  Observations from records/files:
  - Records showed that the RV park system typically operated at well below the permitted flow;
  - Monitored TKN levels in the treated effluent were consistently high.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet data.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. GW Depth reported to be 180'.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NM-ND1
NOTE: The only data obtained for this system is provided in this document.
System is not included in spreadsheet data.

A. Basic Information

- State/County where system is located; Lincoln County, NM
- Date permit was issued; Original permit, 1983 (Renovations/modifications in 1987, 1993 and 1999).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today).

B. Design Information

Basic Design Information

- Type(s) of facilities served; Public school.
- Design Flow; 6,000 gpd total combined flow (2 systems);
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?

Note: This system layout and components of this system were not in the files. The original system appears from the records to have not been functioning adequately, and so another SBR unit was placed in parallel with one of the package plants serving the residential units.

- Type of System
  1. Collection system
  2. Pretreatment system (primary, secondary, disinfection) Dual-compartment grease interceptor tank; Cromoglass Model CA100 Sequencing Batch Reactor package plant.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) Subsurface leachfield.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
  (5) Soil/land loading rate.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NM-ND1
NOTE: The only data obtained for this system is provided in this document.
System is not included in spreadsheet data.

(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; New Mexico Department of the Environment; Ground Water Quality Division.
- Effluent quality limits (regulatory performance standards/limits for system); 20 mg/L Total Nitrogen in treated effluent.

  Monitoring requirements:
  - Quarterly effluent quality samples for TKN, NO_3-N, TDS and Chloride.
  - Quarterly reports on monthly discharge volumes (based on pump run hours & discharge pump rate);
  - Inspect grease interceptor tank on a quarterly basis, and pump & clean as needed.
  - Inspect leachfield semi-annually to ensure proper maintenance and determine any conditions needing correction.
  - Quarterly GW monitoring of water levels to nearest hundredth of a foot.
  - Quarterly GW samples taken for TKN, NO_3-N, TDS and Chloride.
  - Maintain records for all activities.

- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? ; If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? Yes.
- Regularly scheduled operation and maintenance activities;
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);

  Are there inspection or other "walkover" photos of the system that may be available to us? No.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
- Influent Quality Data to the system (if available) and QA/QC provisions employed;

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NM-ND1
NOTE: The only data obtained for this system is provided in this document.
System is not included in spreadsheet data.

- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.
  Results from only one sampling event (January 9, 2006) were obtained from NM records. Two samples were collected for each of the following parameters for the treatment plant effluent.

NO_3-N:	1.71 mg/L and 3.88 mg/L;
TKN:	3.33 mg/L and 0.7 mg/L.
TDS:	1520 mg/L and 1640 mg/L;
Chloride:	300 mg/L and 288 mg/L.

- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. GW Depth reported to be 40'.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

The specifications sheet from the manufacturer reports that each CA100 treatment unit consumes 78 kwh per 24 hours.

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NM-ND2
NOTE: No effluent quality monitoring data was obtained for this system.

A. Basic Information

- State/County where system is located; Grant County, NM
- Date permit was issued;
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). Sometime prior to 2002

B. Design Information

Basic Design Information

- Type(s) of facilities served; Community system.
- Design Flow; Phase 1: 10,000 gpd
  Phase 2: 5,800 gpd
  Phase 3: 7,000 gpd.
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system
  2. Pretreatment system (primary, secondary, disinfection)
     Phase 1: 7,000 gallon septic tank; 14,000 gallon equalization tank; Two trickling filters in series; Two synthetically lined wetland cells in parallel; Leachfield disposal;
     Phase 2: 7,200 gallon septic tank; Two synthetically lined constructed wetland cells operated in series; Discharge to a clay-lined holding pond, followed by disposal in a leachfield;
     Phase 3: 7,200 gallon septic tank; Two synthetically lined constructed wetland cells operated in parallel; Discharge to a clay-lined holding pond, followed by disposal in a leachfield.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) Subsurface infiltration leachfields.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;

NOTE: No effluent quality monitoring data was obtained for this system.

(5) Soil/land loading rate.
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; New Mexico Department of the Environment; Ground Water Quality Division.
- Effluent quality limits (regulatory performance standards/limits for system);
  - 20 mg/L TN for all 3 systems.

  Monitoring requirements:
  1. Monitor monthly discharge volumes and report;
  2. Wetland Effluent quality monitored quarterly for TKN, NO_3, and Chloride.
  3. Semi-annual ground water monitoring for NO_3, TKN, TDS and Choride.

- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? No.
- Regularly scheduled operation and maintenance activities;
  - Checking of sludge/scum levels in tanks bi-annually, and cleaning as needed/recommended. If scum layer is within 3 inches or solids level within 12 inches of the intake of the outlet tee, the contents of the tanks shall be pumped by a licensed hauler. Tanks inspection and pumping records shall be submitted to NMED annually on or before December 31 of each year.
  - Maintain wetland water levels at a minimum of 2” below the surface of the gravel layer.
  - Maintain minimum of 2’ freeboard in the effluent holding ponds at all times.
  - Undesirable or excessive vegetation is to be removed, and a healthy population of desirable plants maintained.
  - Records maintained.

- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NM-ND2
NOTE: No effluent quality monitoring data was obtained for this system.

Are there inspection or other "walkover" photos of the system that may be available to us? No.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.
    - In April, 2002, NMED informed the owner's representatives that the most recent monitoring reports showed the following:
        - Phase 1 effluent of 9.6 mg/L Total Nitrogen;
        - Phase 2 effluent of 30.8 mg/L Total Nitrogen;
        - Phase 3 effluent of 19.7 mg/L Total Nitrogen.

      The Phase 1 system had apparently added trickling filter units to the treatment train, and the NMED letter stated that total nitrogen levels had subsequently lowered, and began meeting TN effluent quality limits. The letter went on to say that it was unlikely that the 20 mg/L TN effluent limit could be met for the Phase 2 and Phase 3 systems without modifications to the system.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. GW Depth reported to be 7.5 to 20'.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NM-ND-3
NOTE: No data was obtained for this system.

A. Basic Information

- State/County where system is located; Torrance County, NM
- Date permit was issued; June, 2003.
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 2003.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Community System
- Design Flow; 14,400 gpd; 9,000 gpd; and 10,800 gpd (3 systems)
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system Effluent collection system (primarily STEG);
  2. Pretreatment system (primary, secondary, disinfection) Advantex units;
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) Subsurface "leach beds".

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:

  Systems consists of:

  1. Site A: 5400 gpd Advantex AX20 units (six) (West Plant) and 9000 gpd AX100 units (two) (East Plant)
  2. Site B: AX20's (ten units) treating up to 9,000 gpd;
  3. Site C: 5,400 gpd treated by AX20's (six) (West plant) and 5,400 gpd treated by AX100's (two) (East Plant).

  Treated effluent must not exceed 20 mg/L TN.
  Treated effluent goes to a common subsurface leach/dispersal bed.

  (2) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (3) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
  (4) Loading rates to unit processes;
  (5) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;

(6) Soil/land loading rate.
(7) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; New Mexico Department of the Environment; Ground Water Quality Division.
- Effluent quality limits (regulatory performance standards/limits for system); Monitoring requirements:
    1. Semi-annually, measure depth to water and analyze GS samples from 3 monitoring wells for NO3-N, TKN, TDS and Chloride.
    2. Quarterly, analyze effluent from a diverter box located between all 5 treatment plants and each respective lead bed for TKN, NO3-N, TDS and Chloride.
    3. Remove solids from treatment plants as needed based on process control testing;
    4. Monthly, record meter readings and calculate discharge volumes for Sites A & C;
    5. Monthly, record number of pumping cycles and calculate discharge volumes at Site B.

- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Private entity. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system?
- Regularly scheduled operation and maintenance activities;
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);

    Are there inspection or other "walkover" photos of the system that may be available to us? No.

    The community's systems have reportedly suffered from insufficient and/or inadequate routine maintenance/management practices. The service provider is located a relatively long distance away from the systems.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. GW Depth reported to be 50'. GW monitoring wells are sampled.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); Approximately $970,000 for Phases I and II. Costs were estimated to be approximately $12,000/connection (home) for Phase I, and $9,000/connection for Phase II.

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

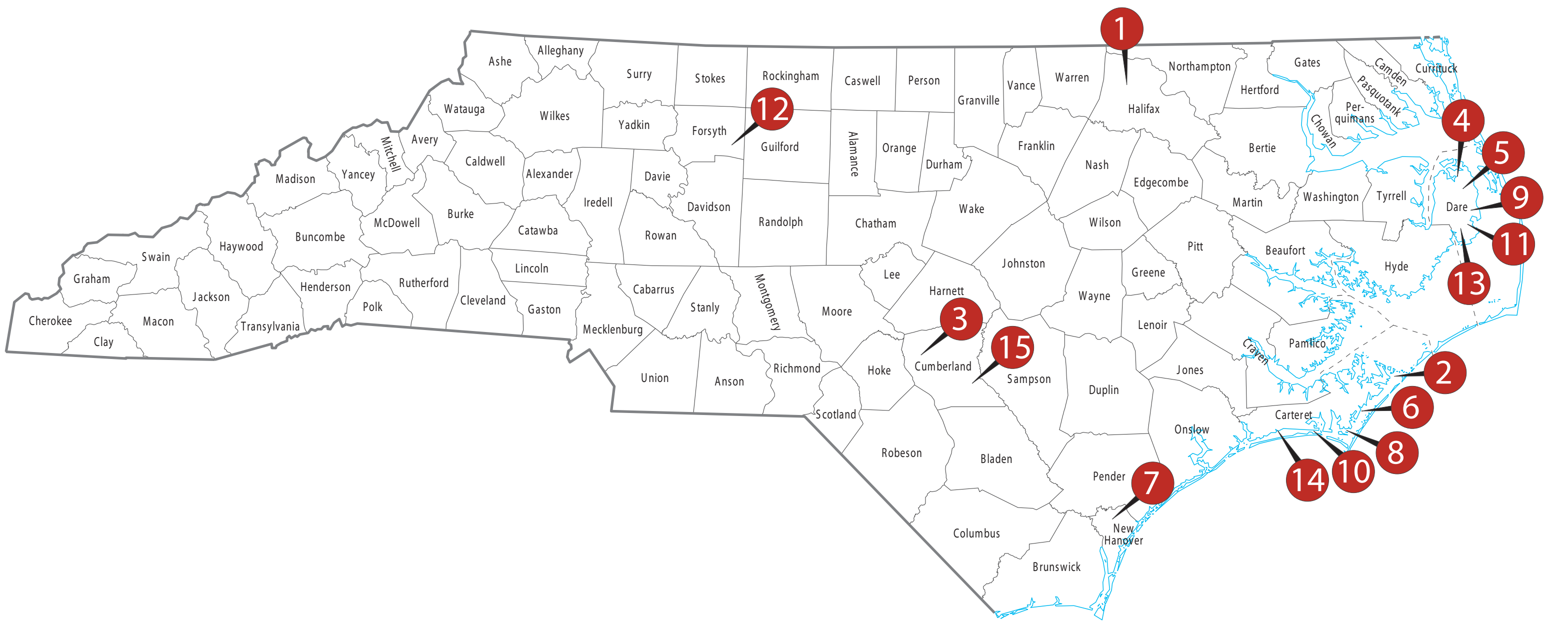
Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged

The monthly fees pay for the following:

- Sand filters' inspections
- Service calls
- Septic tanks pumped approximately every 3 years
- Record-keeping of maintenance/service activities;
- Repayment of the state revolving fund loan.

Appendix 8.A
By-County Locations of North Carolina Systems



1. Halifax County; Septic Tank, Bioclere Trickling Filter Treatment Unit (24/20 w/ 1600 Gal. Clarifier), Pressure Dosed Drainfield; 3,000 GPD Drainfield Disposal & 2,040 GPD Pump/Haul system. Into service Feb. 2003 (This system installed to replace existing system following a fire at the rest home, and put into service Feb. 2003); Design flow 5,040 gpd; Privately Managed; Rest Home.

2. Carteret County; Gravity sewers; Two grease traps with effluent filters (elementary: 4000-gal + high school: 6000-gal); Two septic tanks with effluent filters (elementary: 10000-gal + high school: 18000-gal); 5 flow splitter boxes; Three 1000-gallon pump tanks; RSF (9750-sf); UV Disinfection; LPP distribution (Two 10000-gal pump tanks, four 6" LPP supply lines). Into service 1998; Design flow 27,600 gpd; Publicly Managed; High School & Elementary School.

3. Cumberland County; 12,000-gal ST, Two Grease Traps with total capacity of 7,000 gal. 14,000 flow equalization RSF dosing tank, RSF (three trains, total of 3,816 sf, with LPP distribution), 8,000-gal final dosing tank with dual pumps/forcemains to two LPP fields (2,266 linear feet). Into service July 2001; Design flow: 6,000 gpd to Drainfield, 11,400 gpd Pretreatment System; Publicly Managed; High School.

4. Dare County; Grease traps/septic tanks, total of 17,000 gallons septic tank capacity (w/effluent filter); Bioclere system (no disinfection); Duplex pumping system to two low pressure pipe fields. Into service Nov. 2000; Design flow 10,232; Privately Managed; Shopping Center.

5. Dare County; Gravity/conventional w/lift stations; Extended aeration package plant (aerated equalization basin, aeration basins, clarifiers (Aer-o-Flo prefabricated steel plant), dual media sand/anthracite tertiary filter (Pollution Control Systems, Inc.), In-line turbidity measurement w/data logger, UV disinfection - Ultra Dynamics System); Low pressure pipe subsurface dispersal system. Into service 1993; Design flow: 44,940 gpd to Drainfield, 80,000 gpd Pretreatment; Privately Managed; Residential Community System (PUD).

6. Carteret County; Gravity/conventional w/lift stations; 8" gravity sewer, 2873-gallon lift station; 3" forcemain to coated steel extended aeration package plant, including a 7829-gallon equalization basin, 5000-gallon aerated sludge holding tank, 50450-gallons of aeration basin capacity 238 sf clarifier; 34.7 square feet of tertiary rapid sand filtration; tablet chlorinator, 5750-gallon final dosing tank; Low pressure pipe subsurface dispersal system (3 independently dosed fields, total of 6750 LF of trench). Into service 1986; Design flow 25,000 gpd (plant capacity 50,000 gpd); Privately Managed; Condominiums & Marina.

7. New Hanover County, North Carolina (Coastal); 10 grinder pump stations feeding 2" pressure sewer main; 8" gravity sewer; 1102-gallon main lift station with 3" forcemain feeding extended aeration package plant, including 4234-gallon equalization basin, 3387- gallon aerated sludge holding tank; 20253-gallon aeration basins, 71.5-sf secondary clarifiers; 14-sf (total) dual tertiary rapid sand filters, stilling well/flow meter, tablet chlorinator with 417-gallon contact chamber; 4549-gallon final dosing tank. Plant is a Hydro-Aerobics Model H-200-SHSU rated for 20,000 gpd @ 300 mg/l BOD5; 2 LPP fields, 2800 linear feet, total – original unsleeved LPP system failed and was replaced with sleeved system with larger orifices. The replacement trenches were installed between the existing lines. Into service June 1988 (LPP fields were replaced in 2003); Design flow 15,840 gpd; Privately Managed (HOA); Residential Subdivision.

8. Carteret County (Coastal NC); Gravity/conventional w/lift station to treatment plant; Package extended aeration plant with denitrification filters (Two sand filter cells with methanol injection); UV disinfection; Low pressure pipe (2 fields). Into service 1998; Design flow: 13,800 gpd (Treatment capacity 20,000 gpd); Privately Managed; Hotel.

9. Dare County (Coastal NC); Gravity/conventional sewering; Grease Traps; Septic tanks; Two modified 30/24 Bioclere units in series; Two conventional drainfields. Into service 2001; Design flow 9,600 gpd; Privately Managed; Restaurant.

10. Carteret County (Coastal NC); Existing gravity sewer and lift station (23,000-gallon converted septic tank) to extended aeration package treatment plant, with 8,603-gal equalization basin, 2 aeration tanks (23,864 gallons, total), 2 secondary clarifiers (3,370 gal., 72 sq ft, total), 2 aerated sludge holding tanks (3,291-gal, total), 2 tertiary sand filters (14 sq ft, total), 1,121-gallon mudwell, 1,065-gallon clearwell, tablet chlorinator with 445-gallon chlorine contact chamber, 1,400-gallon final dosing tank; Two LPP fields (2,100, LF total). Into service 1992; Design flow 20,000 gpd; Privately Managed; Residential Inn.

11. Dare County (Coastal NC); Gravity with lift station to pump up to plant; Extended aeration package plant. 4" gravity sewer, 2538-gallon main lift station, 4" forcemain to treatment plant including 5110-gallon equalization basin, 17055-gallon aeration basins, 3395-gallon, 72-sf secondary clarifiers, 1705-gallon aerated sludge holding tank, 14.25-sf tertiary rapid sand filters, stilling well/flow meter, 3270-gallon final dosing tank, dual alternating pumps, two 4" effluent supply lines; Two LPP fields, with a total of 2640-lf. Initially unsleeved low pressure pipe; replaced in same area with sleeved LPP. Into service 1990; Design flow 17,000 gpd; Privately Managed; Shopping Mall.

12. Forsythe County (Piedmont/Foothills); Conventional gravity collection; Septic tanks, recirculating sand filter; Pressure manifold to deep conventional trenches (64-72" trench bottoms). Into service 5/31/90 (Repair 1/31/01); Design flow 10,800 gpd; Privately Managed; Rest Home.

13. Dare County (Coastal); Conventional/lift station. Grease trap/sewer goes to main lift station which is pumped to treatment area, which includes the septic tank and pretreatment; 3000-gal grease trap, two 4000-gal septic tanks in series, 30/24 Bioclere unit, 1200-gal secondary settling tank with effluent screen, 5000-gal dosing tank; Two low pressure pipe fields (7600 sf total). Into service August 2002; Design flow 7,200 gpd; Publicly Managed; Elementary School.

14. Carteret County (Coastal); Grinder pumps at each house, pressure sewers; 28 grinder pump stations to 15,600-gallon surge tank, pumping to three-way flow splitter (one closed off) and 40,000 gpd extended aeration plant – two 20,000 gpd trains, each with a 3,000-gal sludge holding tank, 20,000-gal aeration basin, 3700-gallon dual-hopper clarifier, 60,000-gpd dentrification/solids removal filters with methanol feed system (three 14-sf deep-bed gravity filters, 4600-gal clearwell, 4000-gal mudwell), dual tablet chlorinators, 1350-gallon chlorine contact chamber, stilling well and flow monitoring device, 2500-gal final pump drainfield dosing tank; 4 LPP fields (three installed, one future) @ 59,000 sf, total. Into service 5/31/90 (Repair 1/31/01); Design flow: Permitted for 28,028 gpd, Plant designed for total of 60,000 gpd w/ three 20K trains, and 40,000 gpd LPP fields; Privately Managed (HOA); Residential Community.

15. Cumberland County; ST/GT - conventional; 12,000-gal ST, two GTs with total capacity of 7,000 gal. 14,000 flow equalization RSF dosing tank, RSF (three trains, total of 3,816 sf, with LPP distribution), 8,000-gal final dosing tank with dual pumps/forcemains to two LPP fields; 2 LPP fields installed in conventional trenches, 2,266 LF total. Into service July 2001; Designed for: 11,400 gpd treatment system, 6,000 gpd to fields; Publicly Managed; Elementary School.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NC-1

A. Basic Information

- State/County where system is located; North Carolina, Halifax County (Coastal Plain)
- Date permit was issued; Replacement System Permit Issued February 2003.
- Date system went into service (confirm that there are at least 5 years of operation of the system before today) Close to 5 years

B. Design Information

Basic Design Information

- Type(s) of facilities served; Rest Home
- Design Flow; 5,040.
- History of systems on site: Is this system a replacement? Yes. If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? New system was required following a fire at the rest home.
- Type of System
  1. Collection system N/A
  2. Treatment system (primary, secondary, disinfection) 2000 Gal. Grease Trap; 5,000 Gal. Septic Tank; 24/20 Bioclere Trickling Filter Unit w/ 1600 Gal. Clarifier; Dosing Tank (5,000 Gal.).
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); 3,000 GPD pumped conventional subsurface dispersal field; 2,040 GPD Pump/Haul portion of system.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following: Dual Pressure Manifold Distributed Conventional Drainfields, @ 1,200 linear feet.
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
  (5) Soil/land loading rate.
  (6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; Halifax County Health Dept.; Environmental Health Division; P.O. Box 10, Halifax, NC 27839.

- Effluent quality limits (regulatory performance standards/limits for system); CBOD5, 30 mg/L ("monthly average"); TSS, 30 mg/L ("monthly average"). One sample per quarter to be collected, and can be grab samples.
- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Private. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? No.
- Regularly scheduled operation and maintenance activities; Yes.
    1. Bioclere unit to be inspected each visitation for proper functioning;
    2. Sludge accumulation checked in settling tank measured and recorded each month;
    3. Pressure Manifold and individual taps purged at least twice a year. Pressure checked and adjusted to 2 feet of head after each purging at least semi-annually. Pump flow rates checked twice annually by the following method:
        a) Determine elevation of water in dosing tank;
        b) Run pumps for 5 minutes;
        c) Measure difference in water elevations and calculate the number of gallons pumped per minute;
        d) Compare design field dosing rate to measured pumping rate. The data must be submitted in the next quarterly report.
    4. Field checked for proper vegetative cover and condition;
    5. Event counters & run-timers recorded at each inspection;
    6. Completion of all Bioclere O&M requirements;
    7. Operator must monitor wastewater levels in the overflow tanks, and maintain all float alarm & telemetry systems;
    8. Drainfield dosing system set for 2 feet of head in the pressure manifolds; Timer to be set to run for 11 minutes & 24 seconrds, then off for 3 hours 48 minutes and 36 seconds before returning to run setting. This is to result in 500-gallon doses. This schedule may be slightly revised/adjusted based on drawdown testing and concurrence of Health Dept.

- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.); Reported problems in inspection reports include:
    1. Odor (word "Stinks" is used) reported on several occasions;
    2. Effluent filters in need of cleaning;

3. Nozzles in need of cleaning;
4. Some filter flies;
5. Major inflow to system reported;
6. Solids in pump tank;
7. Manifold lines in need of flushing.

- Are there inspection or other "walkover" photos of the system that may be available to us? Some.

Quantitative
- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See data in NC Excel spreadsheet for system.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. No.

E. Cost Information None available.

Design/Construction
- Initial construction costs for the system (including design and permitting costs if available);

OM&M
- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees
- Connection fees (if applicable);
- Service fee structure and user fees charged

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NC-2

A. Basic Information

- State/County where system is located; NC/Carteret (Coastal)
- Date permit was issued; December 4, 1998.
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1998

B. Design Information

Basic Design Information

- Type(s) of facilities served; 1200 student high school; 800 student elementary school
- Design Flow; 27,600.
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? New system for new schools. Challenges were seasonal flow, high nitrogen in school wastewater, shallow groundwater and adjacent sensitive surface waters.
- Type of System
  1. Collection system gravity/conventional.
  2. Pretreatment system (primary, secondary, disinfection) 4", 6" and 8" gravity sewer, two grease traps with effluent filters (elementary: 4000-gal + high school: 6000-gal), two septic tanks with effluent filters (elementary: 10000-gal + high school: 18000-gal), 5 flow splitter boxes, three 1000-gallon pump tanks, 9750-sf RSF with LPP distribution, UV disinfection, two 10000-gal pump tanks, four 6" LPP supply lines
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) 4 LPP fields (40,000 sf, total), 5 monitoring wells (four for water quality and one piezometer)

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study); Not specified; design basis assumes normal strength domestic (though high nitrogen has been an issue for schools).
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). Per state standards.
  (3) Loading rates to unit processes; 3 gpdpsf for recirc. sand filter. Septic tanks and grease traps sized per state regs (V = Q for large septic tanks). UV sized to handle 30,000 gpd at peaking factor of 2.5.

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; High groundwater table (SHGWT @ 5-6 feet, measured water table at 7-9 feet), adjacent sensitive surface waters.
(5) Soil/land loading rate. 0.70 gpdpsf (aerial loading basis for LPP)
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. Deep borings, soil hydrology (Ksat of soil profile), trasmissivity and specific yield of unconfined aquifer via aquifer test (could not pump from production well, so pumped water in at constant head and also did slug test on observation well), 21 hand/wash borings, completed as temporary piezometers for development of water table contour map. At 1.0 gpdpsf aerial loading rate, mound height predicted to be 1.5'. Some concern about nitrates impacting groundwater at higher loading levels.

C. Regulatory Information

- Regulatory authority and contact info; NC DEH; Carteret County, NC
- Effluent quality limits (regulatory performance standards/limits for system);
- Are there periodic regulatory inspections of the system? Yes

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Owned and operated by Carteret County.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? Yes, four monitoring wells: MW-1-4. MW-5 is a piezometer in the field itself.
- Regularly scheduled operation and maintenance activities; Listed in permit; typical requirements ranging from daily to annual depending on the specific activity.
- Man-hours per week or month routinely committed to O&M activities; Weekly visits required.
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.); Nitrate exceedences in groundwater.
- Are there inspection or other "walkover" photos of the system that may be available to us? None located.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Potable water use data in attached file.
- Influent Quality Data to the system (if available) and QA/QC provisions employed; None available.

- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction
- Initial construction costs for the system (including design and permitting costs if available);

OM&M
- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees
- Connection fees (if applicable);
- Service fee structure and user fees charged.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NC-3

A. Basic Information

- State/County where system is located; NC/Chatham County
- Date permit was issued; April 1, 1999 (state approval).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). July, 2001

B. Design Information

Basic Design Information

- Type(s) of facilities served; 950 student elementary school
- Design Flow; 6,000 gpd (flow reduction based on extreme water conserving fixtures) for drainfields. 11,400 gpd for pretreatment.
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? The original system (put into service in 2001) was for a new school and consisted of RSF to pressure manifold/conventional. Nitrate problems were discovered in monitoring and adjacent water supply wells, so modifications to the system were made including partial flooding of the sand filter (for denitrification) and relocation of the drainfields using LPP distribution in conventional-width (3') trenches.
- Type of System
  1. Collection system ST/GT - conventional.
  2. Pretreatment system (primary, secondary, disinfection) 12,000-gal ST, two GTs with total capacity of 7,000 gal. 14,000 flow equalization RSF dosing tank, RSF (three trains, total of 3,816 sf, with LPP distribution), 8,000-gal final dosing tank with dual pumps/forcemains to two LPP fields.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) 2 LPP fields installed in conventional trenches. 2,266 LF total.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study); Not explicitly stated.
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). Not specified; assumed to be per state standards.
  (3) Loading rates to unit processes; 3 gpd/sf for RSF.
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; A subdivision on

private wells was located about 500' away (downgradient) from the original conventional fields. The soils in the original conventional drainfield area was by all accounts good (sandy loam, sandy clay loam) with groundwater at least 11.0 feet below grade. Better Ksats in Bt horizon dictated relatively shallow trench bottomes. Monitoring wells were required and nitrate issues in downgradient groundwater was discovered within 1-2 years of operation. Replacement fields with better distribution (LPP) to prevent localized overloading were installed at the other end of the site. These have only been in service for 1-2 years.

(5) Soil/land loading rate. 0.30 gpd/sf for original conventional system. 1.0 gpd/sf and 0.8 gpd/sf for replacement LPP system

(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. hand borings, deep borings to 204". constant head permeameter used to measure Ksat in unsaturated horizons, slug tests to estimate Ksat in saturated horizons. Colorado State University mounding models. Transport time (to surface water) calculation.

C. Regulatory Information

- Regulatory authority and contact info; NC DEH; Cumberland County, NC
- Effluent quality limits (regulatory performance standards/limits for system); STE: 200 mg/l BOD, 100 mg/l TSS, 50 mg/l O&G. RSF: 10/10/10 BOD/TSS/O&G and 40% TN reduction from STE.
- Are there periodic regulatory inspections of the system? yes, by law.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Public:
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? yes, the original drainfields had an up- (MW-1) and down-gradient (MW-2) well installed. An additional six monitoring wells were installed as a result of the comprehensive groundwater site assessment required by the state after GW exceedences were noted.
- Regularly scheduled operation and maintenance activities; not indicated, but can be assumed to be consistent with typical RSF and LPP systems.
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.); Inspection information in file. Sand filter had flooding problems. Major nitrate GW violations.
- Are there inspection or other "walkover" photos of the system that may be available to us? None in file.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); does not appear to have been reported
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); labor as daily basis.

OM&M

- Hourly rates for personnel along with hours spent. 1 hour/day for O&M. 2 days/year.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NC-4

A. Basic Information

- State/County where system is located; Dare County, NC (Coastal)
- Date permit was issued; 4-4-00 (state approval); 6-14-00 (Dare Co. improvement permit)
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). Operation permit issued 11-14-00

B. Design Information

Basic Design Information

- Type(s) of facilities served; Shopping center (Grocery, Drug Store, Ice Cream shop, Hair Salon, Restaurant/Deli, Office Space, Newsstand)
- Design Flow; 10,232 gpd
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? Repair of existing system: existing gravity collection system, septic tanks/grease traps, pump tank. New Bioclere, low pressure pipe system. Existing system dates from early 80s, with a repair in early 90s. Overloaded drainfield, insufficient pretreatment.
- Type of System
  1. Collection system: gravity
  2. Pretreatment system (primary, secondary, disinfection): grease traps/septic tanks (w/effluent filter), Bioclere system (no disinfection)
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system): duplex pumping system to two low pressure pipe fields.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study); design flow based on state regs., confirmed by water use records. Influent wastewater characteristics appear to be based on monitoring of old system (795 mg/l BOD_5 post grease trap).
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). Bioclere loading rates based on their standard design criteria, supported by references.
  (3) Loading rates to unit processes; 1st stage bioclere 0.086 lbs BOD_5/cf-d. 2nd stage 0.030 lbs BOD_5/cf-d. Hydraulic, surface overflow rates of 261 gpdpsf at average flow and 521 gpdpsf at peak. 2.7 hour detention time at average flow.

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; Very porous sands, concerns about nitrogen in groundwater.
(5) Soil/land loading rate. Approximately 0.46 gpdpsf LTAR (LTAR for LPP systems are based on total aerial loading in NC).
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. Groundwater monitoring required. A hydrogeologic report was prepared in support of design, but could not be located in the regulatory files.

C. Regulatory Information

- Regulatory authority and contact info; Dare County Health Department.
- Effluent quality limits (regulatory performance standards/limits for system); Flow < 10,232; CBOD5, 20 < 30 mg/l; TSS < 30; TN < 30. Monthly monitoring of pump tank April through October.
- Are there periodic regulatory inspections of the system? Yes, per state rules.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Private, with subcontract to private operator.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? Groundwater monitoring. Quarterly for nitrates, fecals, water level, ammonia, chloride, sulfate, TDS and pH.
- Regularly scheduled operation and maintenance activities; Established in operation permit (see file) and approved specs.
- Man-hours per week or month routinely committed to O&M activities; Permit requires operator visit twice per week minimum.
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
- Are there inspection or other "walkover" photos of the system that may be available to us? None located.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Public water utility records were used to confirm design flow.
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data

for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees

- Connection fees (if applicable); unknown
- Service fee structure and user fees charged

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NC-5

A. Basic Information

- State/County where system is located; NC/Dare (Coastal)
- Date permit was issued; Phased system, so multiple approvals and permits. Original permit was in 1993, but additions continue to present.
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1993

B. Design Information

Basic Design Information

- Type(s) of facilities served; 80-unit PUD with total of 200 bedrooms, swimming pool w/decks and restrooms, snack bar; laundry and maintenance facility; additional facilities proposed for future.
- Design Flow; 44,940 gpd (drainfields); 80,000 gpd (treatment plant) – 120,000 gpd, ultimate loading.
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? This is a "new" facility that has been constructed in numerous phases, starting out as a standard septic system, clustering and then ramping up to conventional collection system and wastewater treatment plant.
- Type of System
  1. Collection system gravity/conventional w/lift stations
  2. Pretreatment system (primary, secondary, disinfection) Extended aeration package plant: aerated equalization basin, aeration basins, clarifiers (Aer-o-Flo prefabricated steel plant), dual media sand/anthracite tertiary filter (Pollution Control Systems, Inc.), In-line turbidity measurement w/data logger, UV disinfection (Ultra Dynamics System)
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) Low Pressure Pipe

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study); Assumed domestic strength per EPA onsite manual (1980).
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). OSWS recommendations (based on 10-state standards); Metcalf and Eddy for diffuser losses, aeration basin mixing demands, sludge generation estimate.
  (3) Loading rates to unit processes;

a. Equalization basin = 25% design flow
b. Aeration basin = approx 24 hour HRT & 30 cfm/1000 cf or 3,150 cf/pound BOD (Ten states is 2000 cf/#)
c. 28-day sludge holding capacity
d. 5,000 gpdpsf tertiary filters.

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; High volumetric flows; site very good with little mounding potential predicted or observed.

(5) Soil/land loading rate. 1.5 gpdpsf (aerial LPP loading rate, w/pretreatment).

(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. Hydrologic and lithologic characterization to 20 foot depth; determination of tranmissivity and specific yield of unconfined aquifer based on pump test; 16 hand/wash borings, completed as piezometers. MODFLOW groundwater mounding analysis. Nutrient, organic loading and heavy metals loading and transport analyses.

C. Regulatory Information

- Regulatory authority and contact info; NC DEH; Dare County, NC
- Effluent quality limits (regulatory performance standards/limits for system).
- Are there periodic regulatory inspections of the system? Yes

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Private ownership, contracted with private operator.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? Yes, groundwater monitoring wells.
- Regularly scheduled operation and maintenance activities; Listed in permit; typical requirements ranging from daily to annual depending on the specific activity.
- Man-hours per week or month routinely committed to O&M activities; ORC visits required 5 days/week.
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.).
- Are there inspection or other “walkover” photos of the system that may be available to us? None located.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated).

- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged;

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NC-6

A. Basic Information

- State/County where system is located; NC/Carteret (Coastal)
- Date permit was issued; August 28, 1992 (most recent operating permit in file).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1986

B. Design Information

Basic Design Information

- Type(s) of facilities served; 93 condominium units (21 one-bdrm, 70 two-bdrm, 2 three-bdrm); 39 slip marina.
  - Design Flow; 25,000 gpd (treatment capacity is installed for 50,000 gpd).
  - History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? Started out as a new extended aeration system/LPP design in 1986, two LPP fields were repaired/replaced in 1997 due to failure at the fill/natural sand interface which was not properly blended during the initial fill placement.
  - Type of System
    1. Collection system gravity/conventional w/lift stations
    2. Pretreatment system (primary, secondary, disinfection) 8" gravity sewer, 2873-gallon lift station, 3" forcemain to coated steel extended aeration package plant, including a 7829-gallon equalization basin, 5000-gallon aerated sludge holding tank, 50450-gallons of aeration basin capacity 238 sf clarifier, 34.7 square feet of tertiary rapid sand filtration, tablet chlorinator, 5750-gallon final dosing tank
    3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) 3 independently-dosed LPP fields with a total of 6750 LF of trench. Two replacement fields were constructed by trenching through the fill material and then backfilling the new trenches with appropriate fill material and reinstalling sleeved LPP lines in the same locations as original.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study); Assumed 200 mg/l BOD (basis not specified)
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). Not specified, but likely OSWS recommendations (loosely based on 10-state standards).
  (3) Loading rates to unit processes;
    a. EQ basin = 2.5 hour HRT

b. Aeration basin, approx 24 hour HRT with aeration capacity = 3,150 cf/pound BOD (Ten states is 2000 cf/#)
c. Aerated sludge holding = 1.5 cf/100 gpd capacity or 30 cfm/1000 cf aeration (for mixing)
d. 250 gpdpsf for clarifier loading
e. 1.1 gpmpsf tertiary filters
f. 0.5 hour chlorine contact HRT.
g. Tertiary filter clearwell = 15 gpm/sf @ 10 minute backwash cycle.

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; High groundwater table required removal of surface layer and fill to a finished elevation of 21.5' MSL. White Oak River adjacent to site, so GW monitoring required.
(5) Soil/land loading rate. 1.5 gpdpsf (aerial loading basis for LPP)
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. Hydrogeological analysis including deep borings and double-ring infiltrometer testing for Ksat measurement. No restrictive layers to 25' depth. Infiltrative capacity exceeded 45 inches per hour (too fast to develop saturation for Ksat measurement).

C. Regulatory Information

- Regulatory authority and contact info; NC DEH and Carteret County Environmental Health, NC
- Effluent quality limits (regulatory performance standards/limits for system);
- Are there periodic regulatory inspections of the system? yes, by state regulation

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Private ownership (HOA), contracted with private operator.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? Yes, there are three monitoring wells, one in each field.
- Regularly scheduled operation and maintenance activities; Listed in permit; typical requirements ranging from daily to annual depending on the specific activity.
- Man-hours per week or month routinely committed to O&M activities; Operator unable to provide estimate.
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.); Long history of inspection reports on file at state offices; previous surfacing problems with LPP fields resulting from poor fill installation, particularly at the fill/natural sand interface. More recently, the coated

steel plant is in a deteriorating condition (very common for coastal package plants in NC) and needs replacement or major structural repairs.

- Are there inspection or other "walkover" photos of the system that may be available to us? None were found in file.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Use stilling well with water level indicator and chart recorder.
- Influent Quality Data to the system (if available) and QA/QC provisions employed; N/A
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); Unclear, because there have been many "disasters" and structural repairs. It was a used plant to begin with, which was recoated and reinstalled. They believe total costs for replacement of the system will exceed $1,000,000.

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
  - $1,500 per month operation (labor)
  - $2,500 per month chemicals
  - $3,000-4,000 per month sludge hauling
  - Lab fees and personnel costs have been highly variable

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged Unclear; it appears that financing the replacement costs is a problem. Fees are not structured to cover such a major expenditure.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NC-7

A. Basic Information

- State/County where system is located; NC/New Hanover (Coastal)
- Date permit was issued; June 22, 1988 (original engineers certification).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). March 1988

B. Design Information

Basic Design Information

- Type(s) of facilities served; 44, 3-bedroom single family housing units
- Design Flow; 15,840 gpd
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? Began as new cluster package plant to LPP. LPP fields were replaced in 2003.
- Type of System
  1. Collection system Combination: some gravity/conventional and some GP stations at each house.
  2. Pretreatment system (primary, secondary, disinfection) 10 grinder pump stations feeding 2” pressure sewer main; 8” gravity sewer; 1102-gallon main lift station with 3” forcemain feeding extended aeration package plant, including4234-gallon equalization basin, 3387-gallon aerated sludge holding tank; 20253-gallon aeration basins, 71.5-sf secondary clarifiers; 14-sf (total) dual tertiary rapid sand filters, stilling well/flow meter, tablet chlorinator with 417-gallon contact chamber; 4549-gallon final dosing tank. Plant is a Hydro-Aerobics Model H-200-SHSU rated for 20,000 gpd @ 300 mg/l BOD_5
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) 2 LPP fields, 2800 linear feet, total – original unsleeved LPP system failed and was replaced with sleeved system with larger orifices. The replacement trenches were installed between the existing lines.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we’re only dealing with domestic wastewater in this study); 300 mg/l BOD_5.
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer’s literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). Not specified; assumed to be per state standards.
  (3) Loading rates to unit processes;

a. 24 hr HRT for aeration chamber
b. 4 hr HRT for clarifiers
c. 15%Q for aerated sludge holding
d. 42 mg/l BOD (?) and TSS for tertiary filters
e. Aeration capacity of 2100 cf/lb BOD5 (20,000 gpd @ 300 mg/l) or for mixing of 30 CFM/1,000 cf volume, which controls design.

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; None specified (probably space and lack of treatment capacity of highly permeable soils). This is a sand to loamy sand site with SHGWT over 4' below grade.

(5) Soil/land loading rate. 1.5 gpdpsf with pretreatment (aerial loading basis for LPP)

(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. Only soils work appeared to be done by the state (predates requirements mandating more extensive hydrogeological evaluation).

C. Regulatory Information

- Regulatory authority and contact info; NC DEH; New Hanover County, NC
- Effluent quality limits (regulatory performance standards/limits for system); Not specified.
- Are there periodic regulatory inspections of the system? Yes, by law.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Owned by HOA; contract operations by private operator.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? No.
- Regularly scheduled operation and maintenance activities; Not specified (may be listed in operations permit), but can be assumed standard for package plant – LPP. Type VI system requires 5 day/week ORC visits.
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.); Inspection reports not located. The original LPP system failed.
- Are there inspection or other "walkover" photos of the system that may be available to us? None in file.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Does not appear to have been reported, or else the county did not provide full monitoring reports to us.
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction
- Initial construction costs for the system (including design and permitting costs if available);

OM&M
- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees
- Connection fees (if applicable);
- Service fee structure and user fees charged

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NC-8

A. Basic Information

- State/County where system is located; Carteret County, NC (Coastal)
- Date permit was issued; 5-14-98 (state approval); 10-6-98 (Operations Permit)
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). October, 1998

B. Design Information

Basic Design Information

- Type(s) of facilities served; Hotel (111 rooms with laundry and limited food service)
- Design Flow; 13,800 gpd;
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? New.
- Type of System
  1. Collection system: Gravity with lift station to pump up to plant
  2. Pretreatment system (primary, secondary, disinfection): Package extended aeration plant with denitrification filters.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system): Low pressure pipe (2 fields).

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study); Flow rate based on state rules with use of low-flow plumbing fixtures; some flow data from similar system provided for justification. Strength assumed typical domestic, 240 mg/l BOD.
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). Calcs provided by plant vendor
  (3) Loading rates to unit processes; 0.69 gpm/sf for denit filters at average flow; 2.07 at peak flow. 24 hour HRT for aeration basins.
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; Porous sands, concerns re: nitrate in groundwater.
  (5) Soil/land loading rate. 1.5 gpdpsf.
  (6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. Mounding analysis, using results of deep borings and hand-auger borings and hydraulic conductivity measurement

from constant-head permeameter and pump test for other hydrogeological parameters for model. Hydrogeologist/soil scientist

C. Regulatory Information

- Regulatory authority and contact info; Carteret Co. Health Department
- Effluent quality limits (regulatory performance standards/limits for system); Specified in operating permit (referenced attached file) for flow, pH, ammonia, BOD, nitrate, nitrite, TKN, TSS, FCs, methane, COD, MBAS, O&G, TP, VOCs.
- Are there periodic regulatory inspections of the system? Yes, per state rules.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Appears to be private, with private operator.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? Yes, four monitoring wells sampled April, August, November for FC, TDS, TOC, ammonia, nitrate, chloride, TP and VOCs (Nov. only)
- Regularly scheduled operation and maintenance activities; Established in operation permit and approved specs.
- Man-hours per week or month routinely committed to O&M activities; 5x per week operator visits required for type VI system.
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);

  Items requiring attention from a May 2006 inspection report included:
    - Rusting top & underside of the aeration tank rim;
    - Splitter box in need of either replacement or sandblasting & repainting;
    - Inflow pipe replacement from lift station to equalization tank;
    - Event counters replacement at flow equalization control panel;
    - Guide rails & brackets for pumps in need of replacement;
    - Vegetation needing to be cut back at drainfield.
- Are there inspection or other “walkover” photos of the system that may be available to us? None located.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
- Influent Quality Data to the system (if available) and QA/QC provisions employed; No.

- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent. Info pending from engineer.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees

- Connection fees (if applicable); N/A
- Service fee structure and user fees charged N/A

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NC-9

A. Basic Information

- State/County where system is located; Dare County, NC
- Date permit was issued; 12-21-01 (state approval)
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 12-21-01

B. Design Information

Basic Design Information

- Type(s) of facilities served; Restaurant
- Design Flow; 9,600 gpd;
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? Believe this is a repair.
- Type of System
  1. Collection system: gravity, assumed
  2. Pretreatment system (primary, secondary, disinfection): Bioclere.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system): pump to conventional.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following: unknown, there is no design information in the state files
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
  (5) Soil/land loading rate. 1.0 gpd/sf.
  (6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; Dare County Health Department,
- Effluent quality limits (regulatory performance standards/limits for system); 30/30/30 mg/l, CBOD5/TSS/TN
- Are there periodic regulatory inspections of the system? Yes, per state rules.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NC-9

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Private
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? No.
- Regularly scheduled operation and maintenance activities; Established in operation permit.
- Man-hours per week or month routinely committed to O&M activities; 8 man-hours/month, average.
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
- Are there inspection or other "walkover" photos of the system that may be available to us? none found

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); reference monitoring reports
- Influent Quality Data to the system (if available) and QA/QC provisions employed; not measured
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. reference monitoring reports

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); unknown.

OM&M

- Hourly rates for personnel along with hours spent. $480 for 8 man-hours/month.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.) none specified.

Fees

- Connection fees (if applicable); N/A
- Service fee structure and user fees charged N/A

Other: No state file, so no access to plans and specs.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NC-10

A. Basic Information

- State/County where system is located; NC/Carteret (Coastal)
- Date permit was issued; January 5, 1993.
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). May 1992

B. Design Information

Basic Design Information

- Type(s) of facilities served; 46 Dwelling units (17 single beds, 13 double beds, and washing machines; 1 dwelling unit with kitchen, four washing machines), no food service
- Design Flow; 20,000 gpd.
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? This is a replacement/upgrade of the original septic tank/conventional system.
- Type of System
  1. Collection system Existing/original gravity/conventional w/lift stations
  2. Pretreatment system (primary, secondary, disinfection) Existing gravity sewer and lift station (23,000-gallon converted septic tank) to extended aeration package treatment plant, with 8603-gal equalization basin, 2 aeration tanks (23864 gallons, total), 2 secondary clarifiers (3370 gal., 72 sq ft, total), 2 aerated sludge holding tanks (3291-gal, total), 2 tertiary sand filters (14 sq ft, total), 1121-gallon mudwell, 1065-gallon clearwell, tablet chlorinator with 445-gallon chlorine contact chamber, 1400-gallon final dosing tank.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) Two LPP fields (2100, LF total)

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study); Assumed 300 mg/l BOD (basis not specified).
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). Not specified, but likely, OSWS recommendations (based on 10-state standards).
  (3) Loading rates to unit processes;
    a. Equalization basin = 25% design flow
    b. Aeration basin, approx 24 hour HRT.

c. Air for mixing = **30 cfm/1000 cf** (controls) or 2,100 cf/pound BOD (Ten states is 2000 cf/#)
d. Air for sludge holding = 1 cf/person minimum
e. 5,000 gpdpsf tertiary filters
f. Secondary clarifier = 4 hour HRT, SLR < 300 gpdpsf (167 actual)
g. Chlorine contact time of 0.5 hour HRT
h. Clearwell = 15 gpm/sf @ 10 minute backwash cycle.

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; Repair/replacement of existing conventional system under parking lot.
(5) Soil/land loading rate. 1.9 gpdpsf (aerial loading basis for LPP).
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None in file – was repair and also predated some of the more advanced site evaluation requirements.

C. Regulatory Information

- Regulatory authority and contact info; NC DEH; Carteret County, NC
- Effluent quality limits (regulatory performance standards/limits for system).
- Are there periodic regulatory inspections of the system? Yes

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Private ownership, contracted with private operator.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? No.
- Regularly scheduled operation and maintenance activities; Listed in permit; typical requirements ranging from daily to annual depending on the specific activity.
- Man-hours per week or month routinely committed to O&M activities; Requires daily ORC visits.
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
- Are there inspection or other “walkover” photos of the system that may be available to us? None located.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.

- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction
- Initial construction costs for the system (including design and permitting costs if available);

OM&M
- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees
- Connection fees (if applicable);
- Service fee structure and user fees charged;

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NC-11

A. Basic Information

- State/County where system is located; Dare County, NC (Coastal)
- Date permit was issued; 11-18-88 (original state approval); 3-14-03 (repair)
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). Summer, 1990.

B. Design Information

Basic Design Information

- Type(s) of facilities served; 84,744-sf shopping center (no food service).
- Design Flow; 13,000 gpd (for drainfields, per flow reduction) 17,000 gpd for pretreatment system.
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? Original system was standard extended aeration package plant to LPP. In 2003, extensive repairs were done to the corroded plant, including replacing some equipment. Additionally, the LPP drainfields were replaced.
- Type of System
  1. Collection system: Gravity with lift station to pump up to plant.
  2. Pretreatment system (primary, secondary, disinfection): Extended aeration package plant. 4" gravity sewer, 2538-gallon main lift station, 4" forcemain to treatment plant including 5110-gallon equalization basin, 17055-gallon aeration basins, 3395-gallon, 72-sf secondary clarifiers, 1705-gallon aerated sludge holding tank, 14.25-sf tertiary rapid sand filters, stilling well/flow meter, 3270-gallon final dosing tank, dual alternating pumps, two 4" effluent supply lines
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system): Two LPP fields, with a total of 2640-lf. Initially unsleeved low pressure pipe; replaced in same area with sleeved LPP.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study); Design flow based on use of low-flow fixtures and data from comparable facilities. Influent characteristics assumed standard.
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). Package plant design by PCI Sewage Treatment Systems, likely meeting minimum state guidelines.
  (3) Loading rates to unit processes;.report not located.

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; Highly permeable sand. High groundwater initially, but site leveled/filled.
(5) Soil/land loading rate. 0.98 gpdpsf (aerial basis for LPP)
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None in file (predates requirements?).

C. Regulatory Information

- Regulatory authority and contact info; Dare County Health.
- Effluent quality limits (regulatory performance standards/limits for system).
- Are there periodic regulatory inspections of the system? Yes, per state rules.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Appears to be privately owned and operated.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? No.
- Regularly scheduled operation and maintenance activities; Established in operation permit.
- Man-hours per week or month routinely committed to O&M activities;
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.); Badly corroded/deteriorating package plant structure and components, replaced in extensive recent repair. LPP system was unsleeved and violated property line setbacks, so it too was replaced at same time (2003). Unclear whether there were problem (e.g., surfacing) noted with old drainfields.
- Are there inspection or other "walkover" photos of the system that may be available to us? There are many good photos of plant corrosion in a structural report prepared by a tank inspection/repair consultant (in state files). Unknown if there are other photos.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Stilling well/flow meter in package plant.
- Influent Quality Data to the system (if available) and QA/QC provisions employed; N/A
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); Engineer indicated that this information is unavailable.

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NC-12

A. Basic Information

- State/County where system is located; NC/Forsythe (Piedmont/Foothills)
- Date permit was issued; original approval 9/8/89; repair approval 5/24/00
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 5/31/90 (installation inspection report); repair 1/31/01

B. Design Information

Basic Design Information

- Type(s) of facilities served; 90-bed rest home with laundry
- Design Flow; 10,800 gpd
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? Original system was way undersized and replaced with new tankage, pumps and pressure manifolds feeding conventional drainfields. This new system failed within 5-6 years and was replaced with recirculating sand filter pretreatment to new pressure manifolds and drainfields using deep trenches to penetrate more permeable soil horizon.
- Type of System
  1. Collection system Gravity/conventional
  2. Pretreatment system (primary, secondary, disinfection) Septic tanks, recirculating sand filter
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) Pressure manifold to deep conventional trenches (64-72" trench bottoms)

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study); Influent was analyzed for the repair design. Found high MBAS concentrations (32.5 mg/l); other parameters more or less normal.
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). For RSF, common practice and state guidance. For tanks and drainfields, state regs.
  (3) Loading rates to unit processes; 2 gpdpsf for RSF; 0.5 gpdpsf for drainfield.
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; Old system (without pretreatment) was failing hydraulically in the Bt horizon. Soil evaluation and Ksat measurement found significantly higher conductivities in the BC

horizon, so deep trenches with pretreatment was recommended. New, deep lines were installed between existing conventional lines.

(5) Soil/land loading rate. 0.5 gpdpsf

(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. 20 foot deep borings, pits, Ksat of various horizons, transects to map more permissive BC horizon across site, particle size analysis on Bt and BC.

C. Regulatory Information

- Regulatory authority and contact info; NC DEH; Forsythe County, NC
- Effluent quality limits (regulatory performance standards/limits for system); BOD_5 of 200 mg/L for transfer tank, 15 mg/L for sand filter effluent; TSS of 100 and 10, respectively; G+O of 50 and 10, respectively; TN of 40 mg/L in sand filter effluent; Ammonia of 10 mg/L as N in sand filter effluent; MBAS of 5 in sand filter effluent and pH of 6-9 in sand filter effluent.
- Are there periodic regulatory inspections of the system? Yes

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Private ownership and operation.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? No, but there are water level monitoring wells in some of the deep trenches.
- Regularly scheduled operation and maintenance activities; Monthly inspection of pumps, controls and floats; weekly inspection of spray nozzles, recordation of pump cycle counters and run times, pump grease trap every six months, pump septic tanks annually, clean effluent filters on septic tank annually, clean effluent filters on grease trap quarterly, measure/adjust manifold pressures and delivery rates every six months.
- Man-hours per week or month routinely committed to O&M activities; unknown
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.); Nothing is noted in the file, with the exception of the failure of the old system, due in part to lack of maintenance among other things..
- Are there inspection or other “walkover” photos of the system that may be available to us? None located;

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Main water meter which correlates well with flow estimated using pump run times for the wastewater system. For four weeks in early 2001, daily flows averaging 6191, 5924, 7165 and 5814 were recorded.

- Influent Quality Data to the system (if available) and QA/QC provisions employed;
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent. Info. pending from engineer.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged;

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NC-13

A. Basic Information

- State/County where system is located; NC/Dare (Coastal)
- Date permit was issued; July 7, 2002
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). August 2002

B. Design Information

Basic Design Information

- Type(s) of facilities served; Elementary school with 600 students (cafeteria, no showers)
- Design Flow; 7,200 gpd
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? Replacement of existing school (buildings)/system. Acceptable space and repair area were limited so pretreatment was necessary to allow higher LTAR.
- Type of System
  1. Collection system Conventional/lift station. Grease trap/sewer goes to main lift station which is pumped to treatment area, which includes the septic tank and pretreatment.
  2. Pretreatment system (primary, secondary, disinfection) 3000-gal grease trap, two 4000-gal septic tanks in series, 30/24 Bioclere unit, 1200-gal secondary settling tank with effluent screen, 5000-gal dosing tank.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) Two low pressure pipe fields (7600 sf total)

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study); 350 mg/l BOD_5, 200 mg/l TSS, 75 mg/l TKN (based on "school with cafeteria")
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). For tanks and drainfields, state regs. For Bioclere, based on AWT design process and 30/30 limits.
  (3) Loading rates to unit processes; Bioclere filter: 0.043 lbs. $CBOD_5/ft^3$-day, < 1200 gpdpsf peak hourly hydraulic loading (design is for 183 at average and 367 at peak loading). 3.8-hour HRT.
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; Limited space/site

features (404 wetlands, a marsh, gullies, a borrow site). Low elevation (finished drainfield elevations are at 10' MSL) and associated high groundwater table (SHWT @ 44-48" below original grade). Little hydraulic gradient.

(5) Soil/land loading rate. 0.95 gpdpsf (aerial LPP basis, based on pretreatment)

(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. Standard shallow borings, mounding analysis based on assumed soil/site properties and SHWT. Geotechnical borings to a depth of 30'.

C. Regulatory Information

- Regulatory authority and contact info; NC DEH; Dare County, NC
- Effluent quality limits (regulatory performance standards/limits for system); From permit flow 7200 gpd, $CBOD_5$ 30 mg/l, TSS 30 mg/l.
- Are there periodic regulatory inspections of the system? Yes.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Public ownership and operation.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? Yes, two monitoring wells, one upgradient one downgradient.
- Regularly scheduled operation and maintenance activities; Listed in permit.
- Man-hours per week or month routinely committed to O&M activities; Minimum of one ORC visit per week required.
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
- Are there inspection or other "walkover" photos of the system that may be available to us? None located.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Yes.
- Influent Quality Data to the system (if available) and QA/QC provisions employed; None available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. Yes.

E. Cost Information – None provided by engineer.

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees

- Connection fees (if applicable); N/A
- Service fee structure and user fees charged N/A

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NC-14

A. Basic Information

- State/County where system is located; NC/Carteret (Coastal)
- Date permit was issued; January 9, 1998.
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1998

B. Design Information

Basic Design Information

- Type(s) of facilities served; 28 four-bedroom homes; 20 four-bedroom homes and 14 three-bedroom homes
- Design Flow; Permit: 28,028 gpd. Plant design for 60,000 gpd (three 20K trains). LPP design: 40,000 gpd.
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? New grinder pump pressure sewer, extended aeration system with denitrification and LPP design. Designed to be installed in phases to accommodate incremental increases in flow.
- Type of System
  1. Collection system Grinder pumps at each house, pressure sewer.
  2. Pretreatment system (primary, secondary, disinfection) 28 grinder pump stations feeding 2", 2 ½", 3 ½", 4" pressure sewer to 15,600-gallon surge tank, pumping to three-way flow splitter (one closed off) and 40,000 gpd extended aeration plant – two 20,000 gpd trains, each with a 3,000-gal sludge holding tank, 20,000-gal aeration basin, 3700-gallon dual-hopper clarifier, 60,000-gpd dentrification/solids removal filters with methanol feed system (three 14-sf deep-bed gravity filters, 4600-gal clearwell, 4000-gal mudwell), dual tablet chlorinators, 1350-gallon chlorine contact chamber, stilling well and flow monitoring device, 2500-gal final pump drainfield dosing tank.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) 4 LPP fields (three installed, one future) @ 59,000 sf, total.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study); Assumed 240 mg/l BOD (basis not specified), effluent BOD/TSS of 10 mg/l.
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF

MOP, EPA design manual methodology, Metcalf Eddy, etc.). Not specified, but likely, OSWS recommendations (based on 10-state standards).

(3) Loading rates to unit processes;
   a. 30% Q for surge tank sizing (20 cfm/1000 cf aeration)
   b. Aeration basin = approx 24 hour HRT and 30 cfm/1000 cf aeration
   c. Sludge holding = 7,000 gal and 30 cfm/1000 cf aeration
   d. Secondary clarifiers = 4-hour HRT and 300 gpdpsf surface loading
   e. 1.00 gpmpsf tertiary filters
   f. 0.5 hour CC HRT
   g. Clearwell = 15 gpm/sf @ 10 minute backwash cycle
   h. Sludge holding @ 10% daily flow.

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; High groundwater table required removal of surface layer and fill to a finished elevation of 21.5' MSL. River adjacent to site, so GW monitoring required.

(5) Soil/land loading rate. 1.03 gpdpsf (aerial loading basis for LPP)

(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. Deep borings, Ksats in different zones (via constant head permeameter in vadose zone and slug testing in saturated zone) and mounding analysis. Ksat and specific yield from aquifer pump test to 28' depth. Site generally coarse sand with slightly restrictive spodic layer of varying thickness at 4.5-6.0 feet. Seasonal high GWT at 55-85" below grade. LPP layout results in modeled 1.4' mounding height.

C. Regulatory Information

- Regulatory authority and contact info; NC DEH; Carteret County, NC
- Effluent quality limits (regulatory performance standards/limits for system);
- Are there periodic regulatory inspections of the system? Yes

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Private ownership (HOA), contracted with private operator.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? Yes, three monitoring wells: MW-1 upgradient, MW-2 and MW-3 downgradient.
- Regularly scheduled operation and maintenance activities; Listed in permit; typical requirements ranging from daily to annual depending on the specific activity.
- Man-hours per week or month routinely committed to O&M activities; Requires 5 day/week ORC visits.

- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.).
- Are there inspection or other "walkover" photos of the system that may be available to us? None located.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Stilling well/flow meter.
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NC-15

A. Basic Information

- State/County where system is located; NC/Cumberland County
- Date permit was issued; April 1, 1999 (state approval).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). July, 2001

B. Design Information

Basic Design Information

- Type(s) of facilities served; 950 student elementary school
- Design Flow; 6,000 gpd (flow reduction based on extreme water conserving fixtures) for drainfields. 11,400 gpd for pretreatment.
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? The original system (put into service in 2001) was for a new school and consisted of RSF to pressure manifold/conventional. Nitrate problems were discovered in monitoring and adjacent water supply wells, so modifications to the system were made including partial flooding of the sand filter (for denitrification) and relocation of the drainfields using LPP distribution in conventional-width (3') trenches.
- Type of System
  1. Collection system ST/GT - conventional.
  2. Pretreatment system (primary, secondary, disinfection) 12,000-gal septic tank, two grease traps with total capacity of 7,000 gal. 4,000 flow equalization RSF dosing tank, RSF (three trains, total of 3,816 sf, with LPP distribution), 8,000-gal final dosing tank with dual pumps/forcemains to two LPP fields.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system) 2 LPP fields installed in conventional trenches. 2,266 LF total.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study); Not explicitly stated.
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). Not specified; assumed to be per state standards.
  (3) Loading rates to unit processes; 3 gpd/sf for RSF.

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; A subdivision on private wells was located about 500' away (downgradient) from the original conventional fields. The soils in the original conventional drainfield area was by all accounts good (sandy loam, sandy clay loam) with groundwater at least 11.0 feet below grade. Better Ksats in Bt horizon dictated relatively shallow trench bottom placement. Monitoring wells were required and elevated nitrate concentrations in downgradient groundwater were discovered within 1-2 years of operation. Replacement fields with better distribution (LPP) to prevent localized overloading were installed at the other end of the site. These have only been in service for 1-2 years.

(5) Soil/land loading rate. 0.30 gpd/sf for original conventional system. 1.0 gpd/sf and 0.8 gpd/sf for replacement LPP system

(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. Hand borings, deep borings to 204". constant head permeameter used to measure Ksat in unsaturated horizons, slug tests to estimate Ksat in saturated horizons. Colorado State University mounding models. Transport time (to surface water) calculation.

C. Regulatory Information

- Regulatory authority and contact info; NC DEH; Cumberland County, NC
- Effluent quality limits (regulatory performance standards/limits for system); STE: 200 mg/l BOD, 100 mg/l TSS, 50 mg/l O&G. RSF: 10/10/10 BOD/TSS/O&G and 40% TN reduction from STE.
- Are there periodic regulatory inspections of the system? Yes, by law.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Public: Cumberland County Board of Education.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? Yes, the original drainfields had an up- (MW-1) and down-gradient (MW-2) well installed. An additional six monitoring wells were installed as a result of the comprehensive groundwater site assessment required by the state after GW nitrate exceedences were noted.
- Regularly scheduled operation and maintenance activities; Not indicated, but can be assumed to be consistent with typical RSF and LPP systems.
- Man-hours per week or month routinely committed to O&M activities; Requires weekly ORC visits.

- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.); Inspection information in file. Sand filter had flooding problems. Major nitrate GW violations.
- Are there inspection or other "walkover" photos of the system that may be available to us? None located.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Does not appear to have been reported
- Influent Quality Data to the system (if available) and QA/QC provisions employed; None available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); Original costs ~$200,000 (have spent another ~$500,000 since system construction for replacement and associated costs).

OM&M

- Hourly rates for personnel along with hours spent. Not specified.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.) Power usage "negligible". ~$1,000/year for sludge pumping.

Fees

- Connection fees (if applicable); N/A
- Service fee structure and user fees charged N/A

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NC-ND-1
Note: No effluent quality data for this system

A. Basic Information

- State/County where system is located;
  - North Carolina/Orange County (Piedmont)
- Date permit was issued;
  - 02/16/1990
- Date system went into service (confirm that there are at least 5 years of operation of the system before today).
  - 10/01/1995

B. Design Information

Basic Design Information

- Type(s) of facilities served;
  - 25 unit mobile home park
- Design Flow;
  - 9000 GPD
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
  - The system serves the expansion of an existing MHP and is the original system.
- Type of System
  1. Collection system
  - Each mobile home is served by an individual septic tank and the effluent is collected via a network of gravity lines that lead to a central pump / dosing station.
  2. Pretreatment system (primary, secondary, disinfection)
  - Primary is by septic tank. A settling chamber with an Orenco biofilter precedes the LPP dosing tank with 4 pumps. There is no secondary treatment
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system)
  - Subsurface trenches in 4 independently dosed drainfields with LPP distribution.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
    - Assumption is that waste is domestic strength only. Residential flow from 3 bedroom units is 360 GPD.

  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or

recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).

- System was designed by a professional engineer using state (NC) and local county (Orange County) design criteria.

(3) Loading rates to unit processes;

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;

- 36 to 48" of provisionally suitable soil (Group IV clay) overlaying saprolite. Trenches were installed at a depth of 18" to the trench bottom.

(5) Soil/land loading rate.

- 0.15 GPD/ft2 (system footprint, not trench bottoms)

(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

- None

C. Regulatory Information

- Regulatory authority and contact info;
  - Orange County Health Department
- Effluent quality limits (regulatory performance standards/limits for system);
  - none
- Are there periodic regulatory inspections of the system?
  - The Operator monitors the system every month
  - The Health Department monitors the system every 12 months

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
  - Private operator certified by the State of NC
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system?
  - No
- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers?
  - Owned by a private corporation
- Regularly scheduled operation and maintenance activities;
  - Monthly maintenance and operation visits by the operator
- Man-hours per week or month routinely committed to O&M activities;
  - Estimated 6 to 8 hours per month

- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
- Are there inspection or other "walkover" photos of the system that may be available to us?
    - None existing.

Quantitative
- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
    - Each pump has an elapsed time meter which is read and recorded monthly. This is calculated along with the corresponding pump delivery rate and an average daily flow is determined once/month.

        2-2006: 6505 gpd avg.
        1-2006: 5641 gpd avg.
        5-2005: 3474 gpd avg.
        4-2005: 6868 gpd avg.
        3-2005: 5862 gpd avg.
        1-2005: 4687 gpd avg.
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
    - There are no influent quality standards for this system.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.
    - There are no effluent quality standards for this system.

E. Cost Information

Design/Construction
- Initial construction costs for the system (including design and permitting costs if available);
    - unknown

OM&M
- Hourly rates for personnel along with hours spent.
    - unknown
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
    - unknown

Fees
- Connection fees (if applicable);
    - N/A

Note: No effluent quality data for this system

- Service fee structure and user fees charged
  - N/A

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System NC-ND-1
Note: No effluent quality data for this system

Summary of Inspection Reports:

Over the period from January 2001 through February 2006, a total of 50 inspection reports were reviewed. During this period:

8 reports indicated system was compliant with permit and operation requirements;
40 reports indicated the system was non-compliant: Problems/violations included:

- Broken turn-ups in field areas;
- Septic tanks, grease traps and/or pump tanks needing cleaning/pumping;
- Broken/cracked conduits;
- Broken riser hatch;
- Field in need of clearing or mowing;
- Tees in need of replacement;
- Development of depressions/low spots in drainfield(s);
- Inoperable alarm;
- Effluent filter in need of cleaning;
- Evidence of surfacing effluent;
- Alarm not sounding loud enough, or not sounding at all;

2 reports indicated some portion of the system was malfunctioning. Causes included:

- Average flow above permitted limit (13,723 gpd measured average flow);
- Lines in need of flushing.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
NC-OperatorData-1
NOTE: Data was provided by private operator (not from regulatory files)

A. Basic Information

- State/County where system is located; Davidson County, NC (Piedmont)
- Date permit was issued; 12-19-96 (original state approval)
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). May 1998

B. Design Information

Basic Design Information

- Type(s) of facilities served; Shopping center (full service grocery store, drug store, retail, 2 (takeout) restaurants.
- Design Flow; 5,650 gpd (for drainfields per flow reduction) almost 9,000 gpd for pretreatment system.
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? New system, but the RSFs immediately failed, so it was converted to recirc. aerated gravel filters in 2000.
- Type of System
  1. Collection system: gravity
  2. Pretreatment system (primary, secondary, disinfection): Recirculating aerated gravel filters.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system): Perc Rite drip irrigation system.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study); design flow based on use of low-flow fixtures and data from comparable facilities. Influent characteristics for gravel filter design based on existing system sampling.
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). Gravel filter aeration based on EPA guidance.
  (3) Loading rates to unit processes; 2.5 gpdpsf based on full, unreduced flow rate.
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; Did not encounter rock at depths up to 25'. Encountered water at 24' in one boring. Saprolite present around 36".
  (5) Soil/land loading rate. 0.1 gpdpsf, drip

(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. Deep borings and saturated hydraulic conductivity measurements were taken for a lateral subsurface flow analysis. Soil consultant.

C. Regulatory Information

- Regulatory authority and contact info; Davidson County Health Department
- Effluent quality limits (regulatory performance standards/limits for system); Draft operation permit indicates 30/30 BOD/TSS, 20 O&G and 6-8 pH.
- Are there periodic regulatory inspections of the system? Yes, per state rules.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Appears to be privately owned by facility owner.
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system? No.
- Regularly scheduled operation and maintenance activities; Established in operation permit and approved specs.
- Man-hours per week or month routinely committed to O&M activities 10 man-hours per month
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.); Wet spots on drip fields and ponding in RSF during inspections reports for the original RSF installation, necessitating conversion to aerated RGF. ORC indicates that drip spin filter clogging is a maintenance issue at this time – have to be cleaned every 5-8 days. Attribute to a Chinese restaurant on the system. Have had trouble with computer systems being affected by summer thunderstorms.
- Are there inspection or other "walkover" photos of the system that may be available to us? unknown

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Measured via PercRite computer system. Data is available electronically.
- Influent Quality Data to the system (if available) and QA/QC provisions employed; There is some limited influent data for the old, failed RSF in the state file.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data

for regulated parameters; In addition, whatever other monitoring data has been collected and is available. Operator has provided well-organized electronic effluent data for RGF system.

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); Unknown – owner could not be contacted.

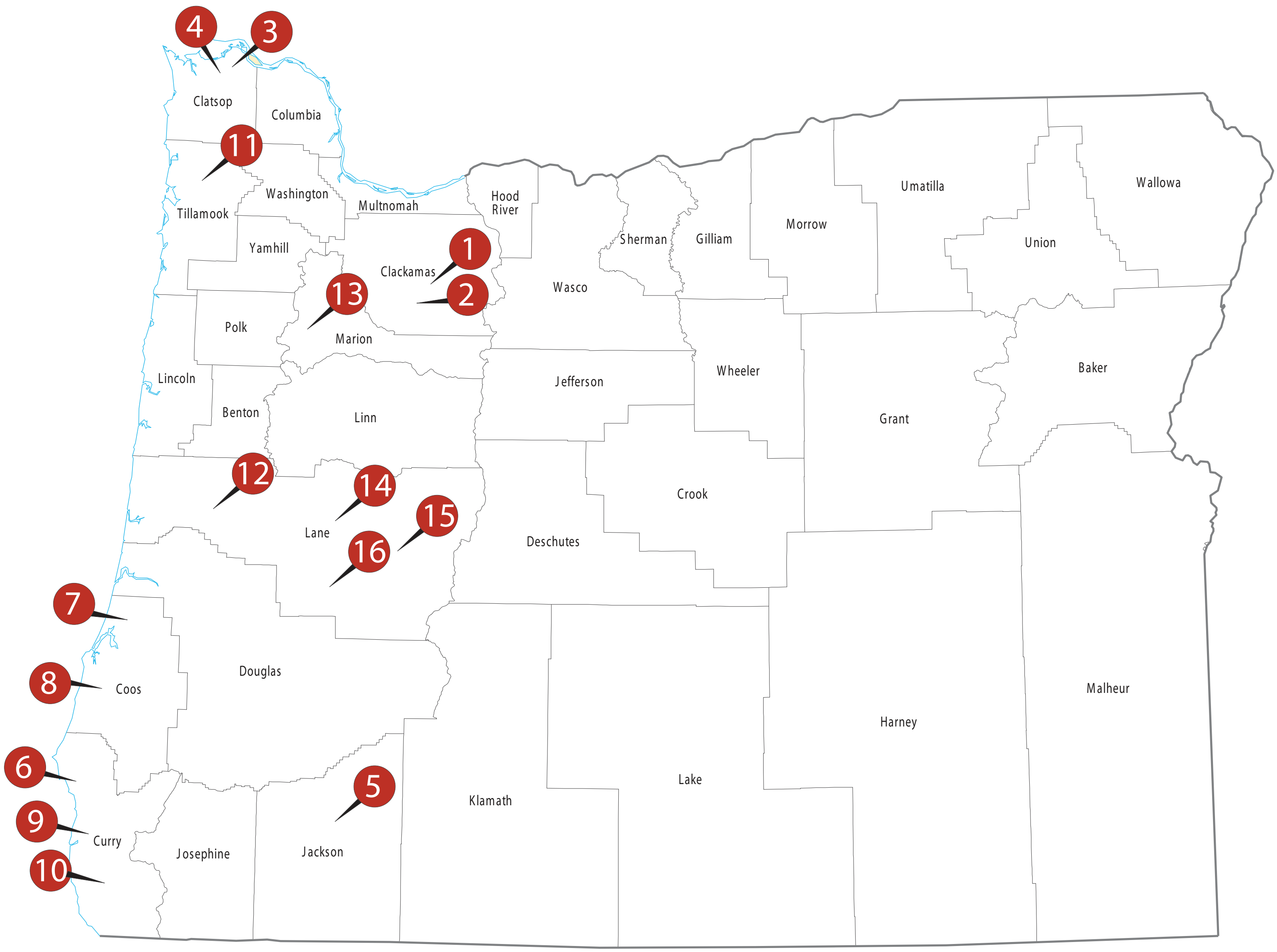
OM&M

- Hourly rates for personnel along with hours spent. $75/hour; roughly 14 hours/month.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.) $120/month for sample analysis.

Fees

- Connection fees (if applicable); NA, single owner
- Service fee structure and user fees charged NA, single owner

Appendix 9.A
By-County Locations of Oregon Systems For Which Data Was Gathered



1. Clackamas County; Conventional gravity collection; Septic tankpretreatment (16,200 gallons capacity); Recirculating sand filter (3,000 ft2), with 6,500 gallon recirculation tank; Subsurface drainfield (3,200 L.F.); System into service July 1994; Design flow 9,400 gpd (Max daily flow 10,400 gpd); Privately Managed; Residential Subdivision.

2. Clackamas County; Septic tank pretreatment; Recirculating sand filterwith recirculation tank; Subsurface pressure dosed drainfield; System into service September 2000; Design flow 8,000 gpd; Privately Managed; Church.

3. Clatsop County; Grease Trap (3,000 gallons); Septic tank pretreatment (3,000 gallons); Subsurface pressure dosed drainfield (3,000 gallon dosing tank, to 8 Drainfield cells); System into service May 1993; Design flow 7,350 gpd; Privately Managed; Restaurant/Inn.

4. Clatsop County; Septic tank pretreatment; Rotating Biological Contactor w/Methanol feed; Anoxic treatment unit; Subsurface Drainfield; System into service 1984; Design flow 19,500 gpd; Privately Managed; Mobile Home Park.

5. Jackson County; Septic tank pretreatment (10-1,000 Gallon tanks); Recirculating Sand/Gravel Filter (4,878 ft2); Subsurface Drainfield (1,400 L.F. of trench); System intoservice 1996; Design flow 6,000 gpd; Privately Managed; Mobile Home Park.

6. Curry County; Septic tank pretreatment; Recirculating Sand Filter; Subsurface Drainfield; System into service 2000; Design flow 16,000 gpd; Privately Managed;
Inn/Resort.

7. Coos County; Septic tank pretreatment; Recirculating Sand Filter; Subsurface Drainfield; System into service 1998; Design flow 8,600 gpd; Privately Managed; RV Park.

8. Coos County; Septic tank pretreatment; Recirculating Sand Filter; Subsurface Drainfield; System into service 2000; Design flow 13,550 gpd; Privately Managed; RV Park and Campsites.

9. Curry County; Septic tank pretreatment; Subsurface Drainfield; System intoservice 1999; Design flow 13,500 gpd; Privately Managed; Community System.

10. Curry County; Septic tank pretreatment; Recirculating Textile Filters; Subsurface Drainfield; System into service 2001; Design flow 13,500 gpd; Privately Managed; Community System.

11. Tillamook County ; Septic tank pretreatment; Recirculating gravel filter (2,877 ft2); Subsurface Pressurized Drainfield/Seepage Bed (52'x74', in sandy soils); System into service 1988; Design flow 14,500 gpd; Privately Managed; Church Camp.

12. Lane County; Septic tank pretreatment; Recirculating gravel filter (32'x48'); Subsurface Drainfield; System into service 1999; Permitted flow = 5,503 gpd (Design flow for RGF = 7,100 gpd); Privately Managed; RV Park.

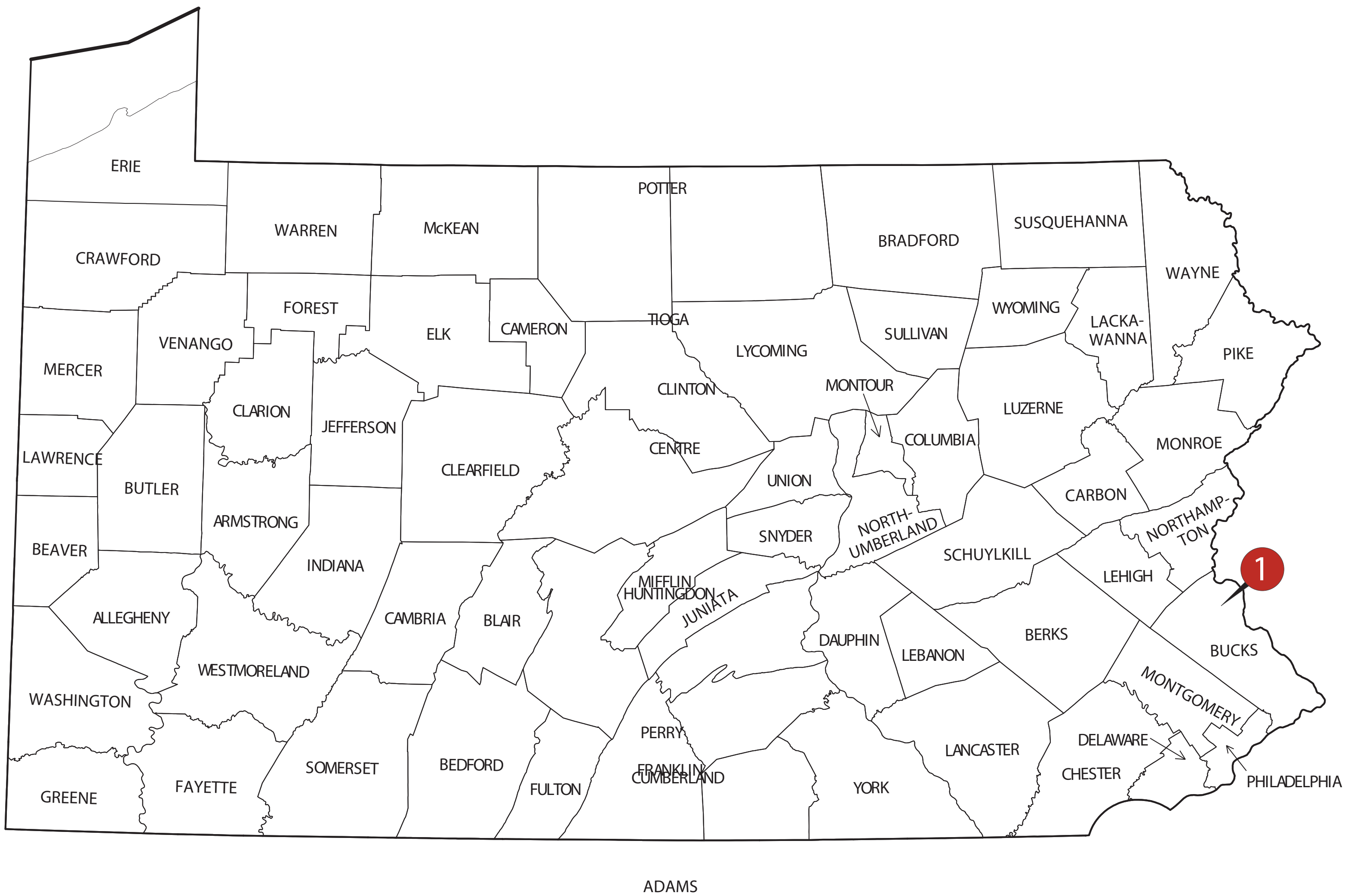
13. Marion County; Septic tank pretreatment; Recirculating gravel filter (49' x 78'); Subsurface Drainfield (8,120 L.F. of Seepage trenches); System into service 1999; Design flow 19,110 gpd; Publicly Managed; School (K-12).

14. Lane County; Septic tank pretreatment; Recirculating Gravel Filter (3,950 ft 2); Subsurface Drainfield (6,760 L.F. of trenches); System into service 2001; Design flow 19,750 gpd; Privately Managed; Mobile Home Park.

15. Lane County; Septic tank pretreatment (11,000 gallons); Recirculating Gravel Filter; Subsurface Drainfield (1,650 L.F.); System into service 2001; Design flow 5,500 gpd; Publicly Managed; Middle School.

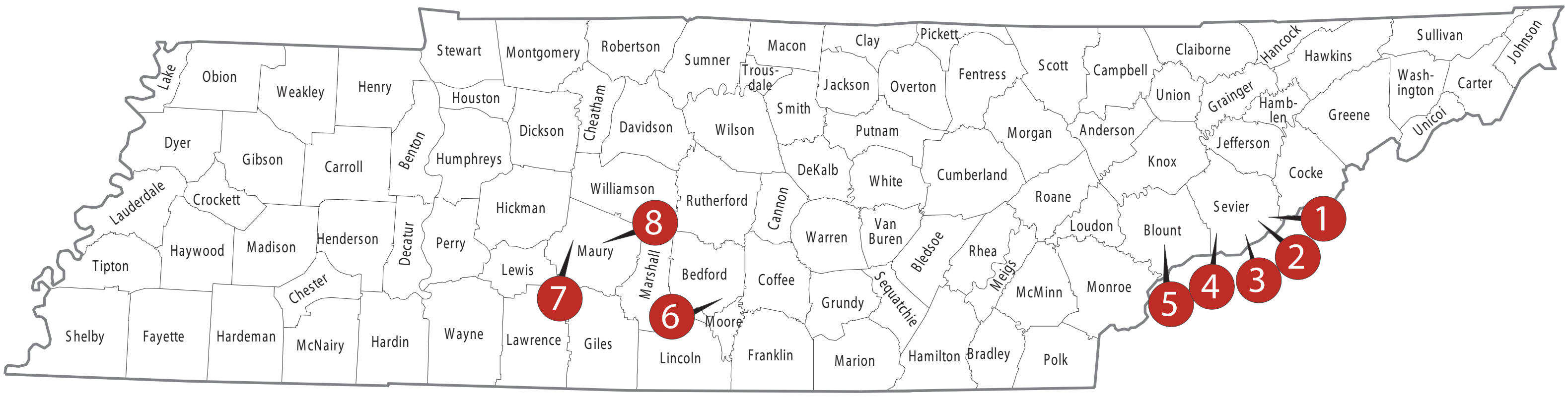
16. Lane County; Septic tank pretreatment (2-3,000 gallon tanks); Recirculating Gravel Filter (3,000 gallon recirc. tank); Subsurface Drainfield (1,000 gallon dosing tank & 1,400 L.F. of trench); System into service 1992; Design flow 5,750 gpd; Privately Managed; Mobile Home Park.

Appendix 10.A
By-County Locations of Pennsylvania Systems



1. Bucks County; Conventional Collection System with 1 grinder lift station serving a portion of the collection system; Primary, secondary & tertiary aerated lagoon treatment system; Chlorination; Surface irrigation of treated effluent; Until May 2006, permitted for 40,000 gpd; Thereafter permitted for 58,300 gpd; Township acquired and began operating system in 1991; Publicly Managed; Community system.

Appendix 11.A
By-County Locations of Tennessee Systems



1. Sevier County; STEP/STEG Collection system (Septic tank pretreatment via collection system); Bioclere treatment system; Drip Irrigation; System into service 2003. Design (Permitted) flow 30,000 gpd; Managed by privately owned public utility; Resort/Rental Cabins.

2. Sevier County; STEP/STEG Collection System; Recirculating Sand/Gravel Filter; Drip Irrigation; Into service 2000; Design flow 18,000 gpd; Managed by privately owned public utility; Resort/Rental Cabins.

3. Sevier County; STEP/STEG Collection System; Recirculating Sand/Gravel Filter; Drip Irrigation; Into service 2000; Design flow 15,750 gpd; Managed by privately owned public utility; Resort/Rental Cabins.

4. Sevier County; STEP/STEG Collection System; Bioclere Treatment System; Drip Irrigation; Into service 2002; Design flow 30,000 gpd; Managed by privately owned public utility; Resort/Rental Cabins.

5. Blount County; STEP/STEG Collection System (septic tank pretreatment); Recirculating sand/gravel filter treatment system; Drip Irrigation; Into service 2000; Design flow 23,100 gpd; Managed by privately owned public utility; Subdivision.

6. Bedford County; STEP Collection System (septic tank pretreatment); Recirculating sand/gravel treatment; Drip Irrigation; Into service May 2002; Design flow 7,000 gpd; Managed by privately owned public utility; Residential condominiums.

7. Maury County; STEP Collection System (septic tank pretreatment); Recirculating sand/gravel treatment; Drip Irrigation; Into service January 1998; Design flow 40,000 gpd; Managed by privately owned public utility; Residential Subdivision.

8. Maury County; STEP Collection System (septic tank pretreatment); Recirculating sand/gravel treatment; Drip Irrigation; Into service February, 2001; Design flow 15,000 gpd; Managed by privately owned public utility; Church.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TN-1

A. Basic Information

- State/County where system is located; TN/Sevier
- Date permit was issued; May 2003 (most recent).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 2003

B. Design Information

Basic Design Information

- Type(s) of facilities served; Rental Cabins
- Design Flow; 30,000 gpd
- History of systems on site: Is this system a replacement? No
- Type of System
  1. Collection system: STEP/STEG small diameter sewer system
  2. Pretreatment system (primary, secondary, disinfections); Bioclere
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Drip Irrigation

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study: Domestic wastewater (BOD_5 150 mg/l; TSS 80 mg/L)
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). State design criteria.
  (3) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; Slopes.
  (4) Soil/land loading rate; 2.0 inches per week over approximately 4 acres
  (5) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; Tennessee Department of Environment and Conservation (TDEC)
- Effluent quality limits (regulatory performance standards/limits for system); BOD_5 (once quarterly) limit of 45 mg/L; Ammonia as N (once quarterly) report; All Grab Samples

- Are there periodic *regulatory* inspections of the system? Initial Site visit

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Privately owned public utility. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Private contractors

- Regularly scheduled operation and maintenance activities;
  - Check Flow meter readings; Check alarm panel; Check screw-on caps at ends of field lines (to confirm that no tampering has occurred, and that caps are in place).
  - Monthly: Clean effluent filters; Check HydroTek valve box;
  - Visit Sites Periodically
  - Check all pumps
  - Check electronics
  - Lab testing includes:
    - BOD_5
    - Ammonia and Nitrate as N

- Man-hours per week routinely committed to O&M activities;
  ~ 2 hours per week, total.

  Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
  - Pump or Motor replacement, cost of ; ($350-$600)
  - Float Replacement, cost of; ($40-$60)

- Are there inspection or other "walkover" photos of the system that may be available to us? Yes

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Flow Meter
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); Approximately $300,000, including engineering.

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
  - Power costs average $159.57 monthly ($1,914.88 for the most recent 12 months/year)
  - Sludge pumping locally costs $250 per residential size tank (1,500 gallons), but to date, very few tanks have been pumped for these systems.

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged

  Residential customers pay flat rate statewide of $35.54 per month. Commercial (which will include this project) units pay a graduated rate based on flow ($75 without food, and $100 with food) for up to 300 gpd average then up.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TN-2

A. Basic Information

- State/County where system is located; TN/Sevier
- Date permit was issued; August 2006 (most recent).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 2000.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Rental Cabins
- Design Flow; 18,000 gpd
- History of systems on site: Is this system a replacement? No
- Type of System
  1. Collection system: STEP/STEG small diameter sewer system
  2. Pretreatment system (primary, secondary, disinfections); RSF
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Drip Irrigation

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study: Domestic wastewater (BOD_5 150 mg/l; TSS 80 mg/L)
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). State design criteria.
  (3) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; Slopes.
  (4) Soil/land loading rate; 2.0 inches per week over approximately 2.3 acres
  (5) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; Tennessee Department of Environment and Conservation (TDEC)
- Effluent quality limits (regulatory performance standards/limits for system); BOD_5 (once quarterly) limit of 45 mg/L; Ammonia as N (once quarterly) report; All Grab Samples

- Are there periodic *regulatory* inspections of the system? Initial Site visit

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Privately owned public utility. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Private contractors

- Regularly scheduled operation and maintenance activities;
    - Check Flow meter readings; Check alarm panel; Check screw-on caps at ends of field lines (to confirm that no tampering has occurred, and that caps are in place).
    - Monthly: Clean effluent filters; Check HydroTek valve box;
    - Visit Sites Periodically
    - Check all pumps
    - Check electronics
    - Lab testing includes:
        - BOD_5
        - Ammonia and Nitrate as N

- Man-hours per week routinely committed to O&M activities;
  ~ 2 hours per week, total.

  Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
    - Pump or Motor replacement, cost of ; ($350-$600)
    - Float Replacement, cost of; ($40-$60)

- Are there inspection or other "walkover" photos of the system that may be available to us? Yes

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Manual read Flow Meter
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); Approximately $227,000, including engineering.

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
  - Power costs average $136.05/month ($1,632.58 for the most recent 12 months/year)
  - Sludge pumping costs $250 locally per residential size tank (1,500 gallons), but to date, very few tanks have been pumped for these systems.

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged

Residential customers pay flat rate statewide of $35.54 per month. Commercial (which will include this project) units pay a graduated rate based on flow ($75 without food, and $100 with food) for up to 300 gpd average then up.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TN-3

A. Basic Information

- State/County where system is located; TN/Sevier
- Date permit was issued; October 2006 (most recent).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 2000.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Rental Cabins
- Design Flow; 15,750 gpd
- History of systems on site: Is this system a replacement? No
- Type of System
  1. Collection system: STEP/STEG small diameter sewer system
  2. Pretreatment system (primary, secondary, disinfections); RSF
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Drip Irrigation

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study: Domestic wastewater (BOD_5 150 mg/l; TSS 80 mg/L)
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). State design criteria.
  (3) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; Slopes.
  (4) Soil/land loading rate; 2.0-2.5 inches per week over approximately 2.0 acres
  (5) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; Tennessee Department of Environment and Conservation (TDEC)
- Effluent quality limits (regulatory performance standards/limits for system); BOD_5 (once quarterly) limit of 45 mg/L; Ammonia as N (once quarterly) report;

Nitrate as N (once quarterly) limit of 20 mg/l; E. Coli (once quarterly) limit 23 colonies/100 ml; All Grab Samples

- Are there periodic *regulatory* inspections of the system? No

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Privately owned public utility. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Private contractors

- Regularly scheduled operation and maintenance activities;
  - Check Flow meter readings; Check alarm panel; Check screw-on caps at ends of field lines (to confirm that no tampering has occurred, and that caps are in place).
  - Monthly: Clean effluent filters; Check HydroTek valve box;
  - Visit Sites Periodically
  - Check all pumps
  - Check electronics
  - Lab testing includes:
    - BOD_5
    - Ammonia and Nitrate as N
    - E. Coli

- Man-hours per week routinely committed to O&M activities;
  ~ 2 hours per week, total.

  Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
  - Pump or Motor replacement, cost of ; ($350-$600)
  - Float Replacement, cost of; ($40-$60)

- Are there inspection or other "walkover" photos of the system that may be available to us? Yes

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Flow Meter
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a

minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

Cost Information

Design/Construction
- Initial construction costs for the system (including design and permitting costs if available); Approximately $179,000, including engineering.

OM&M
- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
    - Power costs average $201.19 per month ($2,414.33 for the most recent 12 months/year).
    - Sludge pumping costs $250 locally per residential size tank (1,500 gallons), but to date, very few tanks have been pumped for these systems.

Fees
- Connection fees (if applicable);
- Service fee structure and user fees charged

Residential customers pay flat rate statewide of $35.54 per month. Commercial (which will include this project) units pay a graduated rate based on flow ($75 without food, and $100 with food) for up to 300 gpd average then up.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TN-4

A. Basic Information

- State/County where system is located; TN/Sevier
- Date permit was issued; March 2007 (most recent).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). March 2002 for most recent treatment plant.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Rental Cabins
- Design Flow; 30,000 gpd
- History of systems on site: Is this system a replacement? No
- Type of System
  1. Collection system: STEP/STEG small diameter sewer system
  2. Pretreatment system (primary, secondary, disinfections); Bioclere
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Drip Irrigation

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study: Domestic Wastewater
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). State design criteria.
  (3) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; Surface irrigation system.
  (4) Soil/land loading rate; 2-2.4 inches/week over 3.5 acres
  (5) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; Tennessee Department of Environment and Conservation (TDEC)
- Effluent quality limits (regulatory performance standards/limits for system); BOD_5 (once quarterly) limit of 45 mg/L; Ammonia as N (once quarterly) report and Nitrate as N (once quarterly) limit 25 mg/l; E. Coli (once quarterly) limit 23 colonies/100 ml; All Grab Samples

- Are there periodic *regulatory* inspections of the system? Initial Site visit

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Privately owned public utility. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Private contractors

- Regularly scheduled operation and maintenance activities;
  - Check Flow meter readings; Check alarm panel; Check screw-on caps at ends of field lines (to confirm that no tampering has occurred, and that caps are in place).
  - Monthly: Clean effluent filters; Check HydroTek valve box;
  - Visit Sites Periodically
  - Check all pumps
  - Check electronics
  - Lab testing includes:
    - BOD_5
    - Ammonia and Nitrate as N
    - E Coli
- Man-hours per week routinely committed to O&M activities;
  ~ 2 hours per week, total.

  Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
  - Pump or Motor replacement, cost of ; ($350-$600)
  - Float Replacement, cost of; ($40-$60)

- Are there inspection or other "walkover" photos of the system that may be available to us? Yes

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Flow Meter
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); Approximately $300,000, including engineering

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
  - Power costs average $214.71 per month ($2,576.55 for the most recent 12 months/year).
  - Sludge pumping costs $250 locally per residential size tank (1,500 gallons), but to date, very few tanks have been pumped for these systems.

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged

  Residential customers pay flat rate statewide of $35.54 per month. Commercial (which will include this project) units pay a graduated rate based on flow ($75 without food, and $100 with food) for up to 300 gpd average then up.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TN-5

A. Basic Information

- State/County where system is located; TN/Blount
- Date permit was issued; March 2005 (most recent).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 2000

B. Design Information

Basic Design Information

- Type(s) of facilities served; Residential
- Design Flow; 23,100 gpd
- History of systems on site: Is this system a replacement? No
- Type of System
  1. Collection system: STEP/STEG small diameter sewer system
  2. Pretreatment system (primary, secondary, disinfections); Interceptor Tank; Recirculating Sand Filter.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Drip Irrigation

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study: Typical Domestic; BOD 150 mg/l; TSS 100 mg/l
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). State design criteria.
  (3) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; Surface drip irrigation system.
  (4) Soil/land loading rate; 2.0 inches per week over approximately 3.3 acres
  (5) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; Tennessee Department of Environment and Conservation (TDEC)
- Effluent quality limits (regulatory performance standards/limits for system); BOD_5 Single Grab Sample (once quarterly) limit of 45 mg/L; Ammonia and Nitrate as N (once quarterly) report results

- Are there periodic *regulatory* inspections of the system? Initial Site visit

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Public. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Public Utility Staff

- Regularly scheduled operation and maintenance activities;
    - Check Flow meter readings; Check alarm panel; Check screw-on caps at ends of field lines (to confirm that no tampering has occurred, and that caps are in place).
    - Monthly: Clean effluent filters; Check HydroTek valve box; Switch valve to different field area and flush lines.
    - Visit Sites Periodically
    - Check all pumps
    - Check electronics
    - Lab testing includes:
        - BOD_5
        - Ammonia and Nitrate as N

- Man-hours per week routinely committed to O&M activities; 40-60 hours per week, total.

  Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
    - Pump or Motor replacement, cost of ; ($350-$600)
    - Float Replacement, cost of; ($40-$60)

- Are there inspection or other "walkover" photos of the system that may be available to us? Yes

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Flow Meter
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available

- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); Approximately $144,000, including engineering.

OM&M

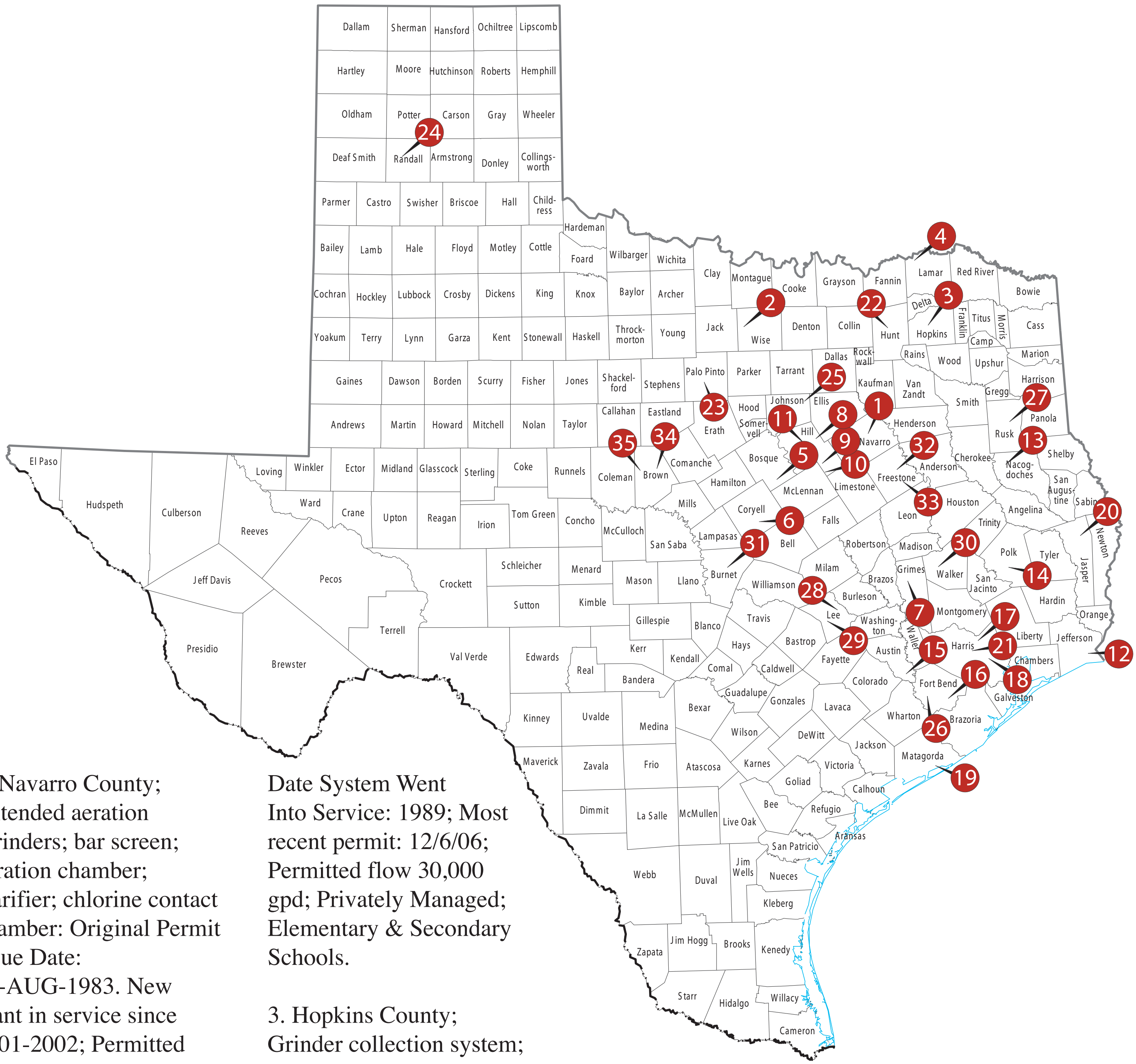
- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
    - Power costs average $170.16 per month ($2,041.95 for the most recent 12 months/year).
    - Sludge pumping costs $250 locally per residential size tank (1,500 gallons), but to date, very few tanks have been pumped for these residential systems.

Fees

- Connection fees (if applicable);
- Service fee structure and user fees charged

  Residential customers pay flat rate statewide of $35.54 per month. Commercial units (does not apply to this project) pay a graduated rate based on flow ($75 without food, and $100 with food) for up to 300 gpd average then up.

Appendix 12.A
By-County Locations of Texas Systems



1. Navarro County; Extended aeration (grinders; bar screen; aeration chamber; clarifier; chlorine contact chamber: Original Permit Issue Date: 02-AUG-1983. New plant in service since 2001-2002; Permitted flow 12,000 gpd; Privately Managed; Community System.

2. Wise County; Conventional Gravity Collection; Grinder pumps; Bar Screen; Extended Aeration (2 plants @ 15,000 gpd); Chlorine Disinfection: Date System Went Into Service: 1989; Most recent permit: 12/6/06; Permitted flow 30,000 gpd; Privately Managed; Elementary & Secondary Schools.

3. Hopkins County; Grinder collection system; Bar screens; Three Aerated Lagoons; Flocculating Clarifier; Two Slow Sand Filters; Chlorine Contact Chamber: Original Permit Issue Date: 08-SEP-1999; Permitted flow 40,000 gpd; Publicly Managed; Recreational Parks (RV's and Campsites).

4. Lamar County; 3 Lined Facultative Lagoons/Ponds; Very little discharge (mostly evaporation): Original Permit Issue Date: 29-NOV-1991; Permitted flow 7,000 gpd; Publicly Managed; Military Facilities.

5. Bosque County; Conventional gravity sewers; Grinder pump station at plant; Bar Screen; Oxidation Ditch/"Racetrack"; 2 Clarifiers; Chlorine Disinfection. Original Permit Issue Date: 27-JUN-1974; Permitted flow 49,000 gpd; Public Managed; Community System.

6. Coryell County; 1-Facultative pond (~1/2 acre) and 2-Stabilization Ponds (each~1/2 acre); All ponds un-lined, no aeration: System in service since year 2000; Permitted flow 50,000 gpd; Publicly Managed; Community System.

7. Grimes County; Grinder lift stations leading to an aerated tank unit (Purestream); Chlorination: Age of system at least 5 years; Permitted flow 7,000 gpd; Privately Managed; Elementary & Secondary Schools.

8. Hill County; Pond system (3 ponds - assume 1 facultative, unlined, and 2 stabilization ponds, unlined, all non-aerated): Original Permit Issue Date: 29-JUL-1994; Permitted flow 40,000 gpd; Publicly Managed; Community System.

9. Hill County; Activated Sludge, extended aeration mode; (Bar screens, equalization tank, aeration chamber; clarifier; chlorination): Original Permit Issue Date: 28-JUN-1974; New plant installed 2001; Permitted flow 25,000 gpd; Privately Managed; Community System.

10. Hill County; Imhoff tank; Oxidation ponds (1 aerated); Tertiary filter (sand/gravel gradated): Original Permit Issue Date: 21-FEB-1975; Ponds installed in 1970's; Tertiary filter installed in 1998; Permitted flow 36,000 gpd; Publicly Managed; Community System.

11. Hill County; Bar screens; Oxidation Ditch; Clarifier; Pump that lifts effluent to creek for discharge: Original Permit Issue Date: 03-MAR-1976. Plant went into service in 1970's; Permitted flow 40,000 gpd; Privately Managed; Community System.

12. Jefferson County; Equalization Basin; Three Aeration Chambers; Clarifier; Two Sand Filters; Chlorine Contact Chamber: Original Permit Issue Date: 13-FEB-1977; Permitted flow 14,000 gpd; Privately Managed; Parks & Recreation Areas - RV & Campsites.

13. Nacogdoches County; Wetland treatment system; Original Permit Issue Date: 29-OCT-1999; Permitted flow 10,000 gpd; Publicly Managed; Elementary & Secondary Schools.

14. Polk County,; Grinder collection system; Activated Sludge (PEECO plant) operating in extended aeration mode: Original Permit Issue Date: 20-APR-1977; Permitted flow 35,000 gpd; Publicly Managed; Parks & Recreation Areas - RV & Campsites.

15. Austin County; Equalization Basin; Two Aeration Basins; Clarifier; Chlorine Contact Chamber: Original Permit Issue Date: 08-FEB-1977; Permitted flow 8,000 gpd; Publicly Managed; Parks & Recreation Areas - RV & Campsites.

16. This system determined during study to be the same as TX #26

17. Harris County; Grinders; Bar Screen; Aeration Basin; Clarifier; Chlorine Disinfection: Original Permit Issue Date: 7-OCT-1999; Permitted flow 15,000 gpd; Privately Managed; Elementary Schools.

18. Harris County; Grinders; Bar Screen; Aeration Basin; Clarifier; Chlorine Disinfection: Original Permit Issue Date: 25-JUN-1999; Permitted flow 42,000 gpd; Publicly Managed; Elementary Schools.

19. Matagorda County; Vacuum collection system; PEECO extended aeration package plant (Primary clarifiers; Activated sludge/extended aeration treatment plant sized for 100,000 gpd, though permitted for 50,000 gpd); Discharge. Into service 13- DEC-1999; Permitted flow 50,000 gpd; Publicly Managed; Community System.

20. Jasper County; Grinder pressure sewer collection system; Bar screens; PEECO Extended Aeration/activated sludge plant; Secondary Clarifier; Sand Filtration; Chlorination (contact chamber); Discharge to lake; Current plant in service since 1976; Design flow 35,000 gpd; Publicly Managed; Parks and Recreational Areas.

21. Harris County; Pre-Equalization Basin; Sequencing Batch Reactor; Post Equalization Basin; UV Disinfection; Discharge. Current plant in service since 2001; Design flow 40,000 gpd (monthly average); Publicly Managed; Park & Visitor Center.

22. Hunt County; Bar Screens; Extended Aeration Basins (Activated Sludge); Clarifiers; Chlorine Contact Chamber; Spray Irrigation: Original Permit Issue Date: 1996; WWTP Designed for 22,715 gpd (maximum permitted flow 12,500 gpd); Publicly Managed; Campgrounds/RV Parks & Recreational Areas.

23. Palo Pinto County; Grinder Lift Stations/Collection System; Aerated Lagoon; Two Stabilization Ponds; Spray Irrigation in Non-Public Access Area: Original Permit Issue Date: 1970; Design flow 5,000 gpd (30-day average); Publicly Managed; Campgrounds/RV Parks & Recreational Areas.

24. Randall County; Septic tank pretreatment and effluent collection system; Subsurface low pressure dosed effluent dispersal field: Original Permit Issue Date: 2000 (for current system); Design flow 8,200 gpd; Publicly Managed; Campgrounds/RV Parks & Recreational Areas.

25. Johnson County; Extended Aeration (Bar screen; Aeration tank/basin; Clarifier; Chlorine Contact Chamber; Effluent holding tank; Spray irrigation field: Original Permit Issue Date: 2001 (for current system). Note: Data here is for previous/recently replaced treatment plant; Design flow 7,311 gpd (30-day average); Publicly Managed; Campgrounds/RV Parks & Recreational Areas.

26. Fort Bend County; Extended Aeration (Bar screen; Equalization tank; Aeration tanks/basins; Clarifiers; Chlorine Contact Chamber; Evaporation Pond: Original Permit Issue Date: 1984; Design flow 16,000 gpd; Publicly Managed; Campgrounds/RV Parks & Recreational Areas.

27. Rusk County; Facultative Lagoon; Stabilization Pond; Effluent pump station; Spray irrigation on Bermuda grass field (8.5 acres): Original Permit Issue Date: 1986; Design flow 14,000 gpd; Publicly Managed; Campgrounds/RV Parks & Recreational Areas.

28. Lee County; Extended aeration PEECO plant; Effluent pump station/holding tank; Effluent holding pond prior to spray irrigation on Bermuda grass field (1.7 acres). Current plant in service since early 1989; Design flow 7,500 gpd (monthly average); Publicly Managed; Campgrounds/RV Parks & Recreational Areas.

29. Lee County; Extended aeration plant; Effluent pump station/holding tank; Effluent holding pond prior to spray irrigation on fenced Bermuda grass field. Current plant in service since early 1990; Design flow 10,000 gpd (monthly average); Publicly Managed; Campgrounds/RV Parks & Recreational Areas.

30. Walker County; Grinder lift stations; PEECO Extended aeration plant; Effluent pump station/holding tank; Subsurface dispersal field (approx. 39,000 SF) Current plant in service since 1977; Design flow 50,000 gpd (average monthly); Publicly Managed; Campgrounds/RV Parks & Recreational Areas.

31. Burnet County; Grinder pressure sewer collection system; PEECO Extended Aeration package plant; Chlorination; Surface Irrigation in pastureland. Current plant in service since 2001; Permitted for 40,000 GPD Jun-Aug; 20,000 GPD Mar-May & Sept-Nov, and 6,000 GPD Dec.-Feb.; Publicly Managed; Campgrounds/RV Parks & Recreational Areas.

32. Freestone County; Grinder pressure sewer collection system; Bar screens; “Lakeside” Oxidation Ditch/activated sludge treatment plant; Secondary Clarifier; Chlorination (contact chamber); Surface Irrigation on 1.65 acres. Current plant in service since 1976; Design flow 22,000 gpd (currently permitted for 3,000 gpd); Publicly Managed; Campgrounds/RV Parks & Recreational Areas.

33. Freestone County; Grinder pressure sewer collection system; Bar screens; "Lakeside" Oxidation Ditch/activated sludge treatment plant; Secondary Clarifier; Chlorination (contact chamber); Surface Irrigation on 3.75 acres. Current plant in service since 1976; Design flow 40,000 gpd (currently permitted for 7,000 gpd); Publicly Managed; Campgrounds/RV Parks & Recreational Areas.

34. Brown County; Grinder pressure sewer collection system; Bar screens; Extended Aeration/activated sludge plant; Secondary Clarifier; Chlorination (contact chamber); Surface Irrigation; Current plant in service since early 1970's; Design flow 10,000 gpd; Publicly Managed; Campgrounds/RV Parks & Recreational Areas.

35. Brown County; Grinder pressure sewer collection system; Bar screens; Extended Aeration/activated sludge plant; Secondary Clarifier; Chlorination (contact chamber); Surface Irrigation; Current plant in service since 1971; Design flow 10,050 gpd; Publicly Managed; Campgrounds/RV Parks & Recreational Areas.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-1

A. Basic Information **12,000 gpd permitted flow; Activated sludge; Discharge.**
- Date most recent permit was issued;
- Date system went into service: 2001-2002

B. Design Information
Basic Design Information
- Type of System
  1. Type of collection system leading to treatment plant (e.g., conventional gravity sewers, effluent sewers, grinder pressure sewers)? Conventional gravity sewers with 3 grinder lift stations leading to treatment plant.

  2. Type of treatment system (primary, secondary, disinfection); (Activated sludge, in extended aeration mode) Bar screen, aeration chamber, clarifier, chlorination contact chamber.

  3. Sizes of unit processes used for treatment. Not available. Design flow of 12,000 gallons per day.

  4. Sizes and/or Loading rates to unit treatment processes (i.e., aerators, clarifiers, areal loading rates for sand filters, etc.) Not available.

  5. Size of dispersal field (total area and linear footage of trench or drip tubing). NA (discharge).

C. Operation, Maintenance and Monitoring Information

Qualitative
1. Are there periodic regulatory inspections of the system? TCEQ annual inspections.

2. Is the system managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Publicly owned plant managed by private service provider.

3. What are the regularly scheduled operation and maintenance activities? Daily checks of system and sample collection/flow monitoring.

4. Man-hours per week or month routinely committed to O&M activities; Approximately 0.5 hours daily.

5. Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.); Relatively new plant (5 years old);

Some problems reported with plant operation by operator when there are extreme temperature changes.

Quantitative

6. Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); See flow data on spreadsheet;

7. Influent Quality Data to the system (if available); Not available.

8. Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available; See spreadsheet;

D. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); $250,000 for treatment plant installation (estimated costs from City clerk's office).

OM&M

- Hourly rates for personnel along with hours spent.

Private service provider – not available. City reports that service provider is paid from $500 per month. They provide maintenance services. Outside lab services are used.

- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
    - Power usage for treatment plant: Average $400/month; (Lift stations' power usage unknown).
    - Sludge hauling: Approx. $200/month.
    - Lab services average approx. $150/month.

Total monthly reported operation costs: $1,250/month (estimated average), not including repairs and grinder pumping power costs (3 lift stations).

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-2

A. Basic Information 30,000 gpd permitted flow; Discharge.

- Date most recent permit was issued; December 6, 2006
- Date system went into service: 1989.

B. Design Information

Basic Design Information

- Type of System
  1. Type of collection system leading to treatment plant (e.g., conventional gravity sewers, effluent sewers, grinder pressure sewers)? Conventional gravity sewers.

  2. Type of treatment system (primary, secondary, disinfection); Grinder pump station; Bar screens; Extended aeration basins; Clarifier; Chlorine disinfection [Two 15,000 gallon per day plants].

  3. Sizes of unit processes used for treatment. Not available.
  4. Sizes and/or Loading rates to unit treatment processes (i.e., aerators, clarifiers, areal loading rates for sand filters, etc.) Not available.

  5. Size of dispersal field (total area and linear footage of trench or drip tubing). NA (discharge).

C. Operation, Maintenance and Monitoring Information

Qualitative

1. Are there periodic regulatory inspections of the system? TCEQ annual inspections.

2. Is the system managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Publicly owned plant managed by private contractor.

3. What are the regularly scheduled operation and maintenance activities? Daily checks of system and sample collection/flow monitoring.

4. Man-hours per week or month routinely committed to O&M activities; 15 hours per week.

5. Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);

Quantitative

6. Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Flow checked 5 days/week; checked by 22 degree v-notch weir;

7. Influent Quality Data to the system (if available); Not available.

8. Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available; See spreadsheet;

D. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); Unknown.

OM&M

- Hourly rates for personnel along with hours spent.

$833.33 monthly for outside management/operation services.

- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Power usage for treatment plant: $518/month;
Sludge trucking: Approx. $150/month.

Total monthly costs reported: Approx. **$1,501.33** ($18,016 per year).

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-3

A. Basic Information

- State/County where system is located; Hopkins County, Texas.
- Date permit was issued; 08-SEP-1999 (permit re-issued).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). May 1997.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Recreational park (RV's, campsites and day use recreational areas).
- Design Flow; 40,000 gallons per day.
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system: Grinder lift stations & pressure sewer lines.
  2. Pretreatment system (primary, secondary, disinfection); Bar screens; Three Aerated Lagoons; Flocculating Clarifier; Two Slow Sand Filters; Chlorine Contact Chamber:
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); NA (discharge of treated effluent to lake).

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study); Not available.
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). State design criteria.
  (3) Loading rates to unit processes;
  Aeration Organic Loading: Design or Permit: 45 lbs. BOD_5/1000 ft^3/day.
  Actual: 0.10 lbs. BOD_5/1000 ft^3/day.
  Clarifier: Design or permit: For average flow, 400 gpd/ft2; Peak flow, 800 gpd/ft2.
  Actual: For average flow, 7 gpd/ft2; Peak flow, 27 gpd/ft2.
  Chlorine Contact: Designed for minimum of 20 minutes @ Peak flow.

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; NA (Direct Discharge)
(5) Soil/land loading rate.
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.

C. Regulatory Information

- Regulatory authority and contact info; TCEQ.
- Effluent quality limits (regulatory performance standards/limits for system); (See Spreadsheet of effluent quality data).
- Are there periodic *regulatory* inspections of the system? Annual at most typically.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Public. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. The treatment system is operated and maintained by park personnel (Operator with D License). All of the required regulatory compliance laboratory testing is performed by the City of Sulphur Springs, with the exception of chlorine residual testing which is done by treatment plant personnel using a Hach DR100 analyzer.
- Regularly scheduled operation and maintenance activities;
  Check bar screens, aerator, sand filters, clarifier and lift stations daily.
- Man-hours per week or month routinely committed to O&M activities;
  96 hours per month (average) @ $14.85/hour ($1,425.60/month labor, on average).
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);

Date	**Facility**	**Description of Work**	**Materials**
11/1/2003	Clarifier	Clean out and repair leaks in clarifier	Concrete repair material
9/20/2004	Aerator at WW Plant	Rewind motor and replace electric cable and tie cables	100 ft. cable, 60 ft. elec. cable and rewound elec. Motor.
11/3/2003	Aerator at WW Plant	Rewind motor and replace electric cable	60 ft. elec. cable and rewound motor
12/16/2004	Wastewater Building	Replace contactor/starter #5	Contactor/starter
12/16/2004	Wastewater Pond	Remove and rebuild aerator motor	Rewind aerator motor #2.
8/31/2005	Repair liners at wastewater plant	Liner patching	

- Are there inspection or other "walkover" photos of the system that may be available to us? Yes. Site visit report photos.

  The following information was included in a engineering report based on a detailed site inspection of the park's wastewater facilities on 2/26/98. Few mechanical problems had been experienced with the plant at the time of the inspection since it was relatively new at that time, and the facility appeared to be in good working order. However, several problems were noted with regard to the operation of the plant.

  Due to low flow conditions during most of the "off season" (October through April), the treatment plant is very underloaded during that period. During those periods, the plant operator had been discharging only once weekly. It was recommended that one of the aerated ponds be taken off line to maintain more continuous discharge. This would serve to:

  - Reduce power requirements (avoid aerating the larger/full pond volume);
  - Loading rates would be more consistent with design values;
  - Chlorine residual leaving the plant could be better controlled by maintaining more consistent operation of the plant;
  - The sand filters could remain full, which would help protect the liners. The filters had been kept empty except when the plant was discharging, which was causing excessive exposure to sunlight and allowing animals and debris to enter the filters and possibly damage to the liner material.

  It was noted also during the inspection that the chemical metering and chemical storage facilities were located in the same room with the motor control centers and electrical equipment. Exposure to the chemicals (esp. $FeSO_4$ and chlorine) could cause deterioration and/or corrosion of the electrical control panels.

  With regard to the wastewater collection system, several problems were identified for the five lift stations included in the system. Those included:
  - No screens installed on vents;
  - Conduits from wet wells to control panels not sealed;
  - No warning signs on electrical panels or on lift stations.

  The following was noted with respect to each of the five lift stations:

Lift Station	Capacity (HP)	Condition	Comments
Lift Station 1	5 (Duplex)	Good	Gate valves for isolation are inside wet well. Corrosion of guide rails and brackets in wet well. No check valves on discharge line. Junction box for float control wiring in wet well.
Lift	3 (Duplex)	Fair	Severe corrosion of guide rails, brackets and discharge

Station 2			piping in wet well. Junction box for float control wiring is located in wet well. Access to valve vault difficult (constructed of corrugated metal with a large diameter cast iron cover - approximately 3' diameter), making routine maintenance difficult. Valve vault not water proof, and subject to flooding.
Lift Station 3	5 (Duplex)	Fair	Gate valves for isolation are inside wet well. Corrosion of guide rails and brackets in wet well. No check valves on discharge line. Junction box for float control wiring is located in wet well. Erosion around lift station.
Lift Station 4	5 (Duplex)	Good	Gate valves for isolation are inside wet well. Corrosion of guide rails and brackets in wet well. No check valves on discharge line. Junction box for float control wiring is located in wet well.
Lift Station 5	5 (Duplex/Grinder)	Fair	Severe corrosion of guide rails, brackets and discharge piping in wet well. Junction box for float control wiring is located in wet well. Access to valve vault difficult (constructed of corrugated metal with a large diameter cast iron cover - approximately 3' diameter), making routine maintenance difficult. Lift station floods during heavy rains.

Corrosion noted for the lift stations appeared excessive for their age, with a variety of factors possibly contributing to that. Suggestions for addressing the corrosion problems included positive ventilation (possibly on a timer), preventing wastewater from remaining in lift stations for long periods prior to being pumped out by possibly placing pumps on timers, and replacing all components experiencing corrosion with Type 304 or 316 stainless steel components.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet data.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); $1,037684.67 initial construction costs for system, including sewer lines (approximately 3 miles of sewer lines), lift stations (5 lift stations) and wastewater treatment plant.

OM&M

- Hourly rates for personnel along with hours spent. 96 hours per month on average, @ $14.85/hour; Assuming 2.0 multiplier for fringe/overhead, $2,851.20/month labor.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.) Electric power costs as follows:
  FY2001: Average monthly power cost = $1,210.70; Total = $14,528.40.
  FY2002: Average monthly power cost = $1,442.08; Total = $17,304.93.
  FY2003: Average monthly power cost = $1,636.70; Total = $19,640.35.
  FY2004: Average monthly power cost = $1,659.14; Total = $19,909.67.
  FY2005: Average monthly power cost = $1,645.59; Total = $19,747.13.
  FY2006: Average monthly power cost = $1,842.20; Total = $22,106.36.

Using average power costs for FY 2004-2006, electric power costs average $1,715.64 per month.

Excluding any repairs or other costs, monthly electric power plus labor costs average $4,567.

Fees

- Connection fees (if applicable); NA
- Service fee structure and user fees charged NA

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-5

A. Basic Information **49,000 gpd permitted flow; Discharge.**

- Date most recent permit was issued;
- Date system went into service: 1970's.

B. Design Information

Basic Design Information

- Type of System
  1. Type of collection system leading to treatment plant (e.g., conventional gravity sewers, effluent sewers, grinder pressure sewers)? Conventional gravity sewers.

  2. Type of treatment system (primary, secondary, disinfection); Grinder pump to plant; Bar screens; Oxidation ditch ("racetrack"); 2 Clarifiers; Chlorine Disinfection (gas).

  3. Sizes of unit processes used for treatment. Not available.
  4. Sizes and/or Loading rates to unit treatment processes (i.e., aerators, clarifiers, areal loading rates for sand filters, etc.) Not available.

  5. Size of dispersal field (total area and linear footage of trench or drip tubing). NA (discharge).

C. Operation, Maintenance and Monitoring Information

Qualitative

1. Are there periodic regulatory inspections of the system? TCEQ annual inspections.

2. Is the system managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. City employee operates plant; Lab work done by private service.

3. What are the regularly scheduled operation and maintenance activities? Daily checks of system and sample collection/flow monitoring.

4. Man-hours per week or month routinely committed to O&M activities; Approximately 2 hours daily (10 hours/week).

5. Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);

Quantitative

1. Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); See flow data on spreadsheet;

2. Influent Quality Data to the system (if available); Not available.

3. Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available; See spreadsheet;

D. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); Unknown.

OM&M

- Hourly rates for personnel along with hours spent.
  - Assuming a 2.0 multiplier for city operator, approx. $1,825 per month.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
  - Power usage for treatment plant: Approx. $1,700/month;
  - Sludge Hauling: Approx. $83/month;
  - Lab services: Approx. $450/month;

  - Average wastewater bill for customers: $15/month.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-9

A. Basic Information **25,000 gpd permitted flow; Activated sludge; Discharge.**

- Date most recent permit was issued;
- Date system went into service: 2001

B. Design Information

Basic Design Information

- Type of System
    1. Type of collection system leading to treatment plant (e.g., conventional gravity sewers, effluent sewers, grinder pressure sewers)? Conventional gravity sewers with 1 duplex grinder lift station leading to treatment plant.

    2. Type of treatment system (primary, secondary, disinfection); (Activated sludge, in extended aeration mode) Bar screens, equalization, aeration chambers, clarifier, chlorination.

    3. Sizes of unit processes used for treatment. Not available. Design flow of 25,000 gallons per day.

    4. Sizes and/or Loading rates to unit treatment processes (i.e., aerators, clarifiers, areal loading rates for sand filters, etc.) Not available.

    5. Size of dispersal field (total area and linear footage of trench or drip tubing). NA (discharge).

C. Operation, Maintenance and Monitoring Information

Qualitative

1. Are there periodic regulatory inspections of the system? TCEQ annual inspections.

2. Is the system managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Publicly owned plant managed by private service provider.

3. What are the regularly scheduled operation and maintenance activities? Daily checks of system and sample collection/flow monitoring.

4. Man-hours per week or month routinely committed to O&M activities; Approximately 1-2 hours daily.

5. Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.); Relatively new plant (5 years old); To date only blower repairs.

Quantitative

6. Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); See flow data on spreadsheet;

7. Influent Quality Data to the system (if available); Not available.

8. Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available; See spreadsheet;

D. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); $250,000 for treatment plant installation; $40,000 for duplex grinder lift station.

OM&M

- Hourly rates for personnel along with hours spent.

Private service provider – not available. City reports that service provider is paid from $1,200 to $2,500 per month, and that it varies based on time spent. They provide laboratory and maintenance services.

- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Power usage for treatment plant: Average $850/month;
Power usage for lift station: Average $40/month;
Sludge hauling: Approx. $6000-$7000 annually. ($575/month).

Total monthly reported operation costs: $3,315/month (estimated average), $40, 000 annually.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-10

A. Basic Information 36,000 gpd permitted flow; Discharge.

- Date most recent permit was issued;
- Date system went into service: Imhoff tank – 1933; Pond system – 1970's; "Tertiary" filter – 1998; Collection system has been replaced/rehabilitated (grant a few years ago).

B. Design Information

Basic Design Information

- Type of System
  1. Type of collection system leading to treatment plant (e.g., conventional gravity sewers, effluent sewers, grinder pressure sewers)? Conventional gravity sewers.

  2. Type of treatment system (primary, secondary, disinfection); Imhoff tank; Oxidation ponds, including 1 aerated pond; Gradated sand/gravel filter for polishing.

  3. Sizes of unit processes used for treatment. Not available.
  4. Sizes and/or Loading rates to unit treatment processes (i.e., aerators, clarifiers, areal loading rates for sand filters, etc.) Not available.

  5. Size of dispersal field (total area and linear footage of trench or drip tubing). NA (discharge).

C. Operation, Maintenance and Monitoring Information

Qualitative

1. Are there periodic regulatory inspections of the system? TCEQ annual inspections.

2. Is the system managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Publicly owned plant managed by city employee(s).

3. What are the regularly scheduled operation and maintenance activities? Daily checks of system and sample collection/flow monitoring.

4. Man-hours per week or month routinely committed to O&M activities; Approximately 1hour daily.

5. Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.); Compliance problems. Ponds reportedly need cleaning of sludge. Imhoff tank was cleaned in past few years (was impacted). Low income community, relying on grants for improvements. Hoping to have ponds cleaned soon.

Quantitative

6. Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); See flow data on spreadsheet;

7. Influent Quality Data to the system (if available); Not available.

8. Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available; See spreadsheet;

D. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); $100,000 for tertiary filter installation, 1998. Costs unknown for ponds and Imhoff tank.

OM&M

- Hourly rates for personnel along with hours spent.

5-6 hours/week (@ $15/hour approx.); Approx. $400 monthly.

- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Power usage for treatment plant: Average $125/month;
Outside lab services: $150/month.

Total monthly reported operation costs: $675/month (est. average), $8.100 annually.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-11

A. Basic Information **40,000 gpd permitted flow; Discharge.**

- Date most recent permit was issued;
- Date system went into service: 1970's.

B. Design Information

Basic Design Information

- Type of System
  1. Type of collection system leading to treatment plant (e.g., conventional gravity sewers, effluent sewers, grinder pressure sewers)? Conventional gravity sewers.
  2. Type of treatment system (primary, secondary, disinfection); Bar screens; Oxidation ditch ("racetrack"); Clarifier; lift station pumps effluent up to creek (plant is below creek discharge elevation).
  3. Sizes of unit processes used for treatment. Not available.
  4. Sizes and/or Loading rates to unit treatment processes (i.e., aerators, clarifiers, areal loading rates for sand filters, etc.) Not available.
  5. Size of dispersal field (total area and linear footage of trench or drip tubing). NA (discharge).

C. Operation, Maintenance and Monitoring Information

Qualitative

1. Are there periodic regulatory inspections of the system? TCEQ annual inspections.
2. Is the system managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Publicly owned plant managed by private contractor.
3. What are the regularly scheduled operation and maintenance activities? Daily checks of system and sample collection/flow monitoring.
4. Man-hours per week or month routinely committed to O&M activities; Approximately 0.5 hours daily (3 hours/week).
5. Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.); Metal clarifier has corrosion problems. Effluent pump discharging to creek has occasional problems/repairs; other occasional mechanical repairs for plant.

Quantitative

6. Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); See flow data on spreadsheet;

7. Influent Quality Data to the system (if available); Not available.

8. Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available; See spreadsheet;

D. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); Unknown.

OM&M

- Hourly rates for personnel along with hours spent.

Approx. $675 monthly for outside management/operation services.

- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Power usage for treatment plant: NA.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-14

A. Basic Information

- State/County where system is located; Polk County, Texas.
- Date permit was issued; 3/16/06 (most recent).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). May 19, 1977.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Recreational park (RV's, campsites and day use recreational areas).
- Design Flow; 35,000 gpd.
- History of systems on site: Is this system a replacement? This treatment plant was/is scheduled for replacement with a natural treatment system. If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system: Grinder lift stations pumping wastewater from facilities to WWTP.
  2. Pretreatment system (primary, secondary, disinfection); PEECO activated sludge/extended aeration plant (typical to state parks).
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); NA

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study):
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system
  (5) Soil/land loading rate; Discharge.
  (6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; TCEQ.
- Effluent quality limits (regulatory performance standards/limits for system); BOD_5 Daily Average limit of 10 mg/L, and Single Grab of 35 mg/L (1 sample per week); TSS Daily

Average limit of 15 mg/L and Single Grab limit of 60 mg/L (one sample per week); pH limited to between 6 and 9 standard units. Permitted flow: 35,000 gpd (5 samples per week). Minimum effluent DO of 4.0 mg/L, monitored once/week; Effluent Chlorine Residual of at least 1.0 and not greater than 4.0 mg/L after detention for at least 20 minutes, and monitored 5 times/week.

- Are there periodic *regulatory* inspections of the system? Annual at most typically.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Public. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Regularly scheduled operation and maintenance activities;
    - Take daily readings and samples;
    - Clean clarifier;
    - Maintain Chlorine levels, pH, etc.;
    - Take weekly samples to TRA Lab.
    - Monitor and maintain lift stations.
- Man-hours per week or month routinely committed to O&M activities;
    - 48 hours per month for wastewater plant; Assume $15/hour: Using 2.0 multiplier on rate for fringe/overhead, approximately $1440/month.
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
    - Chlorinator repairs over past five years: Approx. $2,500;
    - Control panel replacement: Approx. $2000;
    - 2 effluent pumps replaced: Approx. $6900.

  Problems noted with grinder lift stations in engineering inspection reports included corrosion, lifting of stations out of ground (soil/groundwater conditions), broken vent pipes, one station sunk into ground, and exposed lines.

- Are there inspection or other "walkover" photos of the system that may be available to us? Some in engineering report.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Polylevel Flow Totalizer.
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data

for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See also spreadsheet data.

- Year 2004, *annual* averages were provided for the following:
  - BOD: 2.58 mg/L
  - TSS: 4.71 mg/L
  - DO: 8.31 mg/L
  - pH: 7.15
  - Cl: 2.2 mg/L
- Year 2005, *annual* averages were provided for the following:
  - BOD: 2.25 mg/L
  - TSS: 4.7 mg/L
  - DO: 6.66 mg/L
  - pH: 7.6
  - Cl: 1.84 mg/L
- Year 2006, *annual* averages were provided for the following:
  - BOD: 2.63 mg/L
  - TSS: 2.72 mg/L
  - DO: 6.6 mg/L
  - pH: 6.8
  - Cl: 1.65 mg/L

- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); The original constructed costs of the system were not available. Project card files show a collection system modification in 1979 for $8,300.

OM&M

- Hourly rates for personnel along with hours spent. See above.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
  - Power usage:
    - 2004: 31,606 kwh; If assume $0.10 per kwh, $3,161.
    - 2005: 33,029 kwh; If assume $0.10 per kwh, $3,303.
    - 2006: 43,850 kwh; If assume $0.10 per kwh, $4,385.

Average monthly costs for labor and electric power, and not including sludge pumping/removal or any repairs: $1,794/month.

Fees

- Connection fees (if applicable); NA
- Service fee structure and user fees charged NA

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-15

A. Basic Information

- State/County where system is located; Austin County, Texas.
- Date permit was issued; 2004 ?(most recent).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 2004.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Recreational park (RV's, campsites and day use recreational areas).
- Design Flow*;* 28,000 gpd
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system: __________
  2. Pretreatment system (primary, secondary, disinfection); Extended aeration treatment plant;
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study:
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). State design criteria.
  (3) Loading rates to unit processes;
    - Aeration basin #1: 14' x 7' x 8'-7" (5,000 gallons);
    - Aeration basin #2: 14' x 7' x 8'-7" (5,000 gallons);
    - Clarifier: 14' x 7' x 8'-7" (5,000 gallons);
    - Aeration sludge holding tank, Two (digestion): 7' x 4' x 2' x 8'-10" and 7' x 4'-2" x 7'-4" (1,518 gallons);
    - Chlorine contact chamber: 7'" x 3'-5" x 7' (864 gallons)
    - Storage/equalization Basin: 6'-5" x 7' x 8'-7"

  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system*;*

(5) Soil/land loading rate;
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; TCEQ.
- Effluent quality limits (regulatory performance standards/limits for system*);*
- Are there periodic *regulatory* inspections of the system? Annual at most typically.

D. Operation, Maintenance and Monitoring Information

Qualitative

1. Is the system owned and managed by a public or private entity? Public. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.

2. Regularly scheduled operation and maintenance activities;

3. Man-hours per week or month routinely committed to O&M activities;

4. Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);

5. Are there inspection or other "walkover" photos of the system that may be available to us?

Quantitative

1. Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);

2. Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
3. Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.
4. Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

E. Cost Information

Design/Construction

1. Initial construction costs for the system (including design and permitting costs if available); Initial construction costs for system: $377,625 (2004)

OM&M

1. Hourly rates for personnel along with hours spent

2. Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Fees

1. Connection fees (if applicable); NA
2. Service fee structure and user fees charged NA

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-17 and TX-18 + 2 other Package Plants Owned by School System
(4 Package Plants)

A. Basic Information 15,000 gpd; 42,000 gpd; 60,000 gpd; 63,000 gpd permitted flows; Discharge.

- Date most recent permit was issued;
- Date system went into service:

B. Design Information

Basic Design Information

- Type of System
  1. Type of collection system leading to treatment plant (e.g., conventional gravity sewers, effluent sewers, grinder pressure sewers)? Conventional gravity sewers.
  2. Type of treatment system (primary, secondary, disinfection); Grinder pump station; Bar screens; Extended aeration basins; Clarifier; Chlorine disinfection
  3. Sizes of unit processes used for treatment. Not available.
  4. Sizes and/or Loading rates to unit treatment processes (i.e., aerators, clarifiers, areal loading rates for sand filters, etc.) Not available.
  5. Size of dispersal field (total area and linear footage of trench or drip tubing). NA (discharge).

C. Operation, Maintenance and Monitoring Information

Qualitative

1. Are there periodic regulatory inspections of the system? TCEQ annual inspections.
2. Is the system managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Publicly owned plant managed by private contractor.
3. What are the regularly scheduled operation and maintenance activities? Daily checks of system and sample collection/flow monitoring.
4. Man-hours per week or month routinely committed to O&M activities; 5-7 hours per week, per plant.
5. Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-17 and TX-18 + 2 other Package Plants Owned by School System
(4 Package Plants)

Quantitative

6. Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);

7. Influent Quality Data to the system (if available); Not available.

8. Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available; See spreadsheet;

D. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); Unknown.

OM&M

- Hourly rates for personnel along with hours spent.

Private contractor - unknown

- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Power usage for treatment plant: Not reported;
Sludge trucking: Costs not reported. Sludge hauled approx. every 6 months from each of 4 plants.

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-20

A. Basic Information

- State/County where system is located; Jasper County, Texas.
- Date permit was issued; Most recent issued October 2001.
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1976

B. Design Information

Basic Design Information

- Type(s) of facilities served; Recreational park (RV's, campsites and day use recreational areas).
- Design Flow; 35,000 gpd;
- History of systems on site: Is this system a replacement? No. If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system: Grinder lift stations (17 lift stations and associated collection system piping); 9 lift stations have duplex pumps, and the other 8 have simplex pumps; Approximately 20,000 linear feet of collection piping.
  2. Pretreatment system (primary, secondary, disinfection); Bar Screen; PEECO extended aeration concrete package treatment plant and sand filter (Aeration basin, clarifiers, sand filter dosing chamber, chlorine contact basin, effluent holding tanks; sludge holding);
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Treated effluent is discharged to the lake.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study:
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). State design criteria.
  (3) Loading rates to unit processes;

Aeration Tanks:	7 @ 10'-2.5" x 7' x 15';
Clarifiers:	2 @ 10'-2.5" x 7' x 15';
Sand filter backwash tank;	1@ 10'-2.5" x 6' x 7';
Backwash holding;	1@ 10'-2.5" x 6' x 7';
Chlorine Contact Chamber:	1@ 10'-2.5" x 3' x 7' (1,215 gallons)
Dosing Tank;	1@ 10'-2.5" x 3' x 7';
Aerated Sludge Digester;	1@ 10'-2.5" x 7' x 7'(3,000 gallons)

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; NA.
(5) Soil/land loading rate; NA
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; TCEQ.
- Effluent quality limits (regulatory performance standards/limits for system); BOD_5 Daily Average 10 mg/L; Single Grab Sample limit of 35 mg/L; TSS Daily Average 15 mg/L; Single Grab Sample limit of 60 mg/L; BOD/TSS Daily Max of 25/40 mg/L, respectively; BOD and TSS measured once weekly; pH limited to between 6 and 9 standard units (once monthly); Permitted flow 35,000 gpd (5 times weekly); Chloride five times weekly (1.0 mg/L min., and not greater than 4.0 mg/L)
- Are there periodic *regulatory* inspections of the system? Annual at most typically by TCEQ.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Public. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Operations and maintenance activities are performed by TCEQ licensed park staff.
- Regularly scheduled operation and maintenance activities;

    - Monthly service of blower motors;
    - Weekly cleaning of treatment plant surfaces;
    - Maintenance of chlorinator and chlorine drum levels;
    - Do bi-weekly sludge judge tests in all clarifiers and record results in daily log;
    - Adjust sludge return times to alleviate excess as found by sludge judge test and record results on daily log;
    - Perform monthly jar test to determine the 30 minute settleable solids (SV 30) and record results on daily log;
    - Perform sludge wasting as indicated based on results from above test, into digester tank;
    - DMR reporting;
    - Chemical analyses performed:
        - Daily analyses of total chlorine & manganese adjustment analysis;
        - On a weekly basis, East TX Environmental labs performs weekly chemical analyses including pH, DO, BOD, and TSS.

- Man-hours per week or month routinely committed to O&M activities;
  20 hours weekly; Assuming $17/hour, and using a 2.0 multiplier for labor, monthly labor costs are approximately $2,947 monthly.

- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
  Repairs during the past 5 years include the following:
  - Replaced 2 Blower Motors: $1,104.68;
  - Repaired/replaced aeration chamber diffusers (20): $520;
  - Repaired/replaced 4 lift station panel relays: $1,216.00;
  - Repaired/replaced 2 lift station panel contactors: $190.72.

- Are there inspection or other "walkover" photos of the system that may be available to us? Engineering report.

  Park staff notes that 5 lift stations are still off-line since Hurricane Rita; They anticipate major problems and maintenance upon start-up of those lift stations due to lack of use and corrosion.

  The 1998 engineering report noted the following needs for the collection system:
  - Replace 10,000 feet of 1.5-inch force main;
  - Replace 5,000 feet of 4-inch force main;

  The report noted the following needs for the treatment plant:
  - Bar screens needed replacement;
  - Air piping and diffusers needed replacement;
  - Leaking joints in concrete plant need sealing;
  - Sand filter control panel needed replacement;
  - Flow meter needed replacement;
  - Main electric service panel needed replacement;
  - Sand filter media needed replacement;
  - Aeration blowers needed replacement;
  - The plant light fixture needed replacement;
  - And the chlorine storage building door needed repair.

  The report also noted numerous lift station repairs/improvements that were needed, including:
  - Replacement of pipes, valves, fittings and pump guide rails;
  - Installation of access hatches;
  - Control panel replacements; and
  - Tops of some lift stations needed raising.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);

  - Flow is measured by way of a Milltronics OCM III open channel meter.
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); According to park archival records, the wastewater system appears to have cost $246,026.50 in 1977-1978, not including engineering and surveying.

OM&M

Hourly rates for personnel along with hours spent.

20 hours weekly; Assuming $17/hour, and using a 2.0 multiplier for labor, monthly labor costs are approximately $2,947 monthly.

- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Year	KWH	Avg.KWH/Month	Cost/KWH	Total for Year
2004	15136	1261	$0.0813	$1,230.56
2005	13456	1495	$0.0892	$1,200.28
2006	16377	1489	$0.1128	$1,847.33

- Sludge hauling totals in gallons and dollars from 2002 to 2005 were:

Date	Gallons Sludge	Cost
5/11/02	6,000	$260
8/11/04	5,500	$1,900
10/25/05	1,500	$475
11/01/05	1,500	$475
11/08/05	1,500	$475
11/11/05	1,500	$475

11/16/05	1,500	$475
11/28/05	46,668	$14,000
Totals:	**64,168**	**$18,535**

Average sludge hauling costs for that period were $452 monthly.

- Lab and chemical fees were not reported.

  Total average monthly costs, not including repairs, lab and chemical fees, were: Approximately $3,553 per month ($42,635 annually).

Fees

- Connection fees (if applicable); NA
- Service fee structure and user fees charged NA

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-21

A. Basic Information

- State/County where system is located; Harris County, Texas.
- Date permit was issued; 2002 ?(most recent).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 2001.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Recreational park (RV's, campsites and day use recreational areas).
- Design Flow*;* 40,000 gpd
  History of systems on site: Is this system a replacement? Yes. If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design? Prior to the construction of the SBR plant above this park had a "extended air" plant rated at .01 MGD which was completely rebuilt while awaiting the construction & design of the above SBR. All pumps & pump control panels were replaced; the air lift Waste Activated Sludge system was rebuilt. Air compressor motors & control panel were replaced and a wood frame building for process control tests was built. Chlorine disinfection systems & pumps were rebuilt & replaced several times. Costs for these improvements were not stored electronically and accurate numbers may be available but would take time to recover. Staff estimated a cost of $150,000 for those improvements.
- Type of System
  1. Collection system: 4 Grinder lift stations and associated collection system piping leading to the treatment plant.
  2. Pretreatment system (primary, secondary, disinfection); Pre-Equalization Basin, followed by Sequencing Batch Reactor treatment plant; UV Disinfection;
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system*.* NA – Discharge.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study:
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). State design criteria.
  (3) Loading rates to unit processes;
    - Pre-Equalization basin: 13.5' x 30' x 30';
    - SBR: 20' x 24' x 36';

- Post Equalization Basin: 12.5' x 18' x 36';
- Aerobic Digestor: 13.5' x 4.8' x 5.5';
- UV structure: 10' x 32';
- UV Modules (two): 11' Long.

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
(5) Soil/land loading rate;
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design: NA.

C. Regulatory Information

- Regulatory authority and contact info; TCEQ.
- Effluent quality limits (regulatory performance standards/limits for system); See spreadsheet;
- Are there periodic *regulatory* inspections of the system? Annual at most typically.

D. Operation, Maintenance and Monitoring Information

Qualitative

1. Is the system owned and managed by a public or private entity? Public. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Only laboratory services are handled as outside/private services.

2. Regularly scheduled operation and maintenance activities;
   - Record keeping of meters at plant & lift stations, daily process control data & daily log & daily, weekly, monthly & annual reports. These reports go to five overlapping jurisdictional agencies: Texas Commission of Environmental Quality, Texas Department of Health, Texas Water Development Board, Harris–Galveston Subsidence District, and City of Houston & Harris County.
   - Valve, Hydrant & pump maintenance to include daily checks, repair & replacement as needed.
   - Ultra Violet light cleaning, replacement & repair.
   - Electrical trouble shooting or main distribution, control panels, motor controllers, breakers, surge equipment and phase protection equipment. Electrical also includes back-up generation equipment and switch panels.
   - Replacement & repair of toilet facilities in park to include Sloan valves, commodes, sinks & urinals.
   - Laboratory procedures to include calibration & repair of pH meters, Dissolved Oxygen meters. Readings from meters & sampling results are used for process control decisions. Sampling of Total Suspended Solids, Carbonaceous Biological Oxygen Demand, Ammonia as Nitrogen and Fecal Coliform colony counts.
   - Data entry on computer & purchasing of parts & supplies.

3. Man-hours per week or month routinely committed to O&M activities;
   Hours per week would be 30 to 40 for two persons covering 7 days per week. Pay rates are approximately $15.14.

4. Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
   This plant was new 5 years ago. According to park staff, the following: It was improperly designed in that the surface loading & the biological loading were not matched & the plant has had a severe TSS problem. The permanent solution to this problem is currently under an engineering review by an engineering company specializing in water & wastewater. Pre report estimates for reconfiguration of plant are between $200,000 and $400,000. This would include resizing the main basin by placement of a dividing wall & some sort of filtration system between the post basin & the UV disinfection lights. The cost of construction of this plant was 1.2 million which was over the projected estimate of $800,000.
   Prior to the construction of the SBR plant above this park had a "extended air" plant rated at .01 MGD which was completely rebuilt while awaiting the construction & design of the above SBR. All pumps & pump control panels were replaced; the air lift Waste Activated Sludge system was rebuilt. Air compressor motors & control panel were replaced and a wood frame building for process control tests was built. Chlorine disinfection systems & pumps were rebuilt & replaced several times. Costs for these improvements were not stored electronically and accurate numbers may be available but would take time to recover. Park staff estimate a cost of $150,000 for those improvements (pre-SBR system).

5. Are there inspection or other "walkover" photos of the system that may be available to us? Not of current facility.

Quantitative

1. Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);

Influent is measured by a Polysonics DCT 6088 transit time flow meter with a Honeywell DR4500A circular chart recorder. These are located on the inflow pipe to the plant ahead of the bar screen/ headworks. Effluent is measured by a Magnetrol model 345 ultrasonic with a Honeywell DR4300 circular chart recorder. The ultra sonic pick up is mounted three feet before the 60 degree V- Notch weir.

2. Influent Quality Data to the system (if available) and QA/QC provisions employed;
   Not available.
3. Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data

for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet data.

4. Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

E. Cost Information

Design/Construction

1. Initial construction costs for the system (including design and permitting costs if available); Initial construction costs for system: $1.2 million (2001). An additional $18-20,000 has been spent to bring the plant into compliance.

OM&M

1. Hourly rates for personnel along with hours spent
   Approximately 35 hours per week @ $15.14/hour. Using a 2.0 multiplier for labor costs, this totals approximately $55,110 per year.
2. Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
   Monthly power bills range between $1400.00 & $1700.00 per month.

   The park staff reports that sludge is not hauled from the plant. (?) (possibly accumulating to a point in the digester and storage basins, and not yet full).

   Labor and power costs per year estimated at <u>$73,710</u>.

Fees

1. Connection fees (if applicable); NA
2. Service fee structure and user fees charged NA

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-22

A. Basic Information

- State/County where system is located; Hunt County, Texas.
- Date permit was issued; March 2006 (most recent).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). Original permit issued 8/20/96. The plant was constructed in 1995, and the park opened to the public February 13, 2001.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Recreational park (RV's, campsites and day use recreational areas).
- Design Flow; 22,715 gpd
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system: 2 lift stations & approximately 1 mile of sewer lines, with the majority of that being pressure line from one of the 2 lift stations to the treatment plant.
  2. Pretreatment system (primary, secondary, disinfection); Activated sludge operating in extended aeration mode. Bar screens; Five aeration basins; Two clarifiers; Chlorine contact basin; Effluent pump station (to irrigation).
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Surface irrigation (3 acres).

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study:
  Assumed for design:
  BOD5: Overnight use areas = 250 mg/L
  Day use areas = 100 mg/L
  Host/Residence = 200 mg/L
  Employees = 200 mg/L
  (Approx. 40 lbs./day BOD5 summer, and 6.17 lb.BOD5/day winter assumed)

  TSS: All uses 250 mg/L

  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF

MOP, EPA design manual methodology, Metcalf Eddy, etc.). State design criteria.

(3) Loading rates to unit processes;
Aeration Organic Loading: Design: 11.99 lbs. BOD_5/1000 ft^3/day aeration volume (summer loading);
Clarifier: Design: Maximum, 858 gpd/ft^2;
Chlorine Contact: Designed for detention of 23.46 minutes @ Peak flow.

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; Surface irrigation system.

(5) Soil/land loading rate. For three acres at the design flow, the soil loading rate would be 0.174 gallons per day per square foot. Permitted application rate not to exceed 2.84 acre-feet per year per acre irrigated.

(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; TCEQ.
- Effluent quality limits (regulatory performance standards/limits for system); BOD5 daily average limit of 20 mg/L and Single Grab limit of 65 mg/L; pH limited to between 6 and 9 standard units. Permitted flows: Nov.-April = 4,375 gpd; June-September = 12,500 gpd; and months of May and October = 7,500 gpd.
- Are there periodic *regulatory* inspections of the system? Annual at most typically.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Public. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Ownership and operations of the wastewater treatment plant were transferred from the owner. to the Sabine River Authority on Oct. 1, 2006. The plant was previously operated by park staff (with state operator licenses).
- Regularly scheduled operation and maintenance activities;
    - Daily maintenance includes cleaning bar screens, weirs, traps, and checking grinder pumps and air flow system; feeding chick food or fish food to keep system active in winter months; recording of effluent flow and rainfall.
    - Weekly activities include sampling for pH, BOD and chlorine residual.
    - Monthly activities include 30 minute sludge settling test; spray field pump system check; mowing spray field and evaporation pond dam.

  - Bi-annual activities include sludge removal (February & October), annual calibration of flow meter, and pressure check of back flow preventer check valve.
- Man-hours per week or month routinely committed to O&M activities; Average of 15 hours per week (10 hours @ $15.47/hour, PR V UPO, and 5 hours @$12.14/hour, PR III Back-up UPO); Average of $215.40/week, or $11,200.80/year.
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
  - Effluent pump failure (Sept. 2004), $256; System back-up pump was operated until the repair was completed.
  - TCEQ required a fence be placed around the spray irrigation field and evaporation pont; Staff and volunteers performed the work and utilized donated materials already on hand.
- Are there inspection or other "walkover" photos of the system that may be available to us? No.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Flow is measured at "V" weir, where effluent discharges into the lift station pumping to the evaporation pond, electronically measured via Milltronics OCM III, recorded daily, calibrated annually by A-Tech Calibration Instruments Maintenance Service, as per TCEQ requirements. See systems data spreadsheet for flow data.
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet data.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); $508,948.56 initial construction costs for system.

OM&M

- Hourly rates for personnel along with hours spent. 10 hours per week @ $15.47/hour and 5 hours per week @ $12.14/hour. Using a 2.0 multiplier to cover fringe/overhead, $1,867 average monthly labor costs.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

- $181/month average monthly electric power costs ($2,172 per year);
- AnaLab laboratory chemical analysis fees for TCEQ compliance, $177/month ($2,124/year);
- $220/month chick feed or fish food (Dec.-March) ($880/year);
- $700 annual calibration fees;
- $1,550/year sludge removal fees ($775 for 2500 gallons twice per year);
- There are also annual costs associated with the annual Continuing Education Units for the required training of the UPO and Back-up UPO, at approximately $225 each ($450 annually).

  Total approximately $30,280 per year operations costs, including labor., or $2,523 average monthly costs (not including any system repairs).

Fees

- Connection fees (if applicable); NA
- Service fee structure and user fees charged NA

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-23

A. Basic Information

- State/County where system is located; Palo Pinto County, Texas.
- Date permit was issued; 2004 (most recent).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1970.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Recreational park (RV's, campsites and day use recreational areas).
- Design Flow; 5,000 gpd
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system: Eight grinder lift stations serving facilities around the park, and leading to the treatment plant site. These lift stations have been fairly recently replaced.
  2. Pretreatment system (primary, secondary, disinfection); Aerated Lagoon (5.5' x 20' x 70'); Two Lined (Poly liner) Stabilization Ponds (4.5' x 55' x 70'); Effluent pump station (to irrigation).
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Surface irrigation in a fenced meadow area within the park (3.7 acres non-public access area; Permitted for application of not greater than 2.9 acre-ft per irrigated acre).

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study:
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). State design criteria.
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; Surface irrigation system.
  (5) Soil/land loading rate; Permitted application rate not to exceed 2.9 acre-feet per year per acre irrigated.

(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; TCEQ.
- Effluent quality limits (regulatory performance standards/limits for system); BOD_5 Single Grab Sample (once monthly) limit of 100 mg/L; pH limited to between 6 and 9 standard units. Permitted flow: 5,000 gpd.
- Are there periodic *regulatory* inspections of the system? Annual at most typically.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Public. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Regularly scheduled operation and maintenance activities;
    - Collection System: Once or twice weekly during peak season the lift stations are washed down, and checked to be sure all electrical functions are working properly. Motors and grinders are checked for any odd or different noises.
    - Wastewater Treatment Plant: Aeration and irrigation motors and pumps are checked twice weekly. Pumps and motors are greased if needed.
- Man-hours per week or month routinely committed to O&M activities; 2-10 hours per week, depending on needs.
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
    - In 1981, the wastewater effluent pond was re-lined at a cost of approximately $9,400. It was about 11 years old at that time.
    - Lift station repairs and pump replacements were done periodically over the years, with those costs ranging from several hundred to several thousand dollars.
    - Prior to replacing lift stations, metal vaults (or plugged manholes) were used to install grinder pumps, and metal flaking from corrosion was causing frequent pump replacement (4-6 grinder pumps per year at a cost of $600-$850 per unit). This also caused electrical problems and replacement needs.
    - In late 2005, renovations of the collection system and treatment plant (including liner replacement for ponds) were done (completed 2006).
    - New flow meters were installed in 2006.

- Are there inspection or other "walkover" photos of the system that may be available to us? Yes, from a 1998 engineering inspection report.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Flow Meters. (no further information on these).
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet data.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); In 1976-77, approximately $269,000 in wastewater system repairs and/or improvements was done; It appears that that may have constituted a substantial portion if not all of the original system construction.

  In 2005-2006, there were approximately $875,500 of improvements, including replacement of several lift stations, storage pond rehabilitation work (sludge removal and liner replacement), with sections of sewer line, valves, etc. replaced.

OM&M

- Hourly rates for personnel along with hours spent. 2-10 hours per week, depending on needs. Assuming $16/hour, 6 hours weekly on average, and using a 2.0 multiplier for overhead/fringe, $832/month labor costs.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
  - Average monthly power costs for <u>treatment plant</u> only:
    - 2003: $101.62/month
    - 2004: $229.80/month
    - 2005: 226.20/month
    - 2006: $226.84/month (during months when operational following plant renovation work).
  - $30/month for BOD testing.
  - Sludge was removed once in 29 years (no cost information available);

    Total approximately $13,075.36 ($1,089.61/month) per year operations costs, including labor, excluding any sludge pumping or materials/equipment costs, and excluding power costs for 8 grinder lift stations.

Fees

- Connection fees (if applicable); NA
- Service fee structure and user fees charged NA

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-24

A. Basic Information

- State/County where system is located; Randall County, Texas.
- Date permit was issued; 11/30/05 (most recent).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). Early 2001.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Large amphitheater with daily stage performances in early summer weeks/months; Recreational park (RV's, campsites recreational areas).
- Design Flow; 8,200 gpd
- History of systems on site: Is this system a replacement? Yes. Onsite system needed replacement. If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system: Effluent collection system serving large amphitheater across road, campground and RV dump station.
  2. Pretreatment system (primary, secondary, disinfection); Septic tanks (approximately 21,000 gallons of settling capacity).
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Low pressure dosed subsurface dispersal system (zones dosed in sequence via Hydrotek valves).

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study): Residential strength wastewater characteristics.
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). State design criteria for onsite wastewater systems (30 TAC Chapter 285) were generally used for the design, although septic tank sizing was based on a minimum hydraulic retention time of 2.5-3.0 days, based on peak seasonal usage.
  (3) Loading rates to unit processes;

  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; Soil conditions consist of clay loam, with no shallow groundwater or rocky conditions encountered at depths that would be considered a "limiting condition".

(5) Soil/land loading rate; A soil loading rate of 0.2 gallons per day per square foot were used (loading rate approved by TNRCC/TCEQ for Class III soils).
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; TCEQ.
- Effluent quality limits (regulatory performance standards/limits for system*);* BOD_5 Single Grab Sample (once monthly) limit of 100 mg/L; pH limited to between 6 and 9 standard units. Permitted flow: 8,200 gpd.
- Are there periodic *regulatory* inspections of the system? Annual at most typically.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Public. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Regularly scheduled operation and maintenance activities;
  - Daily: Flow meter readings; Check alarm panel; Check screw-on caps at ends of field lines (to confirm that no tampering has occurred, and that caps are in place).
  - Monthly: Clean 5 effluent filters; Check HydroTek valve box; Switch valve to different field area and flush lines.
- Man-hours per week or month routinely committed to O&M activities; 10 hours per week, at approximately $17.00/hour.
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.); None reported.
  - In June 2005, flow meters were installed to track daily flows for permitting purposes (system initially permitted through municipal permitting, and owner wishing to demonstrate flows are consistently below 5,000 gallons per day to enable permitting through the Onsite Wastewater Program (Chapter 285 rules), which will reduce operational costs (monitoring/reporting, and need for licensed operator regularly at system location).

- Are there inspection or other "walkover" photos of the system that may be available to us? Construction photos.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Flow meter, installed 2005. (No further information available on meter).

- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet data.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); $211,500 approximate initial construction costs for system. In 2005, a flow meter was installed at a cost of approximately $4,900.

OM&M

- Hourly rates for personnel along with hours spent. $17/hour (10 hours per week); Using a 2.0 multiplier for labor/fringe, approximately $1,473 per month labor costs.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
    - Power usage for the system is not known by staff, and consists of periodic activation of the pumps serving the low pressure dosed dispersal field.
    - Septage pumping costs are reported to be approximately $400 annually.
    - Laboratory costs not reported.

Not including any laboratory costs, power usage or repairs, operating costs average approximately $1,507 per month.

Fees

- Connection fees (if applicable); NA
- Service fee structure and user fees charged NA

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-25

A. Basic Information

- State/County where system is located; Johnson County, Texas.
- Date permit was issued; Dec. 2001 (most recent).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1972 and 2002 for most recent treatment plant.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Recreational park (RV's, campsites and day use recreational areas).
- Design Flow*;* 7,311 gpd
- History of systems on site: Is this system a replacement? Yes. Treatment plant had exceed its useful service life. If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system: Three ejector type pump stations and approximately two miles of collection piping convey wastewater to the main treatment plant at the park. (There are small onsite systems serving some of the facilities remote to this collection/treatment system).
  2. Pretreatment system (primary, secondary, disinfection); PEECO extended aeration package treatment plant (Bar screen, aeration basin, clarifiers, chlorine contact basin, flow metering, effluent holding tank).
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system*);* Surface irrigation in a fenced meadow area within the park (Approximately 3 acres of fenced, non-public access area; Permitted for application of not greater than 2.73 acre-ft per irrigated acre).

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study:
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). State design criteria.
  (3) Loading rates to unit processes;

  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system***;*** **System is located in an area with extensive limestone rock outcrop;** Surface irrigation system.

(5) Soil/land loading rate; Permitted application rate not to exceed 2.73 acre-feet per year per acre irrigated.
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; TCEQ.
- Effluent quality limits (regulatory performance standards/limits for system*);* BOD_5 Single Grab Sample (once monthly) limit of 30 mg/L; TSS Single Grab (once monthly) limit of 30 mg/L; pH limited to between 6 and 9 standard units (once monthly); Permitted flow: 7,311 gpd (five times weekly).
- Are there periodic *regulatory* inspections of the system? Annual at most typically.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Public. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Regularly scheduled operation and maintenance activities;
    - Blowers operate on timers;
    - Oil changed in blowers every 1500 hours of operation;
    - Motors greased every 3 years of operation or according to manufacturers recommendations;
    - The OCM III Meter is calibrated annually ($300);
    - Backflow preventer is replaced annually ($50);
    - Air filters replaced annually (approx. $120);
    - Drive belts checked weekly for wear and cracking;
    - Overall operation of following is checked daily:
        - Motor operation
        - Timers
        - Return lines
        - Chlorine supply, diffusers, etc.
    - Lab testing includes:
        - Dissolved oxygen
        - Chlorine-SS-pH
        - BOD, TSS samples sent to lab once monthly;
        - TCLP must be run during term of permit (every 6 years).
- Man-hours per week or month routinely committed to O&M activities;
  20 hours per week, total. (17 hours head operator @ $16.40/hour; Back-up operator 3 hours @ $12.00/hour).

- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
    - A breaker was replaced in October 2006, cost of $35.00;
    - Motor repaired May 2006, cost of $170;
    - Blower belt was replaced ($14);
- Are there inspection or other "walkover" photos of the system that may be available to us? No.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Flow Meter (OCM-III Open Channel Meter). Annual average flow measured from December 2005 through November 2006 is 2,763 gpd.
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. Data was provided only for the old treatment plant for which replacement was completed in 2002. See spreadsheet data.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available**);** Project file records show that the original extended aeration plant and two lift stations were constructed for about $124,200 in 1971-1972. In 2001-2002 a new/replacement wastewater treatment plant and replacement of irrigation system distribution lines/headers (and excluding collection and conveyance system(s) components) were installed at a cost of **approximately $474,000**. [Approximately $221,200 was for the treatment plant; About $99,500 was for the pond; and the remainder for piping and irrigation system improvements.] Those costs **do not include the collection/conveyance system and lift stations.**

OM&M

- Hourly rates for personnel along with hours spent. 20 hours per week, both head operator and back-up; Assuming a 2.0 multiplier on hourly rates to cover fringe/overhead, $2,728.26/month.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
    - Average monthly power costs reportedly approximately $438 ($5,250/year);
    - Approx. $180/month on average for lab testing.

- Approx. $40/month routine equipment servicing/maintenance;
- $60/month calcium hypochlorite purchases;
- $625/month sludge pumping/removal to landfill (approx. $7,500/year).

  Total approximately $4,071.26/month ($48,855 per year) operations costs, including labor. That does not include costs associated with problems/repairs/replacement of components.

Fees

- Connection fees (if applicable); NA
- Service fee structure and user fees charged NA

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-26

A. Basic Information

- State/County where system is located; Fort Bend County, Texas.
- Date permit was issued; 2004 (most recent).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). April 1984

B. Design Information

Basic Design Information

- Type(s) of facilities served; Recreational park (RV's, campsites and day use recreational areas).
- Design Flow; 16,000 gpd
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system: Six grinder lift stations and 4" sewer lines. A 1998 engineering report on the system indicated that all six lift stations were in poor condition and in need of replacement. Observed problems included severe corrosion/deterioration, and in at least one case the station was located in a flood prone area and showed signs of obvious inundation by flood waters at times. Replacement of those stations was estimated in 1998 to cost $301,000.
  2. Pretreatment system (primary, secondary, disinfection); PEECO extended aeration package treatment plant (Bar screen, equalization basin, aeration basin, clarifier, chlorine contact basin).
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Evaporation pond.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study:
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). State design criteria.
  (3) Loading rates to unit processes; Capacities/specs. for unit processes:
    - Average organic load of 13.9 lbs BOD/1000 ft3/day;
    - 20,000 gallons aeration basin volume (two tanks @ 14'x7'x14' and two tanks @ 10'x7'x14');
    - 3 HP aerator;

- 156 ft2 of clarifier surface area (two @ 14'x7'x14');
- 1,500 gallons chlorine contact volume (one chamber @ 10'x5.5'x4.5')

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; Evaporation pond..
(5) Soil/land loading rate; Permitted application rate not to exceed 2.73 acre-feet per year per acre irrigated.
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; TCEQ.
- Effluent quality limits (regulatory performance standards/limits for system);
  - BOD_5: 20 mg/L daily average; 45 mg/L daily max; 65 mg/L Single Grab (monitored once weekly, grab sample);
  - TSS: 20 mg/L daily average; 45 mg/L daily max; 65 mg/L Single Grab (monitored once weekly, grab sample);
  - pH: not less than 6.0 standard units nor greater than 9.0 standard units;
  - Minimum dissolved oxygen of 2.0 mg/L, monitored once weekly by single grab sample.
  - Daily average flow not to exceed 16,000 gpd, with two-hour period flow not to exceed 33 gallons per minute.

- Are there periodic *regulatory* inspections of the system? Annual at most typically.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Public. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Regularly scheduled operation and maintenance activities;
  - Treatment plant is checked daily.
  - Blower oil is changed monthly, and blowers are greased weekly.
  - Sludge is hauled as needed (about 6,000 gallons annually).
- Man-hours per week or month routinely committed to O&M activities;
  - Approximately 5-10 hours per week (10-20 hours weekly for both plants at the park).
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
  - Blower replaced on wastewater storage tank, at cost of $946.
  - Four pumps replaced in holding tank.

- Are there inspection or other "walkover" photos of the system that may be available to us? No.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Ultrasonic flow meter, measured daily. Average flow 1,400 gallons per day.
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet data.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available**);** No information about the initial construction costs for this system were provided.

OM&M

- Hourly rates for personnel along with hours spent. 5-10 hours per week. Assume $17/hour. Assuming approx. a 2.0 multiplier to cover fringe/overhead, approx. $1,105/month average labor costs (7.5 hours/week) just the treatment plant/system.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
    - Average monthly power costs reportedly approximately $355 ($4,260/year);
    - Estimated sludge hauled from treatment plant is reportedly about 6,000 gallons per year, @ $500 per year ($42 monthly);
    - 10% Cl2 purchased at $500/year ($42 monthly);
    - Lab fees approximately $65/month (assuming approximately 2/3 of total annual lab costs for both plants of $1024 is expended for this larger treatment plant).

    Total approximately $1,609/month ($19,308 per year) operations costs, including labor. That does not include costs associated with problems/repairs/replacement of components.

Fees

- Connection fees (if applicable); NA
- Service fee structure and user fees charged NA

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-27

A. Basic Information

- State/County where system is located; Rusk County, Texas**.**
- Date permit was issued; 5/22/06 (most recent).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). August 1986.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Recreational park (RV's, campsites and day use recreational areas).
- Design Flow*;* 14,000 gpd
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system: Approximately 1.5 miles of collection system piping within park, mostly of PVC, and four grinder lift stations. Park personnel indicate it is mostly in good condition, although some line breaks in the force main from one of the lift stations have occurred.
  2. Pretreatment system (primary, secondary, disinfection); Facultative lagoon, stabilization holding pond, irrigation pump station, and irrigation field.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system*);* Spray irrigation system; 8.5 acres of non-public access land; Permitted for application of not greater than 1.85 acre-ft per irrigated acre; Bermuda grass cover.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study:
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). State design criteria.
  (3) Loading rates to unit processes;
    - Facultative lagoon surface area = 0.17 acres (450,000 gallons);
    - Stabilization/holding pond surface area = 0.66 acres (1,075,000 gallons)
    - Irrigation pump capacity (each of 2 pumps), 15 horsepower.

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; Surface irrigation system with Bermuda grass cover.
(5) Soil/land loading rate; Permitted application rate not to exceed 1.85 acre-feet per year per acre irrigated.
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; TCEQ.
- Effluent quality limits (regulatory performance standards/limits for system); BOD_5 Single Grab Sample (once weekly) limit of 100 mg/L; pH limited to between 6 and 9 standard units (once monthly); Permitted flow: 14,000 gpd (five times weekly).
- Are there periodic *regulatory* inspections of the system? Annual at most typically.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Public. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Regularly scheduled operation and maintenance activities;
  - Daily checks of lift stations, float switches and pump operation;
  - Daily check of chlorine tank for leaks;
  - Daily check of chlorine residual in water;
  - Effluent flow to field is measured 3-4 times weekly through a 2" master meter gauge;
  - Take daily reading of water usage at well.
- Man-hours per week or month routinely committed to O&M activities; 20-25 hours per week for normal conditions; more time spent if repairs are needed.
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.); Approx. $15,000 for repairs below in last 5 years:
  - Replacement of lift station float switches;
  - Grinder pump repairs and replacement;
  - Replace grinder station valves and lines;
- Are there inspection or other "walkover" photos of the system that may be available to us? Yes, from engineering report.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); ISCO Model 3210 ultrasonic flow meter. A 1998 engineering report indicated that the meter did not appear to be working properly at that time, and might have been in need of calibration. The report noted that the flume through which flow is measured is an "H type" flume (as used by USDA Soil Conservation Service), with this type not commonly used for wastewater treatment plants. It might therefore be possible that the flow meter was calibrated for a more typical Parshall or Palmer-Bowlus type flume, and it was generally recommended that the meter by calibrated. It was further noted that the flow meter was measuring influent flow to the treatment ponds, although the state permit did not appear to specify where the flow measurement would be taken.

- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet data.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available)**;** Not available.

OM&M

- Hourly rates for personnel along with hours spent. 20-25 hours per week; Assume $15/hour; Using a 2.0 multiplier for labor/fringe, Approximately $2,925/month (at 22.5 hours weekly).
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.); Not available.

Fees

- Connection fees (if applicable); NA
- Service fee structure and user fees charged NA

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-28

A. Basic Information

- State/County where system is located; Lee County, Texas.
- Date permit was issued; 2004 ?(most recent).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1988.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Recreational park (RV's, campsites and day use recreational areas).
- Design Flow*;* 7,500 gpd
- History of systems on site: Is this system a replacement? Yes. If so, why did original fail? In 1988, the current PEECO plant was installed to replace a steel plant of similar type/size that was corroded. What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system: Approximately 6,000 feet of mostly PVC piping. Six grinder lift stations, each with duplex grinder pumps.
  2. Pretreatment system (primary, secondary, disinfection); Extended aeration treatment plant (Bar screen; Aeration basins with aeration provided by 2 blower; Clarifiers; Chlorine contact chamber – using tablet "injection" system; Effluent holding basin; and Sludge digestion); Effluent pump station in the holding basin (to irrigation storage pond).
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system*);* Effluent storage pond with 31,000 gallons capacity for effluent storage prior to irrigation; 1.7 acres of Bermuda grass irrigation, on 18 acres of land; Permitted for application of not greater than 2.1 acre-ft per irrigated acre).

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study:
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). State design criteria.
  (3) Loading rates to unit processes;
    - Aeration tank #1: 8'-7" x 6' x 6'-6";
    - Aeration tank #2: 8'-7" x 6' x 13';
    - Clarifier: 12'-4" x 6' x 13';

- Aeration sludge holding tank (aerobic digestion): 8’-7” x 6’ x 2’-10”;
- Chlorine contact chamber: 7’-4” x 6’ x 3’;
- Holding pond: 4’ x 44’ x 44’ (3:1 slope on sidewalls).

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system; Surface irrigation system.
(5) Soil/land loading rate; Permitted application rate not to exceed 2.1 acre-feet per year per acre irrigated.
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; TCEQ.
- Effluent quality limits (regulatory performance standards/limits for system); BOD_5 and TSS Single Grab Sample (once monthly) limit of 30 mg/L for each (BOD/TSS); pH limited to between 6 and 9 standard units. Chlorine residual of at least 1.0 mg/L;Permitted flow: 7,500 gpd, 30-day average.
- Are there periodic *regulatory* inspections of the system? Annual at most typically.

D. Operation, Maintenance and Monitoring Information

Qualitative

1. Is the system owned and managed by a public or private entity? Public. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. The treatment plants’ operation and maintenance is provided by park staff. The only services provided by an outside service provider are certain lab analyses, and repairs that involve confined space entry.

2. Regularly scheduled operation and maintenance activities;
   - Clean bar screen
   - Check plant for odor
   - Check color and for foaming in aeration tank
   - Check air mixing in aeration tank
   - Check return sludge from clarifier
   - Check sludge color from clarifier
   - Clean inlet baffle to clarifier
   - Check if skimmer is need to return bulking sludge
   - Clean clarifier walls
   - Clean weir box baffle
   - Check belt tightness on blowers
   - Check for leaks in piping
   - Take chlorine residual

- Check chlorine operation
- Check chlorine supply
- Record daily flow
- Check PH and sludge quality evaluation if needed
- Correspondence to TCEQ and monthly reports

3. Man-hours per week or month routinely committed to O&M activities;

The average monthly man-hours for O&M is 20 hours at a rate of $18.00 per hour. The average monthly man-hours spent for correspondence to TCEQ and monthly reports are 4 hours at a rate of $18.00 per hour. Using a 2.0 multiplier for fringe/overhead, monthly labor costs for 24 hours per month would be $864/month.

4. Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);

   i. In October 2004, installed a back flow preventer at a cost of approximately $594.
   ii. In October 2005, replaced three 10" low pressure gate valves, at a cost of about $2,091.
   iii. In October 2005, replaced galvanized piping, air valves, agitator and fiberglass baffles at a cost of approx. $1,800.

   A 1998 engineering report noted the following problems and needs (funds were indicated to have been made available for at least some improvements):
   - Collection system is in poor condition due to age and should be replaced with new PVC piping (Estimated at $84,000);
   - Replacement of 5 of the 6 duplex grinder lift stations was recommended (estimated at $315,000);
   - Repair of leaks at sectional joints of treatment plant;
   - Installation of handrails at treatment plant;
   - [Total treatment plant estimated repair costs were $69,580 (1998 dollars)]
   - Sludge wasting from aeration basin needed;
   - Replacement of tablet chlorine system with sodium hypochlorite disinfection system;
   - Failed automatic controls for irrigation system pumps;
   - Irrigation field in need of leveling due to ponding;
   - Electrical panel for the irrigation system was severely rusted and deteriorated.

5. Are there inspection or other "walkover" photos of the system that may be available to us? Yes, from the1998 engineering inspection report.

Quantitative

1. Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Flow Meters:

   Automatic - Honeywell DR450A Truline Circular Chart set up in final contact chamber. This unit is calculated in gallons per minute.
   Manual – 22 ½ Degree "V" notch Weir set up in final contact chamber. Calculations are in inches and converted to gallons per minute.

2. Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
3. Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet data.
4. Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

E. Cost Information

Design/Construction

1. Initial construction costs for the system (including design and permitting costs if available); Initial construction costs for system unknown.

OM&M

1. Hourly rates for personnel along with hours spent. Approximately 24 hours per month @ $18/hour (times overhead/fringe multiplier of 2.0).
2. Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
   i. Average monthly electrical cost for the treatment plant is $50.00
   ii. Average monthly cost for chemicals at the wastewater treatment plant is $100.00.
   iii. Average yearly cost for calibration for back flow preventer and DR450A Truline Circular Chart is $1,000.00.
   iv. In late 2005, the Park spent $813 for removal of 2,200 gallons of waste sludge (one tank truck full).

   Total approximately $13,981 per year operations costs, including labor, and excluding power costs for the grinder lift stations and any repairs ($1,165 average monthly).

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-29

A. Basic Information

- State/County where system is located; Lee County, Texas.
- Date permit was issued; 2004 ?(most recent).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1990.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Recreational park (RV's, campsites and day use recreational areas).
- Design Flow*;* 10,000 gpd
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system: Approximately 5 miles of mostly PVC collection system piping, installed in 1972. Seven grinder lift stations, each with duplex grinder pumps ranging in size from 2-5 hp. There is also a lift station at the influent point to the wastewater treatment plant.
  2. Pretreatment system (primary, secondary, disinfection); PEECO extended aeration treatment plant (Bar screen; Aeration basins with aeration provided by 2 blower, and 12,000 gallons capacity; Clarifiers; Chlorine contact chamber – using tablet "injection" system; Effluent holding basin; and Sludge digestion); Effluent pump station in the holding basin (to irrigation storage pond); Compacted clay lined holding pond.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system*);* Effluent storage pond with 74,500 gallons capacity for effluent storage prior to irrigation; Non-public access field, located in fenced meadow within park (18 acres of land); Permitted for application of not greater than 2.2 acre-ft per irrigated acre).

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study:
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). State design criteria.
  (3) Loading rates to unit processes;
    - Bar screen: 0'-9" x 3'-0";

- Aeration tank #1: 8'-11" x 6' x 13';
- Aeration tank #2: 8'-11" x 6' x 13';
- Aeration tank #3: 8'-11" x 6' x 6'-6";
- Clarifier: 12'-8" x 6' x 13';
- Aeration sludge holding tank (aerobic digestion): 8'-11" x 3' x 6';
- Chlorine contact chamber: 8'-11" x 3' x 6';
- Holding pond: 40' x 40'x 4' depth (3:1 slope on sidewalls).

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system*;* Surface irrigation system.
(5) Soil/land loading rate; Permitted application rate not to exceed 2.1 acre-feet per year per acre irrigated.
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; TCEQ.
- Effluent quality limits (regulatory performance standards/limits for system*);* BOD_5 and TSS Single Grab Sample (once monthly) limit of 30 mg/L for each (BOD/TSS); pH limited to between 6 and 9 standard units. Chlorine residual of at least 1.0 mg/L;Permitted flow: 7,500 gpd, 30-day average.
- Are there periodic *regulatory* inspections of the system? Annual at most typically.

D. Operation, Maintenance and Monitoring Information

Qualitative

1. Is the system owned and managed by a public or private entity? Public. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. The treatment plants' operation and maintenance is provided by park staff. The only services provided by an outside service provider are certain lab analyses, and repairs that involve confined space entry.

2. Regularly scheduled operation and maintenance activities;
   - Clean bar screen
   - Check plant for odor
   - Check color and for foaming in aeration tank
   - Check air mixing in aeration tank
   - Check return sludge from clarifier
   - Check sludge color from clarifier
   - Clean inlet baffle to clarifier
   - Check if skimmer is need to return bulking sludge

- Clean clarifier walls
- Clean weir box baffle
- Check belt tightness on blowers
- Check for leaks in piping
- Take chlorine residual
- Check chlorine operation
- Check chlorine supply
- Record daily flow
- Check PH and sludge quality evaluation if needed
- Correspondence to TCEQ and monthly reports

3. Man-hours per week or month routinely committed to O&M activities;

The average monthly man-hours for O&M is 20 hours at a rate of $18.00 per hour. The average monthly man-hours spent for correspondence to TCEQ and monthly reports are 4 hours at a rate of $18.00 per hour. Using a 2.0 multiplier for fringe/overhead, monthly labor costs for 24 hours per month would be <u>$864/month</u>.

4. Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);

   i. In February 2005, installed a back flow preventer at a cost of approximately $594.
   ii. In October 2006, replaced three 10" low pressure gate valves, at a cost of about $2,091.
   iii. In October 2006, replaced galvanized piping, air valves, agitator and fiberglass baffles at a cost of approx. $1,800.

A 1998 engineering report, and a TCEQ inspection on 7/21/99 identified a number of problem conditions with various parts of the wastewater collection and treatment system, as noted below. (Funds were indicated to have been made available for at least some improvements):

- All life stations had begun to leak into surrounding ground; It was recommended in the engineering report that all lift stations be replaced.
- Electrical panels serving lift stations in poor condition;
- Dump stations need proper back flow prevention;
- Wastewater treatment plant leaking at sectional joints;
- High solids noted in the aeration basin. Park staff indicated that there were insufficient funds has been available for pumping sludge. [Funds were later made available, and sludge wasting was resumed]
- Backflow prevention needed for treatment plant;
- Disinfection system needs replacing;

- No handrails around treatment plant;
- Pumps at irrigation field operate manually (failed automatic controls);
- Pumps leak effluent when operating;
- Irrigation field electrical panel in poor conditions;
- Irrigation pond needs re-lining;
- Low/settled spots ponding in irrigation field;
- Flow meter needed to record field pumping/application;

The engineering report recommended approximately $510,000 in wastewater collection and conveyance system improvements, and replacement of the wastewater treatment plant at an estimated cost of $210,000 (all 1998 dollars). [Note: A correction in the number of lift stations to be replaced resulted in a revision to the engineering estimate for lift station replacement costs].

5. Are there inspection or other "walkover" photos of the system that may be available to us? Yes, from the 1998 engineering inspection report.

Quantitative

1. Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Flow Meters:

   Automatic - Honeywell DR450A Truline Circular Chart set up in final contact chamber. This unit is calculated in gallons per minute.

   Manual – 22 ½ Degree "V" notch Weir set up in final contact chamber. Calculations are in inches and converted to gallons per minute.

2. Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
3. Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet data.
4. Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

E. Cost Information

Design/Construction

1. Initial construction costs for the system (including design and permitting costs if available); Initial construction costs for system unknown.

OM&M

1. Hourly rates for personnel along with hours spent. Approximately 24 hours per month @ \$18/hour; Using overhead/fringe multiplier of 2.0, approximately \$864/month.
2. Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
    i. Average monthly electrical cost for the treatment plant is \$60.00
    ii. Average monthly cost for chemicals at the wastewater treatment plant is \$100.00.
    iii. Average yearly cost for calibration for back flow preventer and DR450A Truline Circular Chart is \$1,000.00.

    Total approximately \$12,568 per year operations costs (\$1,047.33/month), including labor, and <u>excluding</u> any sludge pumping or materials/equipment costs, and excluding power costs for the grinder lift stations

Fees

1. Connection fees (if applicable); NA
2. Service fee structure and user fees charged NA

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-30

A. Basic Information

- State/County where system is located; Walker County, Texas.
- Date permit was issued; 2002 (most recent re-permitting).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1977.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Recreational park (RV's, campsites and day use recreational areas).
- Design Flow; 50,000 gpd.
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system: The collection system has approximately 3 miles of mostly PVC piping, with about 1,000 of that footage being concrete. Diameter of piping ranges from 2-4 inches. All wastewater is pumped to the WWTP via 14 grinder lift stations located throughout the park. Each lift station has duplex 2-HP grinder pumps, and 2-inch galvanized steel discharge piping, with gate and check valves installed. Problems were noted in a 1998 engineering report with these lift station, as outlined below.
  2. Pretreatment system (primary, secondary, disinfection); PEECO activated sludge/extended aeration plant. Bar screen; 2 Aeration Basins in series; Clarifier with air lift return sludge to 1st aeration basin; Chlorine contact basin; Two Sludge digesters.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Subsurface discharge of treated effluent to approximately 39,000 square feet of drainfield area.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study): Domestic waste characteristics.
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). In general, state design criteria.
  (3) Loading rates to unit processes;
  Aeration Basin: 49,000 gallons

Clarifier surface area: 176 ft2
Chlorine Contact volume: 2,945 gallons
Aerobic sludge Digester: 8,261 gallons

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system. Loamy soils, according to general soil survey.

(5) Soil/land loading rate; Average of 0.29 gpd/ft2 over a 2-year period; Loading ranged from 0.06 to 0.54 gpd/ft2.

(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; TCEQ.
- Effluent quality limits (regulatory performance standards/limits for system*);*
    - BOD5: 30-day avg. not to exceed 20 mg/L; 24-hour composite not to exceed 45 mg/L; Single grab not to exceed 65 mg/L.
    - Permitted flow: 50,000 gpd (5 samples per week).
    - Effluent Chlorine Residual of at least 1.0 and not greater than 4.0 mg/L after detention for at least 20 minutes (monitored 5 times/week).
- Are there periodic *regulatory* inspections of the system? Annual at most typically.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Public. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Regularly scheduled operation and maintenance activities;

  Daily:
  - Check that all pumps and motors are operating or operational as required;
  - Equipment serviced as required in accordance with manufacturers' instruction;
  - Check airlifts for clogging;
  - Operate surface skimmer as required.
  - Skim scum from the inlet baffle or clarifier and empty into sludge holding tank;
  - Skim debris from chlorine tank and empty into sludge holding tank;
  - Hose down walkways, side boards and splash spray areas;
  - Check chlorinator feeding and supply;
  - Check effluent pipe to see that it is clear.

  Weekly:
  - Check diffusers for clogging;
  - Skim floating debris from aeration tank.

  Tri-monthly:

  - Pull and clean diffusers.

- Man-hours per week or month routinely committed to O&M activities;
  - 55 hours per month @ $15.50/hour, and 4 hours/month @ $12.50/hour.
  - If assume a 2.0 multiplier on rate, approximately $1800/month.
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);

Date	Description of Repair Item	Cost of Repair
10/20/04	Repair Blower (WWTP)	$735.00
11/26/04	Repair Blower (WWTP)	$835.00
10/01/05	Lift Station Repair on #3 restroom lift station	$1,995.00
3/17/05	Repair Blower (WWTP)	$556.00
6/21/05	Replace Grinder Pump at lift station	$1,000.00
11/02/05	Repair Blower (WWTP)	$735.00
11/28/05	Replace grinder pump	$1000.00
02/26/06	Repair on electrical panel @ WWTP	$764.00
3/28/06	Repair Blower (WWTP)	$110.00
10/19/06	Repair Blower (WWTP)	$705.00
Total Wastewater System Repairs Reported for 2-year Period		**$8,435.00**
Average monthly Total WW System Repairs for 2-year Period		**$351.46**
Total WWTP-Related Repairs Reported for 2-year Period		**$4,440.00**
Total Lift Station/Collection System Repairs Reported for 2-year Period		**$3,995.00**

There were problems noted with all of the grinder lift stations in a 1998 engineering inspection report including: Corrosion/deterioration of piping; rusted control panels; Covers in need of replacement; pipe leaking; and pump problems.

- Are there inspection or other "walkover" photos of the system that may be available to us? Some in engineering report.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Honeywell Milltronics OCM III flow meter. See spreadsheet for flow data.
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet data.

- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); Although staff did not have specific information about the initial construction costs for the wastewater system, project file cards from the 1970's indicate two large construction project expenditures for the wastewater system. Those include $109,003 in 1976, and $142,250 in 1977. Those are likely associated with the construction of at least a portion of the collection system and the treatment plant (the latter expense refers to treatment plant).

OM&M

- Hourly rates for personnel along with hours spent. See above.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Power usage:

Month	**Power Costs for Wastewater Treatment Plant**
September 2004	$1,165.31
October 2004	$1,148.93
November 2004	$1,435.74
December 2004	$960.64
January 2005	$1,061.05
February 2005	$1,216.13
March 2005	$1,054.61
April 2005	1,114.27
May 2005	$1,198.04
June 2005	$1,010.62
July 2005	$1,018.93
August 2005	$1,347.30
September 2005	$936.99
October 2005	$975.27
November 2005	$1,406.42
December 2005	$1,563.78
January 2006	$1,319.16
February 2006	$970.11
March 2006	$1,091.45
April 2006	$1,335.59
May 2006	$1,390.21
June 2006	$921.42

July 2006	$735.87
August 2006	$892.61
September 2006	$1,461.59
October 2006	$1,182.37
Average Monthly Power Usage over 2-Year Period	**$1,150.55**

Average monthly sludge hauling/pumping costs (based on twice annual hauling): $170.

Average monthly costs (including average monthly system repairs, but **NOT including laboratory analytical costs**): $3,472/month,

Fees

- Connection fees (if applicable); NA
- Service fee structure and user fees charged NA

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-31

A. Basic Information

- State/County where system is located; Burnet County, Texas.
- Date permit was issued; Most recent – Dec. 2004.
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). 1996.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Recreational park (RV's, campsites and day use recreational areas).
- Design Flow*;* Plant designed for max. capacity of **50,000 gpd.** **Note: TCEQ permit is for discharge of no more than: 40,000 gpd during June-August; 20,000 gpd during March-May and September-November; and 6,000 gpd during December-February.**
- History of systems on site: Is this system a replacement? Yes. The lift stations and treatment plant were installed in 1996 to replace existing plant and lift stations that needed replacement; The original collection/piping system was left in place. All lift stations were rebuilt using the existing wet wells. If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system: Twelve grinder lift stations pumping wastewater from facilities around the park to the WWTP.
  2. Pretreatment system (primary, secondary, disinfection); Precast concrete PEECO extended aeration/activated sludge plant (typical to state parks). Consists of: Equalization tank; Two aeration basins; Two final clarifiers; One aerated sludge tank; One Chlorine contact chamber; Two effluent storage ponds; Effluent irrigation system.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system*);* Effluent irrigation system (on 10 acres of non-public access pastureland); Irrigation application rate not to exceed 2.41 acre-feet per year per irrigated acre.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study): Influent quality tests run in the past had these results: BOD levels ranged from 200 mg/l to 2000 mg/l and Ammonia levels ranged from 80 mg/l to 200 mg/l.
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF

MOP, EPA design manual methodology, Metcalf Eddy, etc.). State (TCEQ) design criteria.

(3) Loading rates to unit processes;

Equalization Tank:	10'-10" x 15'-6" x 7'-6";
Aeration Tank #1:	10'-10" x 15'-6" x 15'-6";
Aeration Tank #2:	10'-10" x 31'-6" x 15'-6";
Clarifier:	14'-1" x 23'-6" x 7'-6";
Chlorine Contact Chamber:	10'-10" x 7'-6" x 7'-6";
Aerated Sludge Tank:	10'-10" x 31'-6" x 7'-6".
Effluent Holding Basin #1:	10'-10" x 31'-6" x 20'-0"
Effluent Holding Basin #2:	10'-10" x 52'-0" x 68'-0".

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system

(5) Soil/land loading rate; Not to exceed 2.41 acre-feet per irrigated acre per year.

(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; TCEQ.
- Effluent quality limits (regulatory performance standards/limits for system*);* BOD_5 Daily Average limit of 20 mg/L, and Single Grab of 65 mg/L (one sample per week); TSS Daily Average limit of 20 mg/L and Single Grab limit of 65 mg/L (one sample per week); pH limited to between 6 and 9 standard units; Effluent Chlorine Residual of at least 1.0 after detention for at least 20 minutes, and monitored 5 times/week.
  - Permitted flows, (5 samples per week, and 30-day average): 40,000 gpd June-August;
  - 20,000 gpd March-May and Sept.-Nov.
  - 6,000 gpd Dec.-Feb.

- Are there periodic *regulatory* inspections of the system? Annual at most typically.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Public. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Regularly scheduled operation and maintenance activities;
  - Run daily tests on every stage of the treatment process;
  - Monitor the plant daily and make repairs as needed;
  - Contract lab personnel come weekly and pull Effluent BOD and TSS, and Aeration MLSS.

- Take flow measurements;
- Add chlorine at the contact chamber and add lime as needed to maintain the pH level.

System operator comments:

Original design was for the influent to come straight into plant, this caused inconsistent flow patterns and shock loading of plant due to the high strength of the sewage coming in. Converted 1st aeration chamber into a pre-treatment basin which had pumps installed in it. This allowed us to control the flow going into plant and allowing the influent to aerate and dilute before entering the plant. The main issue has been the clarifiers, which are setup with a baffle wall at the entrance, 3 hoppers and air eductors to remove the sludge. Original design was to hydraulically force the sludge down once it entered the clarifiers instead of it gradually settling on its own. This causes floc shear and blanket wash out. So we positioned the baffle walls two feet further away from the entrance, we were trying to decrease the impact on the floc once it entered the clarifiers. The air eductors in the clarifiers will not draw thick sludge. So we must maintain our MLSS in the aeration at low levels or the clarifiers will load up with sludge and eventually wash over into the weirs. There are 12 lift stations that feed into the plant which sit at idle during the week holding septic wastewater in them. A pre-treatment system was added at our dump station, which has a holding tank and two aerated zones. This was installed to help reduce the impact of the high strength sewage coming into the plant when the RVs were dumping.

- Man-hours per week or month routinely committed to O&M activities;
  - Average hours spent per week on routine plant duties is 24 hours. Assume \$17/hour, with a 2.0 multiplier on hourly rates: \$3,536 monthly.
  - Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.); Since 1996, the following is reported:
    - There has been one major repair project, but cost is unknown. It involved rerouting plumbing, refurbishing pump system in Aeration Chamber #1, which allowed the park to use this as a pre-treatment basin.
    - In addition to that:
      - 4 blower motors at \$500.00 ea., (\$2,000 total);
      - 2 lift pumps and controls at \$1298.00;
      - 3 sprinkler field pumps at \$1200.00 ea., (\$3,600 total);
      - 3 check valves replaced with a total cost of \$1924.00;
      - Field repair of flow meter at \$600.00.

  - Are there inspection or other "walkover" photos of the system that may be available to us? Some in engineering report.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); The following was reported: The flow at the plant is monitored in two places, first at the contact chamber prior to the holding basin using a Milltronics 60 degree "V" notch meter with chart recorder which measures GPM with a daily total. The second flow monitoring place is after the holding basin, prior to the sprinkler field which has a 4" McCrometer meter with chart recorder which measures GPM and daily total. **The plant never runs over 50 % capacity even on weekends and holidays. During the week it runs at less than 20% capacity.**

- Influent Quality Data to the system (if available) and QA/QC provisions employed; Influent quality tests run in the past had these results: BOD levels ranged from 200 mg/l to 2000 mg/l and Ammonia levels ranged from 80 mg/l to 200 mg/l.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet data.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); The original constructed costs of the 1996 improvements (lift stations and treatment plant --- not including collection system & force mains) were reported to be $1,704,614.44 (not including engineering/surveying).

OM&M

- Hourly rates for personnel along with hours spent. See above. $3,536 monthly.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
    - Power usage is unknown – the park has one master meter.
    - Sludge pumping (from aerobic digester) costs average $2,400 annually (14,000 gallons per trip at $1,200 per trip, twice annually).

Average monthly costs for labor and sludge removal, **and not including power usage, repairs and outside lab services, or any repairs:** $3,736/month ($44,832/year).

If power, chemical and outside laboratory costs are assumed based on other comparably sized treatment plants of the same type (PEECO extended aeration), the following costs could be assumed:

- Power usage $7,200 ($600 monthly);
- Monthly laboratory testing approximately $60;
- Cost for chlorine disinfectant $1963.50 ($163.63 monthly);

Use of these additional costs would bring annual operating costs (not including repairs to approximately <u>$4,560/month</u>.

Fees

- Connection fees (if applicable); NA
- Service fee structure and user fees charged NA

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-32

A. Basic Information

- State/County where system is located; Freestone County, Texas.
- Date permit was issued; 2004 (most recent).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). Mid 1970's.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Recreational park (RV's, campsites and day use recreational areas).
- Design Flow; Permitted for 22,000 gpd originally; Later changed to 3,000 gpd.
- History of systems on site: Is this system a replacement? No. If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system: Grinder lift stations pumping wastewater from facilities to WWTP (total of 7 stations serving the two major areas of the park, which are served by two separate treatment systems).
  2. Pretreatment system (primary, secondary, disinfection); Bar Screen; Oxidation ditch; Secondary Clarifier; Waste Activated and Return Activated Sludge Pumping capabilities; Chlorine Contact Chamber; Effluent flow metering; and Effluent pump station that pumps to the land application site.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Surface irrigation of effluent on 1.65 acres (irrigation rate not to exceed 2.1 acre-feet per irrigated acre).

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study):
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). TCEQ criteria.
  (3) Loading rates to unit processes;
    - Oxidation Ditch Volume: 36,560 gallons;
    - Aerator horsepower: 5;
    - Clarifier Surface Area: 64 sq. ft.;
    - Chlorine Contact Volume: 2,400 gallons;
    - Effluent pump capacity: 50 gpm each.

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system
(5) Soil/land loading rate; Not to exceed 2.1 acre-feet per irrigated acre.
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; TCEQ.
- Effluent quality limits (regulatory performance standards/limits for system); BOD_5 Single Grab of 65 mg/L (1 sample per month); pH limited to between 6 and 9 standard units. Permitted flow: 22,000/3,000 gpd (5 samples per week). Effluent Chlorine Residual of at least 1.0 after detention for at least 20 minutes, and monitored 5 times/week.
- Are there periodic *regulatory* inspections of the system? Annual at most typically.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Public. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Regularly scheduled operation and maintenance activities; Not reported.
- Man-hours per week or month routinely committed to O&M activities;
    - 10 hours per week @ $15.42/hour, and 4 hours per week @ $12.82/hour. Using a 2.0 multiplier on rates for fringe/overhead, total of approximately $1,781/month for labor.
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.); None reported.
    - January 2003; Replaced motor on return pump: $132.48;
    - January 2003; Replaced drive coupling on return pump: $14.50;
    - September 2004; Replaced motor on return pump: $132.48;
    - September 2004; Replaced vanes on return pump: $120.93;
    - 2005; Replaced motor on return pump: $177.40;
    - 2005; Replaced vanes on 2 return pumps: $206.98;
    - September 2006; Replaced vanes on 2 return pumps: $197.68.

    Average monthly repair costs for the 3-year period were $27.29.

- Are there inspection or other "walkover" photos of the system that may be available to us? Some in engineering report.
  A 1998 engineering report noted a number of problems and needs with the collection system, and operation of the treatment plant and irrigation system.

Although some or all of those things may have been corrected since that time, they included:

- The control panel for the irrigation pump station was not watertight, and during wet periods there were problems with the operation of the pumps;
- The pump control problem was in turn contributing to flow metering problems (effluent flow reading impacted by water backing up into the chlorine contact basin);
- Oxidation ditch did not have handrails around the perimeter;
- Lift station problems included the following:
    - Exposed discharge piping;
    - One of duplex pumps in a lift station was inoperable;
    - Damage to the concrete top of the station;
    - No isolation valves on discharge piping;
    - Guide rail corrosion;
    - Pump corrosion.

Approximately $84,000 in lift station improvements or replacements were identified in the report for this section of the park.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); PDS 360 Ultra Sonic Open Channel Flow Meter (per Park staff), continuously recording.
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet data.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); According to archived project card file records, it appears that the original cost for constructing the wastewater system for this portion of the park was $402,724, and was completed in early 1976. **However, there is no way of knowing from the files what portion of these costs pertains to this or the other major area of the Park.**

OM&M

- Hourly rates for personnel along with hours spent.
    - 10 hours per week @ $15.42/hour, and 4 hours per week @ $12.82/hour. Using a 2.0 multiplier on rates for fringe/overhead, total of approximately $1,781/month for labor.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
    - Power usage:
        - 2004: Average of $204.13/month; $2,449.62 for the year.
        - 2005: Average of $225.33/month; $2,703.92 for the year.
        - 2006: Average of $248.52/month; $2,982.27 for the year.

    - Lab costs for BOD5 and pH testing: $20/month ($240/year);
    - Flow meter calibration: $275/year;
    - Annual Soil Analysis: $345/year.

    Sludge wasting costs not reported.

Average monthly costs, including the above reported repairs, **and not including sludge pumping/remova**l: $2,128.48/month ($25,541.76 per year).

Fees

- Connection fees (if applicable); NA
- Service fee structure and user fees charged NA

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-33

A. Basic Information

- State/County where system is located; Freestone County, Texas.
- Date permit was issued; 2004 (most recent).
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). Mid 1970's.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Recreational park (RV's, campsites and day use recreational areas).
- Design Flow; Permitted for 40,000 gpd originally; Later changed to 7,000 gpd.
- History of systems on site: Is this system a replacement? No. If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system: Grinder lift stations pumping wastewater from facilities to WWTP (total of 7 stations reportedly serving two areas of the park, each served by a different treatment system).
  2. Pretreatment system (primary, secondary, disinfection); Bar Screen; Oxidation ditch; Secondary Clarifier; Waste Activated and Return Activated Sludge Pumping capabilities; Chlorine Contact Chamber; Effluent flow metering; and Effluent pump station that pumps to the non-public access land application site.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Surface irrigation of effluent on 3.75 acres of non-public access area (irrigation rate not to exceed 2.1 acre-feet per irrigated acre).

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study):
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.). TCEQ criteria.
  (3) Loading rates to unit processes;
    - Oxidation Ditch Volume: 72,600 gallons;
    - Aerator horsepower: Not available;
    - Clarifier Surface Area: 113 sq. ft.;
    - Chlorine Contact Volume: 3,600 gallons;
    - Effluent pump capacity: 90 gpm each.

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system
(5) Soil/land loading rate; Not to exceed 2.1 acre-feet per irrigated acre.
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; TCEQ.
- Effluent quality limits (regulatory performance standards/limits for system); BOD_5 Single Grab of 65 mg/L (1 sample per month); pH limited to between 6 and 9 standard units. Permitted flow: 7,000 gpd (5 samples per week). Effluent Chlorine Residual of at least 1.0 after detention for at least 20 minutes, and monitored 5 times/week.
- Are there periodic *regulatory* inspections of the system? Annual at most typically.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Public. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Regularly scheduled operation and maintenance activities; Not reported.
- Man-hours per week or month routinely committed to O&M activities;
    - 10 hours per week @ $15.42/hour, and 4 hours per week @ $12.82/hour. Using a 2.0 multiplier on rates for fringe/overhead, total of approximately $1,781/month for labor.
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.); None reported.
    - January 2003; Replaced motor on return pump: $127.94;
    - January 2003; Replaced drive coupling on return pump: $14.50;
    - September 2004; Replaced motor on return pump: $132.48;
    - September 2004; Replaced drive coupling on return pump: $14.50;
    - September 2004; Replaced vanes on 2 return pumps: $241.86;
    - September 2005; Replaced drive couplings on return pump: $14.95;
    - September 2005; Replaced vanes on return pump: $103.46;
    - March 2006; Repaired/replaced pump motor: $176.45;
    - March 2006; Replaced drive couplings on return pump: $15.50;
    - September 2006; Replaced vanes on return pump: $98.86;
    - September 2006; Replaced drive couplings on return pump: $15.50.

    Over a 3-year period, repair costs averaged approximately $26 per month.

- Are there inspection or other "walkover" photos of the system that may be available to us? Some in an engineering report.

A 1998 engineering report noted a number of problems and needs with the collection system, and operation of the treatment plant and irrigation system. Although some or all of those things may have been corrected since that time, they included:

- The control panel for the irrigation pump station was not watertight, and during wet periods there were problems with the operation of the pumps;
- The pump control problem was in turn contributing to flow metering problems (effluent flow reading impacted by water backing up into the chlorine contact basin);
- Oxidation ditch did not have handrails around the perimeter;
- Lift station problems included the following:
    - Exposed discharge piping;
    - One of duplex pumps in a lift station was inoperable;
    - No isolation valves on discharge piping;
    - Control Panel corrosion.
    - Guide rail corrosion;
    - Pump corrosion.

Approximately $173,600 in lift station improvements or replacements were identified in the report for this section of the park.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); PDS 360 Ultra Sonic Open Channel Flow Meter (per park staff), continuously recording.
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet data.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); According to archived project card file records, it appears that the original cost for constructing the wastewater system for the park was $402,724, and was completed in early 1976. **However, there is no way of knowing from the files what portion of these costs pertains to this or another area of the park.**

OM&M

- Hourly rates for personnel along with hours spent.
    - 10 hours per week @ $15.42/hour, and 4 hours per week @ $12.82/hour. Using a 2.0 multiplier on rates for fringe/overhead, total of approximately $1,781/month for labor.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
    - Power usage:
        - 2004: Average of $231.16/month; $2,773.89 for the year.
        - 2005: Average of $245.85/month; $2,950.22 for the year.
        - 2006: Average of $278.80/month; $3,345.62 for the year.
    - Lab costs for BOD5 and pH testing: $20/month ($240/year);
    - Flow meter calibration: $275/year;
    - Annual Soil Analysis: $345/year.

    Sludge wasting costs not reported.

Average monthly costs, including the above repairs, and **not including sludge pumping/remova**: $2,157.47/month ($25,890 per year).

Fees

- Connection fees (if applicable); NA
- Service fee structure and user fees charged NA

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-34

A. Basic Information

- State/County where system is located; Brown County, Texas.
- Date permit was issued; Most recent Nov. 2004.
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). Early 1970's.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Recreational park (RV's, campsites and day use recreational areas).
- Design Flow; 10,000 gpd.
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system: Grinder lift stations pumping wastewater from facilities to WWTP.
  2. Pretreatment system (primary, secondary, disinfection); Activated sludge/extended aeration plant (typical to state parks); Bar screen; Aeration basin; Clarifier; Return sludge capability; Chlorine Contact Chamber; Effluent pump station; Evaporation/storage pond with 0.37 acre-feet of capacity; Irrigation.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system); Surface irrigation.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study):
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
  (3) Loading rates to unit processes;
  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system
  (5) Soil/land loading rate; Surface irrigation (1.85 acres of non-public access land; Application rate not to exceed 6.5 acre-ft. per year per irrigated acre);
  (6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; TCEQ.

- Effluent quality limits (regulatory performance standards/limits for system*);* BOD_5 Single Grab of 30 mg/L (1 sample per month); TSS Single Grab limit of 30 mg/L (one sample per month); pH limited to between 6 and 9 standard units. Permitted flow: 10,000 gpd (reported once per month). Effluent Chlorine Residual of at least 1.0 after detention for at least 20 minutes, and monitored 5 times/week.
- Are there periodic *regulatory* inspections of the system? Annual at most typically.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Public. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Regularly scheduled operation and maintenance activities;
  - Daily:
    - Check all pumps and motors for proper operation;
    - Service equipment per manufacturer's requirements;
    - Rake bar screen and dispose of screenings;
    - Check aeration delivery system for any clogging;
    - Operate surface skimmers as required;
    - Check operation of froth control system, if used;
    - Skim scum from inlet baffle of clarifier and empty into sludge holding tank;
    - Skim debris from chlorine tank and empty into sludge holding tank;
    - Hose down walkways, sideboard and spray areas;
    - Check chlorinator feed and supply;
    - Check irrigation field and clean irrigation head if needed;
    - Check effluent discharge pipe to verify that it is clear.
  - Weekly:
    - Squeegee clarifier hopper sides;
    - Skim floating debris from aeration tank;
  - Tri-monthly:
    - Pull and clean diffusers.
  - Maintain Chlorine levels, pH, etc.;
  - Collect samples as required;
  - Monitor and maintain lift stations.
- Man-hours per week or month routinely committed to O&M activities;
  - Previously 46 hours per month @ $16.60/hour.
  - This is changing to 46 hours per month @ $16.60/hour and 46 hours per month @ $11.66/hour. Using 2.0 multiplier on rate for fringe/overhead, approximately $2,579/month.

- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
  - Two transfer pumps from WWTP to pond: $1,972;
  - Two electric blower motors: $1,285;
  - Two blowers replaced: $5,160;
  - Ultra sonic flow meter repair (lightning strike): $1,350;
  - Honeywell Chart Recorder repair (lightning strike): $1,500;
  - Replaced LMI external signal ejection pump: $550
  - Replaced electrical starter for blower unit: $731.63

  Total = $12,548.63 for past few years.

- Are there inspection or other "walkover" photos of the system that may be available to us? Some in 1998 engineering report.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Continuous ultra sonic flow meter..
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet data.
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); The original constructed costs of the system, including lift stations are estimated to be $170,281.

OM&M

- Hourly rates for personnel along with hours spent. See above.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
  - Power costs for Treatment Plant:
    - 2004: $2990.28;
    - 2005: $2,926.50;
    - 2006: $3,965.34.

- Power costs for Irrigation System:
    - 2004: $351.56;
    - 2005: $384.63;
    - 2006: $358.80.

- Sludge Hauling costs (based on % of total for park) are estimated to be $98.15/month ($3,533 for 3-year period).

Average monthly costs for labor, sludge hauling, and electric power, not including any repairs or lab costs: $3,038/month.

If repair costs are added in, monthly costs are approximately $3,387 per month.

Fees

- Connection fees (if applicable); NA
- Service fee structure and user fees charged NA

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-35

A. Basic Information

- State/County where system is located; Brown County, Texas.
- Date permit was issued; ?.
- Date system went into service (confirm that there are at least 5 years of operation of the system before today). Spring/summer 1971.

B. Design Information

Basic Design Information

- Type(s) of facilities served; Recreational park (RV's, campsites and day use recreational areas).
- Design Flow*;* 10,050 gpd.
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
- Type of System
  1. Collection system: Grinder lift stations pumping wastewater from facilities to WWTP.
  2. Pretreatment system (primary, secondary, disinfection); Activated sludge/extended aeration plant (typical to state parks); Aeration chamber; clarifier; Return sludge capability; Chlorine Contact Chamber; Effluent pump station; Evaporation pond; Irrigation.
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system*);* Surface irrigation.

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study):
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
  (3) Loading rates to unit processes;

Aeration chamber:	26,932 gallons;
Clarifier:	90 square feet;
Chlorine Contact Chamber:	943 gallons;
Aerated Sludge Digester:	2,244 gallons.

  (4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system

(5) Soil/land loading rate; Surface irrigation (3.63 acres of non-public access land; Application rate not to exceed 2.32 acre-ft. per year per irrigated acre);
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design. None available.

C. Regulatory Information

- Regulatory authority and contact info; TCEQ.
- Effluent quality limits (regulatory performance standards/limits for system*);* BOD_5 Single Grab of 30 mg/L (1 sample per month); TSS Single Grab limit of 30 mg/L (one sample per month); pH limited to between 6 and 9 standard units. **Permitted flow: 10,500 gpd May-October, and 5,000 gpd Nov. – April** (reported once per month). Effluent Chlorine Residual of at least 1.0 after detention for at least 20 minutes, and monitored 5 times/week.
- Are there periodic *regulatory* inspections of the system? Annual at most typically.

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? Public. If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
- Regularly scheduled operation and maintenance activities;
    - Daily:
        - Check all pumps and motors for proper operation;
        - Service equipment per manufacturer's requirements;
        - Rake bar screen and dispose of screenings;
        - Check aeration delivery system for any clogging;
        - Operate surface skimmers as required;
        - Check operation of froth control system, if used;
        - Skim scum from inlet baffle of clarifier and empty into sludge holding tank;
        - Skim debris from chlorine tank and empty into sludge holding tank;
        - Hose down walkways, sideboard and spray areas;
        - Check chlorinator feed and supply;
        - Check irrigation field and clean irrigation head if needed;
        - Check effluent discharge pipe to verify that it is clear.
    - Weekly:
        - Squeegee clarifier hopper sides;
        - Skim floating debris from aeration tank;
    - Tri-monthly:
        - Pull and clean diffusers.

  - Maintain Chlorine levels, pH, etc.;
  - Collect samples as required;
  - Monitor and maintain lift stations.
- Man-hours per week or month routinely committed to O&M activities;
  - Previously 46 hours per month @ $16.60/hour.
  - This is changing to 46 hours per month @ $16.60/hour and 46 hours per month @ $11.66/hour. Using 2.0 multiplier on rate for fringe/overhead, approximately $2,579/month.
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
  - Two electrical motors for blowers: Approx. $1,285;
  - Two blowers replaced: $5,160;
  - Ultra Sonic Flow Meter: $2,304;
  - One 10 hp Berkley transfer pump and motor: $1,765;
  - LMI external signal injector pump: $500;
  - Replaced electrical starter for blower unit: $731.63

  Total = $11,796.43 for past few years.

- Are there inspection or other "walkover" photos of the system that may be available to us? Some in a 1998 engineering report.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated); Continuous ultra sonic flow meter..
- Influent Quality Data to the system (if available) and QA/QC provisions employed; Not available.
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available. See spreadsheet data.

- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field. NA

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available); The original constructed costs of the system, including lift stations are estimated to be $340,561.

OM&M

- Hourly rates for personnel along with hours spent. See above.

- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)
    - Power costs for Treatment Plant:
        - 2004: $4,339.62;
        - 2005: $5,444.24;
        - 2006: $7,593.44.

    - Power costs for Irrigation System:
        - 2004: $213.16;
        - 2005: $224.88;
        - 2006: $263.68.

    - Sludge Hauling costs (based on % of total for park) are estimated to be $200/month ($7067 for 3-year period).

Average monthly costs for labor, sludge hauling, and electric power, not including any repairs or lab costs: $3,434/month.

If repair costs are added in, monthly costs are approximately $3,762 per month.

Fees

- Connection fees (if applicable); NA
- Service fee structure and user fees charged NA

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-ND-1
NOTE: No data was available for this system.

A. Basic Information

- State/County where system is located;
  - Texas, Smith County
- Date permit was issued;
  - June 11, 1999
- Date system went into service (confirm that there are at least 5 years of operation of the system before today).
  - unknown

B. Design Information

Basic Design Information

- Type(s) of facilities served;
  - Mobile home park
- Design Flow;
  - 0.012 MGD
- History of systems on site: Is this system a replacement? If so, why did original fail? What are objectives of the design? What specific problems needed to be overcome by design?
  - Design objective is to treat and dispose of domestic wastewater without disposing of the effluent into water in the state. Effluent is disposed of by means of subsurface drip irrigation.
- Type of System
  1. Collection system
     Wastewater flows by gravity from each home to the wastewater treatment plant
  2. Pretreatment system (primary, secondary, disinfection)
  3. Land application system (surface vs. subsurface, type of distribution system, type of irrigation/trench system)
     Subsurface drip irrigation

Detailed Design Information

- Design Basis and/or Model and Assumptions Used in Developing Design. (This information will need to come from engineers/designers and/or regulators). This at a minimum should include the following:
  (1) Description of data or assumptions used for influent waste strength/characteristics (recall that we're only dealing with domestic wastewater in this study);
  Influent is suggested to have a BOD concentration of 300 mg/L
  (2) Design model or approach for collection, pretreatment and land application systems (e.g., state design criteria; specific manufacturer's literature and/or recommendations, and if so, which; technical design guidelines – e.g., a WEF MOP, EPA design manual methodology, Metcalf Eddy, etc.).
  unknown
  (3) Loading rates to unit processes;
  300 mg/L BOD

(4) Limiting site/soil and design conditions for land/soil dispersal systems, as well as other assumptions used in developing soil application system;
unknown
(5) Soil/land loading rate.
Max. 0.1 gallons per square feet per day (2.75 acre application area)
(6) Hydrogeologic, groundwater mounding, deep borings, etc. and groundwater modeling conducted in support of design.
unknown

C. Regulatory Information

- Regulatory authority and contact info;
  TCEQ Tyler Region Office 903-535-5100
- Effluent quality limits (regulatory performance standards/limits for system);
  20 mg/L BOD, 20 mg/L TSS daily average based on 0.012 MGD
- Are there periodic regulatory inspections of the system?
  Yes, usually every other year

D. Operation, Maintenance and Monitoring Information

Qualitative

- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity.
  Privately owned
- Is subsurface (e.g., lysimeter) or groundwater monitoring conducted for the land/soil dispersal system?
  Yes, soil nutrient samples are collected annually
- Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers?
- Regularly scheduled operation and maintenance activities;
  Operated five days per week by certified wastewater operator
- Man-hours per week or month routinely committed to O&M activities;
  5-10 hours per week
- Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.);
  unknown
- Are there inspection or other “walkover” photos of the system that may be available to us?
  Photos are not available, however, copies of TCEQ compliance investigation reports are available upon request.

Quantitative

- Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
  90 degree v-notch weir, measured instantaneously
- Influent Quality Data to the system (if available) and QA/QC provisions employed;
  unknown
- Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available and QA/QC provisions employed. At a minimum, provide data for regulated parameters; In addition, whatever other monitoring data has been collected and is available.
  Copies of effluent data is not available; effluent data is reviewed during compliance investigations
- Ground water monitoring data (if available), including locations and depths of well sampling points relative to dispersal field.
  unknown

E. Cost Information

Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);
  unknown

OM&M

- Hourly rates for personnel along with hours spent. unknown
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.) unknown

Fees

- Connection fees (if applicable); unknown
- Service fee structure and user fees charged unknown

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-ND-2
NOTE: No data was available for this system.

A. Basic Information

- Date most recent permit was issued;
- Date system went into service: 2002

B. Design Information

Basic Design Information

- Type of System
  1. Type of collection system leading to treatment plant (e.g., conventional gravity sewers, effluent sewers, grinder pressure sewers)? Conventional gravity
  2. Type of treatment system (primary, secondary, disinfection); Septic tank (25,000 gallons) with effluent filters. Drip irrigation system.
  3. Sizes of unit processes used for treatment; 25,000 gallon septic tank; Approx. 5,500 gallon pump tank;
  4. Sizes and/or Loading rates to unit treatment processes (i.e., aerators, clarifiers, areal loading rates for sand filters, etc.)

C. Operation, Maintenance and Monitoring Information

Qualitative

1. Are there periodic regulatory inspections of the system? Annual by TCEQ.
2. Is the system owned and managed by a public or private entity? If publicly owned, are operation and maintenance (management) activities provided by public/utility staff, or by private service providers? Details on the management entity. Public/utility staff – School operator.
3. What are the regularly scheduled operation and maintenance activities?
   - Filters cleaned at least every six weeks, approximately;
   - BOD problems; BOD's are very hard to control; (Serves an elementary school);
   - BOD limited to 100 mg/L
   - About 230 mg/L weekly samples for BOD;
   - Emitters – rodents & rabbits in the summertime tend to chew on the lines; Constantly having to repair emitter lines. (Lines buried about 6-9 inches);
   - For an isolated area spent around $8000 (PLC unit) about a year ago – electric storm blew out system;

4. Man-hours per week or month routinely committed to O&M activities; About 8 hours/week.
5. Repair and trouble call history/records, including replacement of system components (e.g., pumps, fans/blowers, etc.); "Gator" pumps – diaphragms tend to burn out; Occasional pump replacement; Disc filters are in line after the septic tanks;

Water Environment Research Foundation
Large/Community Scale Decentralized Wastewater Systems Study
System TX-ND-2
NOTE: No data was available for this system.

Quantitative

6. Actual measured flow (if available) and how measured (where, what instrumentation, how frequently, how calculated);
   Per day, 6,000 gpd average flow;
   During summer, hardly any flow.
7. Influent Quality Data to the system (if available); Not available.
8. Effluent Quality Data for a minimum of 3 years if available, for each unit process for which it is available None provided.

D. Cost Information

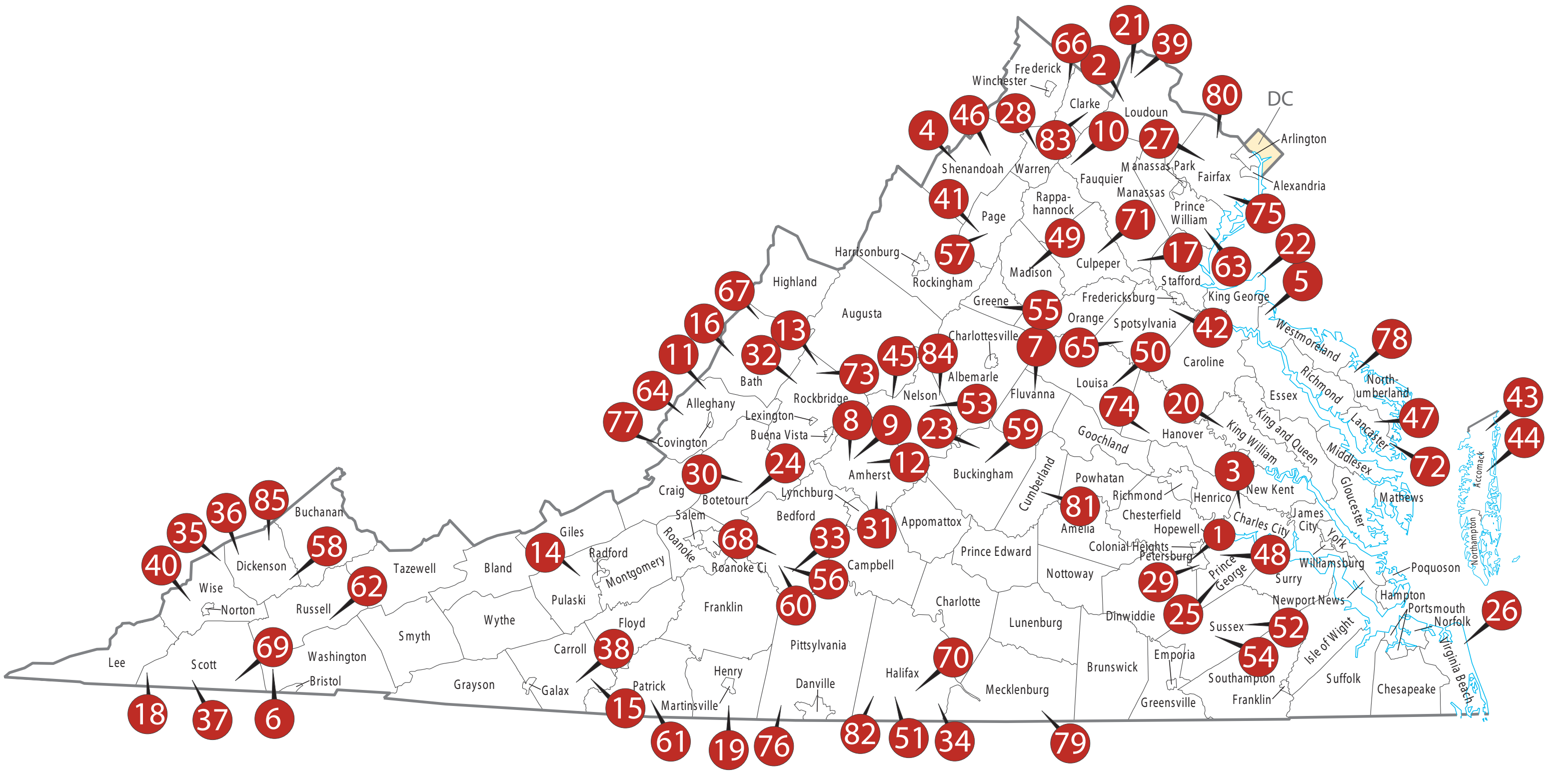
Design/Construction

- Initial construction costs for the system (including design and permitting costs if available);

OM&M

- Hourly rates for personnel along with hours spent.
- Power usage and other operational costs (e.g. sludge and/or septage removal/trucking, etc.)

Appendix 13.A
By-County Locations of Virginia Systems



1. Petersburg County; Flow = 13,000 gpd; Activated Sludge Treatment; Discharge System; Privately owned; Campground.

2. Loudoun County; Flow = 6,200 gpd; Activated Sludge Treatment; Discharge System; Privately owned; RV/Mobile Home Park.

3. Charles City County; Flow = 7,200 gpd; Activated Sludge Treatment; Discharge System; Privately owned; Residential Subdivision.

4. Shenandoah County; Flow = 5,400 gpd; Activated Sludge Treatment; Discharge System; Privately owned; Community System.

5. Westmoreland County; Flow = 6,000 gpd; Activated Sludge Treatment; Discharge System; Publicly owned; Elementary School.

6. Washington County; Flow = 7,000 gpd; Activated Sludge Treatment; Discharge System; Privately owned; Campground.

7. Fluvanna County; Flow = 25,000 gpd; Activated Sludge Treatment; Discharge System; Publicly owned; High School.

8. Amherst County; Flow = 24,000 gpd; Activated Sludge Treatment; Discharge System; Privately owned; Mobile Home Park.

9. Amherst County; Flow = 15,000 gpd; Activated Sludge Treatment; Discharge System; Privately owned; Mobile Home Park.

10. Fauquier County; Flow = 15,000 gpd; Activated Sludge Treatment; Discharge System; Privately owned; Restaurant.

11. Alleghany County; Flow = 15,000 gpd; Activated Sludge Treatment; Discharge System; Publicly owned; Highway Rest Area.

12. Amherst County; Flow = 15,000 gpd; Activated Sludge Treatment; Discharge System; Publicly owned; Residential Subdivision.

13. Rockbridge County; Flow = 50,000 gpd; Activated Sludge Treatment; Discharge System; Privately owned; Truck Stop.

14. Pulaski County; Flow = 39,000 gpd; Activated Sludge Treatment; Discharge System; Privately owned; Motel.

15. Carroll County; Flow =26,000 gpd; Activated Sludge Treatment; Discharge System; Privately owned; Community System.

16. Bath County; Flow =50,000 gpd; Activated Sludge Treatment; Discharge System; Publicly owned; Community System.

17. Fauquier County; Flow = 7,900 gpd; Extended Aeration Treatment; Discharge System; Publicly owned; Elementary School.

18. Scott County; Flow = 5,000 gpd; Extended Aeration Treatment; Discharge System; Privately owned; RV/Mobile Home Park.

19. Henry County; Flow = 28,000 gpd; Extended Aeration Treatment; Discharge System; Publicly owned; Correctional Facilities.

20. King William County; Flow = 20,000 gpd; Extended Aeration Treatment; Discharge System; Publicly owned; Elementary School.

21. Loudoun County; Flow = 15,000 gpd; Extended Aeration Treatment; Discharge System; Privately owned; High School.

22. King George County; Flow = 20,000 gpd; Extended Aeration Treatment; Discharge System; Publicly owned; Community System.

23. Buckingham County; Flow = 10,000 gpd; Extended Aeration Treatment; Discharge System; Privately owned; Retreat Center.

24. Botetourt County; Flow = 15,000 gpd; Extended Aeration Treatment; Discharge System; Privately owned; Mobile Home Park.

25. Prince George County; Flow = 39,000 gpd; Extended Aeration Treatment; Discharge System; Privately owned; Mobile Home Park.

26. Virginia Beach County; Flow = 38,000 gpd; Extended Aeration Treatment; Discharge System; Privately owned; Campground.

27. Fairfax County; Flow = 35,000 gpd; Extended Aeration Treatment; Discharge System; Publicly owned; Community System.

28. Warren County; Flow = 35,000 gpd; Extended Aeration Treatment; Discharge System; Privately owned; Resort.

29. Petersburg County; Flow = 40,000 gpd; Extended Aeration Treatment; Discharge System; Publicly owned; Highway Rest Stop.

30. Botetourt County; Flow = 10,000 gpd; Sequencing Batch Reactor Treatment; Discharge System; Publicly owned; Highway Rest Stop.

31. Amherst County; Flow = 39,500 gpd; Sequencing Batch Reactor Treatment; Discharge System; Privately owned; Church Conference Center.

32. Rockbridge County; Flow = 20,000 gpd; Sequencing Batch Reactor Treatment; Discharge System; Privately owned; Community System.

33. Bedford County; Flow = 5,500 gpd; Sequencing Batch Reactor Treatment; Discharge System; Publicly owned; School.

34. Halifax County; Flow = 15,000 gpd; Extended Aeration Treatment; Discharge System; Privately owned; Community System.

35. Wise County; Flow = 28,000 gpd; Extended Aeration Plants in Parallel and Flow Equalization Basin Treatment; Discharge System; Neither Publicly nor privately owned; Campground/Recreational Area.

36. Dickenson County; Flow = 10,000 gpd; Extended Aeration Package Plant Treatment; Discharge System; Publicly owned; Campground/Recreational Area.

37. Scott County; Flow = 5,000 gpd; Activated Sludge Treatment; Discharge System; Publicly owned; Elementary School.

38. Carroll County; Flow = 30,000 gpd; Extended Aeration Treatment; Discharge System; Privately owned; Motel.

39. Loudoun County; Flow = 15,000 gpd; Extended Aeration with UV Disinfection Treatment; Discharge System; Publicly owned; Community System.

40. Wise County; Flow = 40,000 gpd; Extended Aeration Treatment; Discharge System; Publicly owned; Residential Subdivision.

41. Page County; Flow = 25,000 gpd; "Extended Aeration Activated Sludge Plant" Treatment; Discharge System; Publicly owned; Campground.

42. Spotsylvania County; Flow = 28,000 gpd; Extended Aeration with UV Disinfection; Discharge System; Publicly owned; High School.

43. Accomack County; Flow = 10,000 gpd; Extended Aeration followed by Sand Filtration Treatment; Discharge System; Privately owned; Motel.

44. Accomack County; Flow = 10,000 gpd; Extended Aeration followed by Sand Filtration Treatment; Discharge System; Privately owned; Shopping Center.

45. Nelson County; Flow = 6,200 gpd; Aerated Lagoons Treatment; Discharge System; Publicly owned; Community System.

46. Shenandoah County; Flow =39,000 gpd; Aerated Lagoons Treatment; Discharge System; Privately owned; Seasonal Retreat/conference Center.

47. Lancaster County; Flow =30,000 gpd; Aerated Lagoons Treatment; Discharge System; Privately owned; Resort & Marina.

48. Petersburg; Flow =30,000 gpd; Aerated Lagoons Treatment; Discharge System; Privately owned; Motel.

49. Madison County; Flow = 12,500 gpd; Aerated Lagoons Treatment; Discharge System; Privately owned; Nursing Home.

50. Louisa County; Flow = 20,000 gpd; Aerated Lagoons Treatment; Discharge System; Privately owned; Campground.

51. Halifax County; Flow = 35,000 gpd; Aerated Lagoons Treatment; Discharge System; Publicly owned; Community System.

52. Sussex County; Flow = 40,000 gpd; Aerated Lagoons Treatment; Discharge System; Publicly owned; Community System.

53. Nelson County; Flow = 24,000 gpd; Constructed Wetland Treatment; Discharge System; Publicly owned; Community System.

54. Sussex County; Flow = 30,000 gpd; Upflow Sludge Blanket Filtration from Purestream/Ecofluid LLC Treatment; Discharge System; Publicly owned; School Complex.

55. Greene County; Flow = 26,700 gpd; Imhoff Tank Treatment; Discharge System; Privately owned; School.

56. Bedford County; Flow = 6,000 gpd; Intermittent Sand Filter Treatment; Discharge System; Publicly owned; Elementary School.

57. Page County; Flow = 9,600 gpd; Intermittent Sand Filter Treatment; Discharge System; Publicly owned; High School.

58. Dickenson County; Flow = 9,900 gpd; Intermittent Sand Filter Treatment; Discharge System; Publicly owned; High School.

59. Buckingham County; Flow = 5,000 gpd; Intermittent Sand Filter Treatment; Discharge System; Privately owned; Motel.

60. Bedford County; Flow = 5,000 gpd; Intermittent Sand Filter Treatment; Discharge System; Privately owned; Public Visitor Center.

61. Patrick County; Flow = 10,000 gpd; Lagoons Treatment; Discharge System; Privately owned; Mobile Home Park.

62. Russell County; Flow = 21,000 gpd; Oxidation Pond or Ditch Treatment; Discharge System; Neither publicly nor privately owned; Correctional Facility.

63. Prince William County; Flow = 40,000 gpd; Nitrification-Denitrification Treatment; Discharge System; Publicly owned. Currently off-line. Was terminated 2/14/06; Administrative and Public Event Complex.

64. Alleghany County; Flow = 24,000 gpd; Lagoons Treatment; Discharge System; Privately owned; Children's Home.

65. Spotsylvania County; Flow = 15,000 gpd; Lagoons Treatment; Discharge System; Privately owned; Campground.

66. Clarke County; Flow = 37,000 gpd; Oxidation Pond or Ditch Treatment; Discharge System; Publicly owned; Correctional Facility.

67. Bath County; Flow = 13,000 gpd; Rotating Biological Contactor Treatment; Discharge System; Neither publicly or privately owned; Campground & Recreational Area.

68. Bedford County; Flow = 25,600 gpd; Rotating Biological Contactor Treatment; Discharge System; Publicly owned; High School.

69. Scott County; Flow = 5,000 gpd; Septic Tank, Dosing Tank, Rotary Sand Filter Treatment; Discharge System; Privately owned; RV/Trailer Park.

70. Halifax county; Flow = 35,000 gpd; Rotating Biological Contactor Treatment; Discharge System; Publicly owned; Community System.

71. Culpepper County; Flow = 26,000 gpd; Oxidation Pond or Ditch Treatment; Discharge System; Privately owned; Overnight recreational camp facility.

72. Lancaster County; Flow = 32,500 gpd; Stabilization Tank, Polishing Pond Treatment; Discharge System; Privately owned; Community System.

73. Rockbridge County,VA; Flow = 8,800 gpd; Septic Tanks Treatment; Discharge System; Publicly owned; Middle School.

74. Hanover County; Flow = 37,000 gpd; Dual Channel Oxidation Ditch
Treatment; Discharge System; Publicly owned; Correctional Facility.

75. Fairfax County; Flow = 49,500 gpd; Trickling Filter and Breakpoint
Chlorination Treatment; Discharge System; Publicly owned; School.

76. Pittsylvania County; Flow = 10,400 gpd; Septic Tank Treatment; Discharge System; Publicly owned; High School.

77. Alleghany County; Flow = 15,000 gpd; Septic Tank Treatment; (? Added Process(es) ?) Discharge System; Publicly owned; Campground.

78. Northumberland County; Flow = 8,000 gpd; Single Cell Lagoon Treatment; Discharge System; Publicly owned; High School.

79. Mecklenburg County; Flow = 9,600 gpd; Slow Sand Filtration Treatment; Discharge System; Publicly owned; Middle School.

80. Fairfax County; Flow = 6,000 gpd; Slow Sand Filtration Treatment; Discharge System; Publicly owned; Elementary School.

81. Cumberland County; Flow = 13,000 gpd; Slow Sand Filtration Treatment; Discharge System; Publicly owned; Campground & Recreational Area.

82. Halifax County; Flow = 8,000 gpd; Stabilization Ponds Treatment; Discharge System; Publicly owned; Mobile Home Park.

83. Clarke County; Flow = 40,000 gpd; Stabilization Ponds Treatment; Discharge System; Privately owned; Mobile Home Park.

84. Nelson County; Flow = 25,000 gpd; Trickling Filter Treatment; Discharge System; Publicly owned; Community System.

85. Dickenson County; Flow = 6,000 gpd; Two-Cell Lagoon Treatment; Discharge System; Privately owned; Summer Camp.

WASTEWATER UTILITY

Alabama
Montgomery Water Works & Sanitary Sewer Board

Alaska
Anchorage Water & Wastewater Utility

Arizona
Glendale, City of, Utilities Department
Mesa, City of
Peoria, City of
Phoenix Water Services Dept.
Pima County Wastewater Management
Safford, City of

Arkansas
Little Rock Wastewater Utility

California
Central Contra Costa Sanitary District
Corona, City of
Crestline Sanitation District
Delta Diablo Sanitation District
Dublin San Ramon Services District
East Bay Dischargers Authority
East Bay Municipal Utility District
Eastern Municipal Water District
El Dorado Irrigation District
Fairfield-Suisun Sewer District
Fresno Department of Public Utilities
Inland Empire Utilities Agency
Irvine Ranch Water District
Las Virgenes Municipal Water District
Livermore, City of
Los Angeles, City of
Los Angeles County, Sanitation Districts of
Napa Sanitation District
Orange County Sanitation District
Palo Alto, City of
Riverside, City of
Sacramento Regional County Sanitation District
San Diego Metropolitan Wastewater Department, City of
San Francisco, City & County of
San Jose, City of
Santa Barbara, City of
Santa Cruz, City of
Santa Rosa, City of
South Bayside System Authority
South Coast Water District
South Orange County Wastewater Authority
Stege Sanitary District
Sunnyvale, City of
Union Sanitary District
West Valley Sanitation District

Colorado
Aurora, City of
Boulder, City of
Greeley, City of
Littleton/Englewood Water Pollution Control Plant
Metro Wastewater Reclamation District, Denver

Connecticut
Greater New Haven WPCA
Stamford, City of

District of Columbia
District of Columbia Water & Sewer Authority

Florida
Broward, County of
Fort Lauderdale, City of
Jacksonville Electric Authority (JEA)
Miami-Dade Water & Sewer Authority
Orange County Utilities Department
Reedy Creek Improvement District
Seminole County Environmental Services
St. Petersburg, City of
Tallahassee, City of
Tampa, City of
Toho Water Authority
West Palm Beach, City of

Georgia
Atlanta Department of Watershed Management
Augusta, City of
Clayton County Water Authority
Cobb County Water System
Columbus Water Works
Fulton County
Gwinnett County Department of Public Utilities
Savannah, City of

Hawaii
Honolulu, City & County of

Idaho
Boise, City of

Illinois
Greater Peoria Sanitary District
Kankakee River Metropolitan Agency
Metropolitan Water Reclamation District of Greater Chicago
Wheaton Sanitary District

Iowa
Ames, City of
Cedar Rapids Wastewater Facility
Des Moines, City of
Iowa City

Kansas
Johnson County Wastewater
Unified Government of Wyandotte County/ Kansas City, City of

Kentucky
Louisville & Jefferson County Metropolitan Sewer District
Sanitation District No. 1

Louisiana
Sewerage & Water Board of New Orleans

Maine
Bangor, City of
Portland Water District

Maryland
Anne Arundel County Bureau of Utility Operations
Howard County Bureau of Utilities
Washington Suburban Sanitary Commission

Massachusetts
Boston Water & Sewer Commission
Massachusetts Water Resources Authority (MWRA)
Upper Blackstone Water Pollution Abatement District

Michigan
Ann Arbor, City of
Detroit, City of
Holland Board of Public Works
Saginaw, City of
Wayne County Department of Environment
Wyoming, City of

Minnesota
Rochester, City of
Western Lake Superior Sanitary District

Missouri
Independence, City of
Kansas City Missouri Water Services Department
Little Blue Valley Sewer District
Metropolitan St. Louis Sewer District

Nebraska
Lincoln Public Works and Utilities Department

Nevada
Henderson, City of
Las Vegas, City of
Reno, City of

New Jersey
Bergen County Utilities Authority
Ocean County Utilities Authority
Passaic Valley Sewerage Commissioners

New York
New York City Department of Environmental Protection

North Carolina
Charlotte/Mecklenburg Utilities
Durham, City of
Metropolitan Sewerage District of Buncombe County
Orange Water & Sewer Authority
University of North Carolina, Chapel Hill

Ohio
Akron, City of
Butler County Department of Environmental Services
Columbus, City of
Metropolitan Sewer District of Greater Cincinnati
Northeast Ohio Regional Sewer District
Summit, County of

Oklahoma
Oklahoma City Water & Wastewater Utility Department
Tulsa, City of

Oregon
Albany, City of
Clean Water Services
Eugene, City of
Gresham, City of
Portland, City of Bureau of Environmental Services
Water Environment Services

Pennsylvania
Hemlock Municipal Sewer Cooperative (HMSC)
Philadelphia, City of
University Area Joint Authority

South Carolina
Charleston Water System
Mount Pleasant Waterworks & Sewer Commission
Spartanburg Water

Tennessee
Cleveland Utilities
Knoxville Utilities Board
Murfreesboro Water & Sewer Department
Nashville Metro Water Services

Texas
Austin, City of
Dallas Water Utilities
Denton, City of
El Paso Water Utilities
Fort Worth, City of
Houston, City of
San Antonio Water System
Trinity River Authority

Utah
Salt Lake City Corporation

Virginia
Alexandria Sanitation Authority
Arlington, County of
Fairfax County
Hampton Roads Sanitation District
Hanover, County of
Henrico, County of
Hopewell Regional Wastewater Treatment Facility
Loudoun Water
Lynchburg Regional WWTP
Prince William County Service Authority
Richmond, City of
Rivanna Water & Sewer Authority

Washington
Everett, City of
King County Department of Natural Resources
Seattle Public Utilities
Sunnyside, Port of
Yakima, City of

Wisconsin
Green Bay Metro Sewerage District
Kenosha Water Utility
Madison Metropolitan Sewerage District
Milwaukee Metropolitan Sewerage District
Racine, City of
Sheboygan Regional Wastewater Treatment
Wausau Water Works

Australia
ACTEW (Ecowise)
South Australian Water Corporation
South East Water Limited
Sydney Water Corporation
Water Corporation of Western Australia

Canada
Edmonton, City of/Edmonton Waste Management Centre of Excellence
Lethbridge, City of
Regina, City of, Saskatchewan
Toronto, City of, Ontario
Winnipeg, City of, Manitoba

New Zealand
Watercare Services Limited

STORMWATER UTILITY

California
Fresno Metropolitan Flood Control District
Los Angeles, City of, Department of Public Works
Monterey, City of
San Francisco, City & County of
Santa Rosa, City of
Sunnyvale, City of

Colorado
Aurora, City of
Boulder, City of

Florida
Orlando, City of

Georgia
Griffin, City of

Iowa
Cedar Rapids Wastewater Facility
Des Moines, City of

Kansas
Overland Park, City of

Kentucky
Louisville & Jefferson County Metropolitan Sewer District

Maine
Portland Water District

North Carolina
Charlotte, City of, Stormwater Services

Pennsylvania
Philadelphia, City of

Tennessee
Chattanooga Stormwater Management

Texas
Harris County Flood Control District, Texas

Washington
Bellevue Utilities Department
Seattle Public Utilities

STATE

Arkansas Department of Environmental Quality
Connecticut Department of Environmental Protection
Kansas Department of Health & Environment
Kentucky Department of Environmental Protection
New England Interstate Water Pollution Control Commission (NEIWPCC)
Ohio River Valley Sanitation Commission
Urban Drainage & Flood Control District, CO

CORPORATE

ADS Environmental Services
Advanced Data Mining International
Alan Plummer & Associates
Alpine Technology Inc.
Aqua-Aerobic Systems Inc.
Aquateam–Norwegian Water Technology Centre A/S
ARCADIS
Associated Engineering
Black & Veatch
Blue Water Technologies, Inc.
Boyle Engineering Corporation
Brown & Caldwell
Burgess & Niple, Ltd.
Burns & McDonnell
CABE Associates Inc.
The Cadmus Group
Camp Dresser & McKee Inc.
Carollo Engineers Inc.
Carpenter Environmental Associates Inc.
Carter & Burgess, Inc.
CET Engineering Services
CH2M HILL
CRA Infrastructure & Engineering
CONTECH Stormwater Solutions
D&B/Guarino Engineers, LLC
Damon S. Williams Associates, LLC
Earth Tech Inc.
Ecovation
EMA Inc.
Environmental Operating Solutions, Inc.
Environ/The ADVENT Group, Inc.
Fay, Spofford, & Thorndike Inc.
Freese & Nichols, Inc.
ftn Associates Inc.
Gannett Fleming Inc.
Garden & Associates, Ltd.
Geosyntec Consultants
GHD
Golder Associates Ltd.
Greeley and Hansen LLC
Hazen & Sawyer, P.C.
HDR Engineering Inc.
HNTB Corporation
Hydromantis Inc.
HydroQual Inc.
Infilco Degremont Inc.
Jacques Whitford NAWE, Inc.
Jason Consultants LLC Inc.
Jordan, Jones, & Goulding Inc.
KCI Technologies Inc.
Kelly & Weaver, P.C.
Kennedy/Jenks Consultants
KMK Consultants
Komline Sanderson Engineering Corporation
Larry Walker Associates
Limno-Tech Inc.
The Low Impact Development Center Inc.
Malcolm Pirnie Inc.
Material Matters
McKim & Creed
Metcalf & Eddy Inc.
Monteco Corporation
MPR Engineering Corporation, Inc.
MWH
O'Brien & Gere Engineers Inc.
Odor & Corrosion Technology Consultants Inc.
Original Engineering Consultants, Ltd.
Paradigm Environmental Technologies, Inc.
Parametrix Inc.
Parsons
Post, Buckley, Schuh & Jernigan
Praxair, Inc.
Ring Industrial Group
RMC Water & Environment
Ross & Associates Ltd.
SAIC
Siemens Water Technologies
The Soap & Detergent Association
Smith & Loveless, Inc.
Stantec Consulting Inc.
Stearns & Wheler, LLC
Stone Environmental Inc.
Stratus Consulting Inc.
Synagro Technologies Inc.
Tetra Tech Inc.
Trojan Technologies Inc.
Trussell Technologies, Inc.
URS Corporation
Westin Engineering Inc.
Weston Solutions Inc.
Woodard & Curran
Zoeller Pump Company

INDUSTRY

American Electric Power
American Water
Anglian Water Services, Ltd.
ChevronTexaco Energy Research & Technology Company
The Coca-Cola Company
Dow Chemical Company
DuPont Company
Eastman Chemical Company
Eli Lilly & Company
Merck & Company Inc.
Procter & Gamble Company
Suez Environnment
United Utilities North West (UUNW)
United Water Services LLC

Note: List as of 4/10/08

WERF Product Order Form

As a benefit of joining the Water Environment Research Foundation, subscribers are entitled to receive one complimentary copy of all final reports and other products. Additional copies are available at cost (usually $10). To order your complimentary copy of a report, please write "free" in the unit price column. WERF keeps track of all orders. If the charge differs from what is shown here, we will call to confirm the total before processing.

Name _______________ Title _______________

Organization _______________

Address _______________

City _______________ State _______________ Zip Code _______________ Country _______________

Phone _______________ Fax _______________ Email _______________

Stock #	Product	Quantity	Unit Price	Total
			Postage & Handling	
			VA Residents Add 5% Sales Tax	
			Canadian Residents Add 7% GST	
			TOTAL	

Method of Payment:

(All orders must be prepaid.)

❑ Check or Money Order Enclosed

❑ Visa ❑ Mastercard ❑ American Express

Account No. _______________ Exp. Date _______________

Signature _______________

Shipping & Handling:

Amount of Order	United States	Canada & Mexico	All Others
Up to but not more than:	Add:	Add:	Add:
$20.00	$7.50*	$9.50	50% of amount
30.00	8.00	9.50	40% of amount
40.00	8.50	9.50	
50.00	9.00	18.00	
60.00	10.00	18.00	
80.00	11.00	18.00	
100.00	13.00	24.00	
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