04-DEC-9

Research Digest:

Analysis of Existing Community-Sized Decentralized Wastewater Treatment Systems

by:
Susan M. Parten, P.E.
Community Environmental Services, Inc. (CES)

2008

WERF

ACKNOWLEDGMENTS

Principal Investigator
Susan M. Parten, P.E.
Community Environmental Services, Inc. (CES)

Project Team
Cheryl Rae
James Griffith, P.E.
Community Environmental Services, Inc. (CES).

Victor D'Amato, P.E.
ARCADIS G&M, Inc.

Terry Bounds, P.E.
Orenco Systems, Inc.

Project Subcommittee
Todd A. Danielson, P.E., Chair
Loudoun County Sanitation Authority

Charles L. McEntyre, P.E., DRAC Liaison
Tennessee Valley Authority (TVA)

Robert Goo
U.S. Environmental Protection Agency

Karl Mueldener
Kansas Dept. of Health and Environment

Robert S. Raucher, Ph.D.
Stratus Consulting, Inc.

Water Environment Research Foundation Staff
Daniel M. Woltering, Ph.D.
Director of Research

Mary Strawn
Program Manager

Jeff Moeller, P.E.
Senior *Program Director*

1.0 INTRODUCTION

In much of the U.S., regulators and industry view decentralized wastewater systems located near expanding centralized collection systems as a temporary wastewater service option. Yet decentralized systems can be an important part of the long-term wastewater treatment vista, and having a better understanding of such systems is critical to ensuring that they are properly designed and appropriately implemented.

A Water Environment Research Foundation study examined the performance of large-scale decentralized and small community wastewater systems with flows from 5,000 to 50,000 gallons per day that have operated for at least five years. *Analysis of Existing Community-Sized Decentralized Wastewater Treatment Systems* (stock no. 04DEC9RP) reports the results of the study.

Typical large-scale decentralized subsurface dispersal field. These areas can be used for park and light recreational use areas, in contrast to surface irrigation systems which are typically restricted for at least part of the day from public access. *Courtesy of Orenco Systems, Inc.*

The study examined several aspects of decentralized treatment systems that are important considerations for making comparisons between treatment options. The research team looked at regulatory requirements, technical considerations, treatment performance, and costs—all which vary widely. Using the data they gathered, they made pertinent observations and several practical recommendations. Perhaps one of the most important is their call for electronic databases to be maintained in all states to facilitate performance tracking and future research efforts.

2.0 DATA GATHERING CHALLENGES

Analysis of Existing Community-Sized Decentralized Wastewater Treatment Systems covers effluent quality data for 341 systems in 13 states. Monitoring and reporting requirements vary significantly from state to state, so the effluent quality data differed by state, system size, and other factors. Figure 1 shows the level of information that was obtained from each state, along with the numbers of systems in certain states for which performance data was obtained.

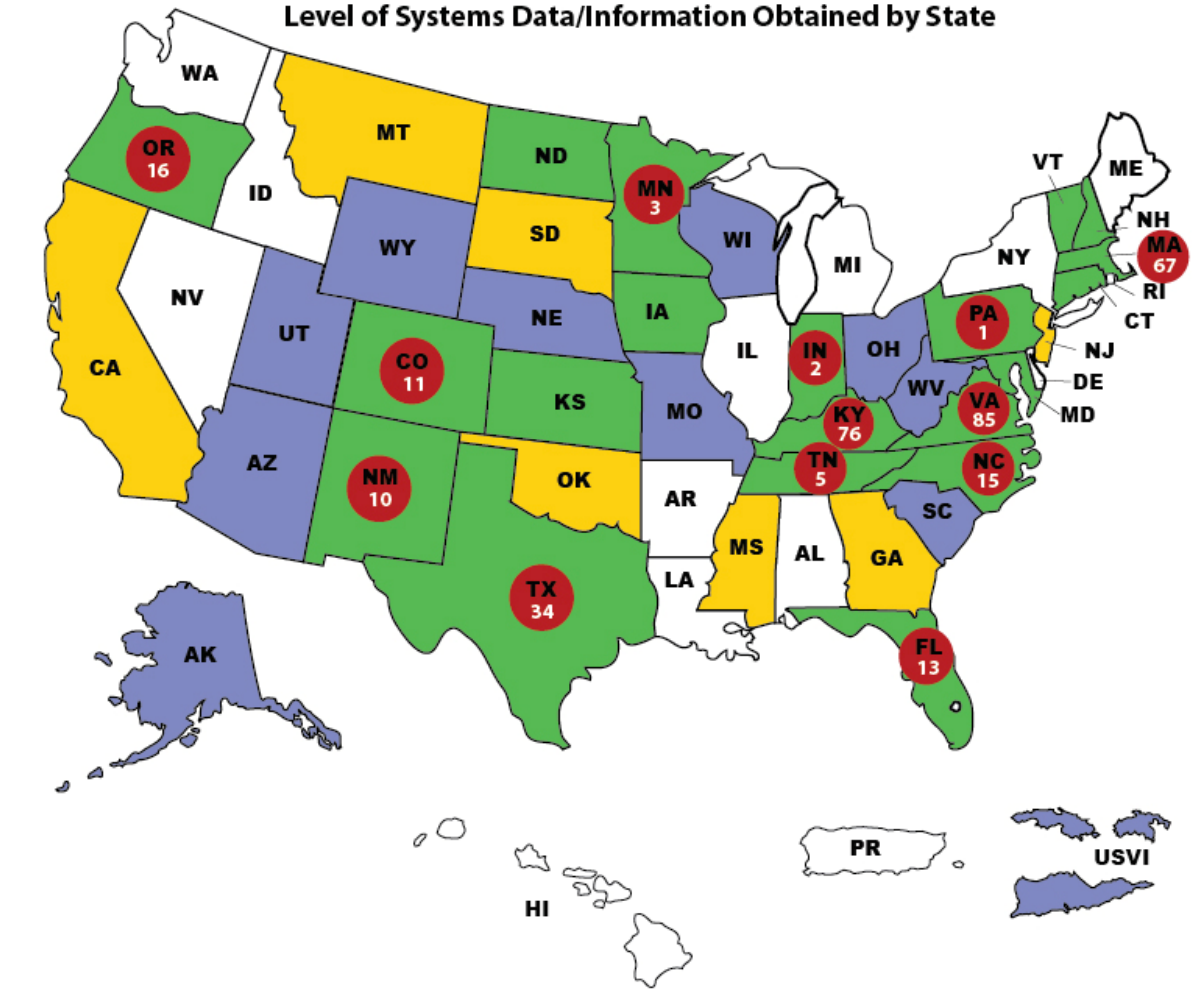
To the extent that system owners, contractors, and operators were willing or able to share information about systems costs, the researchers organized the information by state and system. In most cases, owners provided only a portion of the requested cost information for systems. Private owners and service providers often seemed unwilling to share information, or did not respond to requests. However, researchers obtained some amount of cost information for about 60 systems located in eight states.

Data collection was a uniquely challenging aspect of this project. Effective tracking of system

performance could provide further evidence of the ability of community-sized systems to function within existing effluent quality limits to achieve more cost-effective service than could be obtained with a larger system. The researchers found the absence of statewide electronic databases somewhat surprising given today's record-keeping capabilities. Without such data, they point out, it is not realistically possible to review large populations of systems of certain types and sizes, making it impossible to offer statistically valid observations relative to performance trends. The researchers therefore recommend that states establish regulatory databases with the following information:

- 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 and media type/sizing for filters)
- Method of final effluent disposition (discharge, surface application, or some method of subsurface dispersal)
- Performance/effluent quality requirements ("limits") and reporting requirements

FIGURE 1
Level of Systems Data/Information Obtained by State



States from which effluent quality data was obtained for the noted number of systems.

States providing information on flow, permit numbers, treatment methods, and type of effluent disposition for some number of systems.

States providing information including flow and permit numbers for some number of systems.

States providing replies to inquiries about availability and location of systems information.

No significant information about systems was obtained from these states.

3.0 OBSERVATIONS FROM STUDY

Based on the results of the research, the researchers were able to draw conclusions in a number of areas of interest. Of particular significance were the following:

Design and Performance

The use of certain types of systems much more than others seemed to have less to do with site conditions and project needs, and more to do with preferences of local engineering firms, the presence and availability of certain manufacturers and suppliers, and influences from regulatory entities. Many systems found to be the least cost effective overall for meeting applicable permitting requirements used methods and materials common to centralized wastewater approaches. It appeared that those systems had been designed by engineers most familiar with centralized wastewater service methods, and less familiar with up-to-date accepted industry practices for large scale decentralized systems. Methods and materials used for systems often had useful service lives of only 10-20 years, well short of the life cycle typically used for planning centralized facilities, despite the availability today of components with long service lives.

In general, commonly used technologies appeared capable of meeting specific effluent quality limits. Design details (including unit process sizing and operation) and management practices—with their associated cost considerations—seemed to be the most likely contributors to performance problems where they were observed. However, some treatment methods tended to show more variability of performance and "excursions," particularly when serving certain sectors/facility types. With regard to secondary treatment and nitrification performance, fixed film processes tended to perform the best on average.

Cost

Both construction and operational costs per treated gallon of wastewater vary widely for large scale decentralized wastewater systems, with little correlation found between dollars spent and system performance or reliability. Initial capital costs ranged from $6 to $140 per gallon of daily design wastewater flow but rose to $18 to $494 per gallon of average daily flow of treated wastewater once the systems were in operation, indicating that in many cases the systems might be oversized as designed. Figure 2 shows that public sector projects on average cost significantly more than private sector projects. Of the systems reviewed, the most costly category of system was found to be publicly owned activated sludge treatment systems serving parks and recreational areas in Texas. Those systems commonly used grinder lift stations followed by extended aeration package treatment plants.

20,000 gpd recirculating sand/gravel filter (RSF/RGF). Packed media filters were found to be a reliable and cost-effective method for achieving secondary or advanced treatment. Systems using attached growth/fixed film processes also tended to have significantly lower power and operational costs as compared with activated sludge processes. *Courtesy of Orenco Systems, Inc.*

Operationally, residential user charges for cluster/community systems ranged from $15 to $80 per month, while monthly reported sludge removal/hauling costs ranged from $0.0034 to $0.92 per gallon of daily treated wastewater. Observed correlations between high effluent solids levels and hauling frequency point to operational problems at a given facility. Power costs ranged from $0.01 to $0.81 per average daily gallon of flow. Figure 3 shows that power usage per gallon of treated wastewater tended to be more for activated sludge plants than for systems using some type of packed media/filtration process as the principal method of secondary or advanced treatment.

FIGURE 2
Reported Capital Costs Per Gallon Average Daily Reported Flow

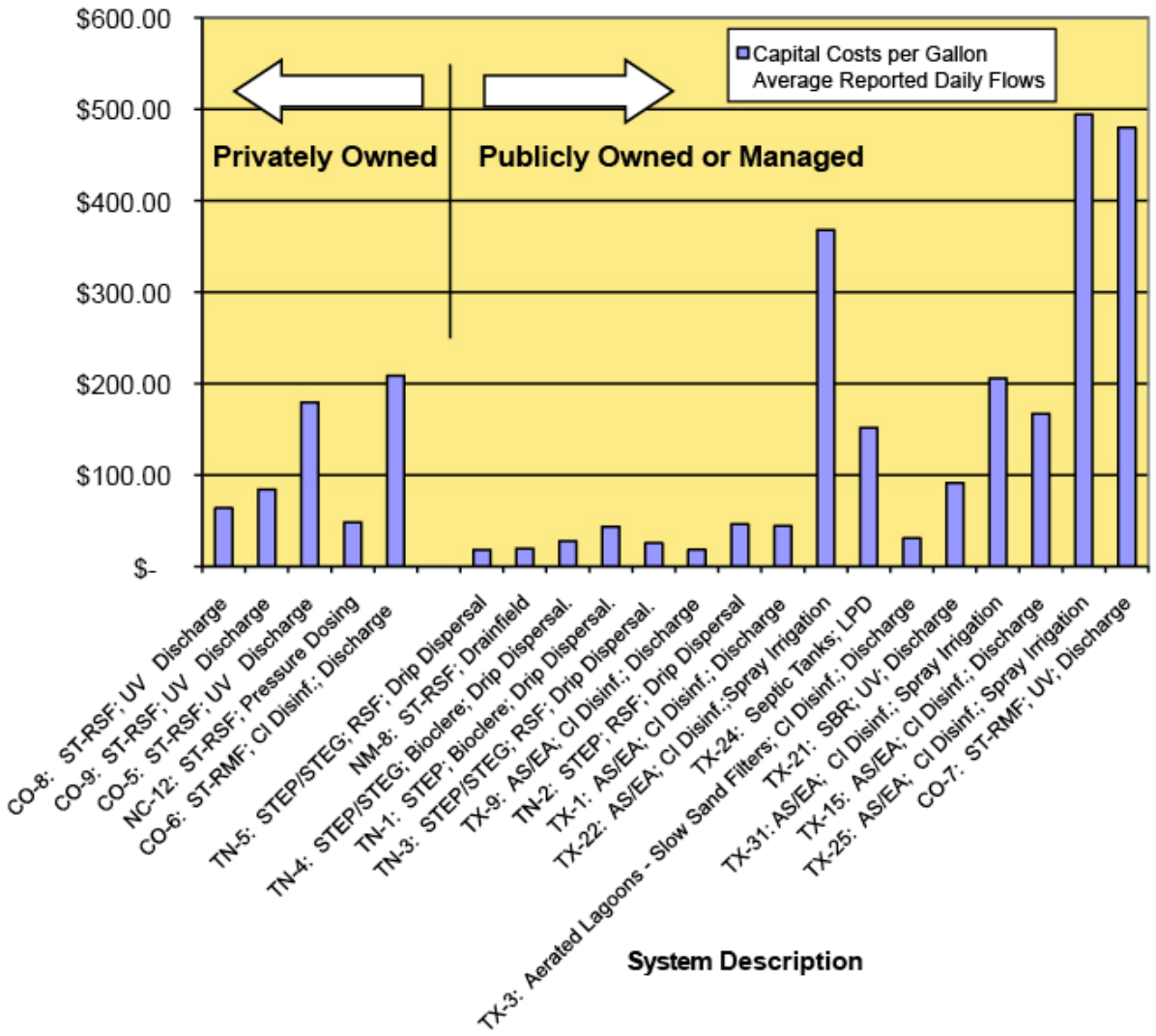
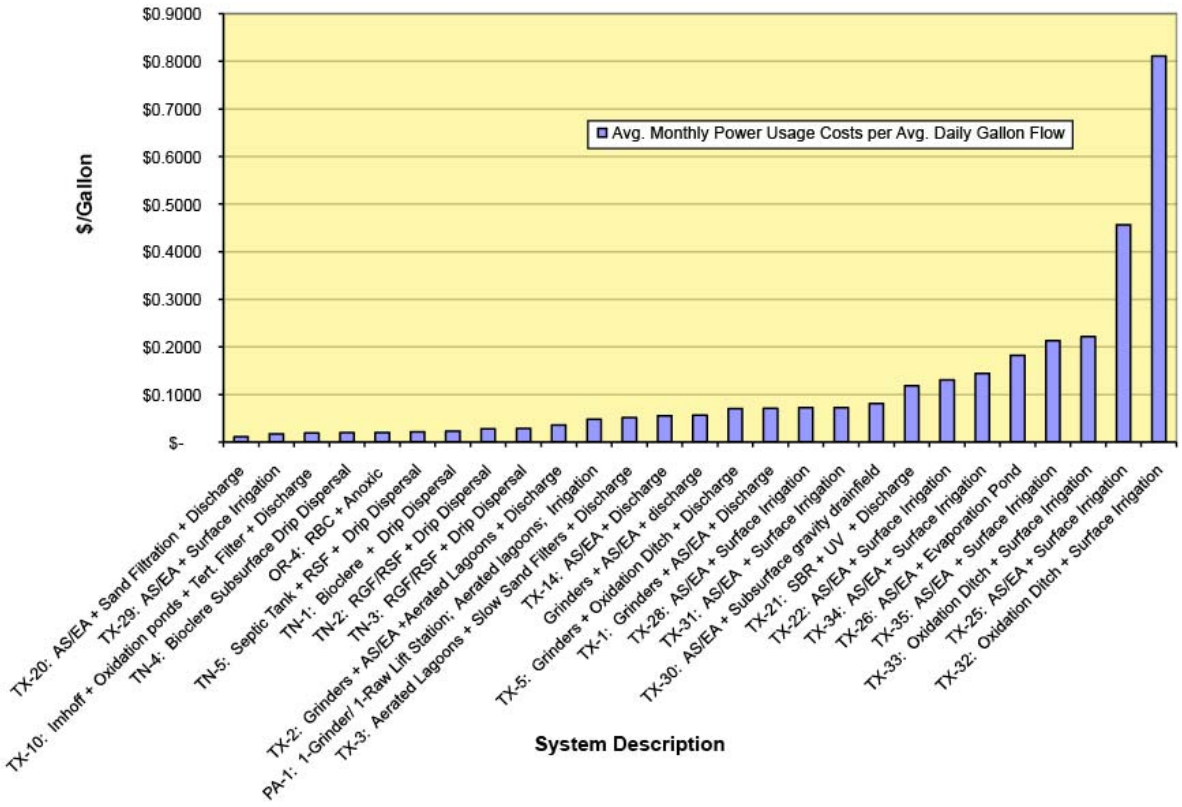


FIGURE 3
Average Monthly Reported Power Usage Costs Per Gallon of Reported Average Daily Flow.



Nutrient Removal

The wealth of data gathered from Massachusetts offered an opportunity to review systems for their nitrogen reduction capabilities. Fixed film treatment processes with an anoxic zone or unit process tended to have the best nitrogen removal performance on average. 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.
  - Of those, 29% 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).
    - RBCs containing an anoxic/denitrification unit process component made up the largest portion of the systems making up that 29%.

40,000 gallon per day Bioclere treatment system serving a shopping center. This is a proprietary recirculating trickling filter system, and is an example of an attached growth/fixed film treatment process. *Courtesy of Aquapoint, Inc.*

7,500 gpd AdvanTex recirculating packed media filter system. The AdvanTex system is similar to RSF/RGF's, but occupies a smaller footprint. Treatment media is housed in non-corrosive enclosed "pods". The modular design enables adding capacity over time for phasing-in developments and tracking flows. *Courtesy of Orenco Systems, Inc.*

Regulator Interviews

The team conducted interviews with several regulators who were willing to share their thoughts on community-sized systems. Several themes emerged in these interviews. Items of key importance to regulators included the following:

- In many but not all cases, authority and responsibilities are split between state and local departments, making permitting such systems more complicated. Additionally, design flow "cut-off" points used to determine the applicable permitting authority vary greatly between states. States also vary in permitting different types of systems through their NPDES permitting process, and through their "groundwater discharge" or land dispersal systems permitting processes.
- Flow equalization and control were repeatedly pointed to by both regulators and operators of systems as critical for achieving good performance. They also recommended establishing appropriate upper limits for soil loading rates for subsurface drip irrigation systems to reduce the likelihood of system failure.
- The absence of good management practices was most often cited by experienced regulators as the biggest problem with systems performance. Regulators however seemed confident that there currently exists the technical means of providing good quality decentralized service.
- 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. Respondents in a state with a large number of activated sludge-based package treatment systems noted start-up problems for seasonal-use treatment facilities.

- 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.
- Regulators from several states expressed a preference for Responsible Management Entities to be public entities such as a city or county, though they acknowledged that in some cases it might be an entity with a more vested interest such as a homeowners association or the developer.
- One regulator 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 conventional systems with which they are familiar.
- For most states there seemed to be a relatively minor or insignificant role, if any, played by the EPA's UIC Class V Well Program with the implementation of sound large scale decentralized wastewater systems providing ground water quality protection. There often appeared to be somewhat of a "disconnect" between that program and statewide regulatory programs responsible for design reviews and permitting.

4.0 RECOMMENDATIONS

In addition to the need for data to be collected in a systematic fashion on the state level, the researchers developed several other recommendations that would remove barriers to implementing decentralized systems and to improve the ability to compare large decentralized systems to one another and to other water quality options.

10,000 gpd activated sludge (extended aeration) treatment plant serving a mobile home park. Most large scale decentralized systems studied in Florida and Texas used some type of activated sludge process. *Courtesy of state regulatory staff, Florida.*

- To evaluate decentralized systems alongside 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 realistic capital and operations costs.
- States should consider policy changes that would remove legal and institutional obstacles.
- Comparing the dollars spent per gallon of design flow with the dollars spent per gallon of average measured flow underscored the need for regulators and engineers and manufacturers to all work toward 1) better estimating design flows, and 2) where possible, using "modular" type or phased-in treatment and dispersal facilities, and tracking flows as usage occurs to avoid over-sizing systems and thereby increasing costs.
- There appears to be a strong correlation between better overall management practices and good system performance. The decentralized wastewater industry may want to use telemetry systems and other state-of-the-art approaches to ensure that systems are

performing as intended. They may also want to require a higher level of long-term involvement by manufacturers.

- Engineers, installers, and operators of systems need statewide education/training and certification, based on up-to-date industry-accepted practices.
- Managers must have system-specific training and experience, rather than arbitrary timetables and broad regulatory requirements that may not be applicable to specific systems.
- The industry needs to develop and implement technologies and approaches that cost-effectively and reliably meet applicable nitrogen limits. While data from some states (i.e., Massachusetts) indicate that some systems are capable of meeting relatively low total nitrogen limits on average, the researchers considered the reliability and consistency of those processes, as well as the costs associated with those systems, to be issues.
- Upper limits for soil loading rates should be developed for subsurface drip irrigation systems.
- Agencies need to use progressive billing/rate systems that can effectively accommodate "split systems," i.e., management programs that include both individual onsite systems and clustered/collective systems.

© Copyright 2008 by the Water Environment Research Foundation. All rights reserved. Permission to copy must be obtained from the Water Environment Research Foundation. Printed in the United States of America

This report was prepared by the organization(s) named below as an account of work sponsored by the Water Environment Research Foundation (WERF). Neither WERF, members of WERF, the organization(s) named below, nor any person acting on their behalf: (a) makes any warranty, express or implied, with respect to the use of any information, apparatus, method, or process disclosed in this report or that such use may not infringe on privately owned rights; or (b) assumes any liabilities with respect to the use of, or for damages resulting from the use of, any information, apparatus, method, or process disclosed in this report.

Community Environmental Services, Inc.

The research on which this report is based was developed, in part, by the United States Environmental Protection Agency (EPA) through Cooperative Agreement No. X-830851 with the Water Environment Research Foundation (WERF). However, the views expressed in this document are solely those of Community Environmental Services, Inc. and neither EPA nor WERF endorses any products or commercial services mentioned in this publication. This report is a publication of WERF, not EPA. Funds awarded under the Cooperative Agreement cited above were not used for editorial services, reproduction, printing, or distribution.

This document was reviewed by a panel of independent experts selected by WERF. Mention of trade names or commercial products does not constitute WERF nor EPA endorsement or recommendations for use. Similarly, omission of products or trade names indicates nothing concerning WERF's or EPA's positions regarding product effectiveness or applicability.

Cover photo courtesy of Orenco Systems, Inc.

For additional information, contact:
Susan M. Parten, P.E.
Community Environmental Services, Inc.
P.O. Box 18806
Austin, TX 78760-8806
Telephone: (512) 443-2733
Email: smparten@ces-txvi.com