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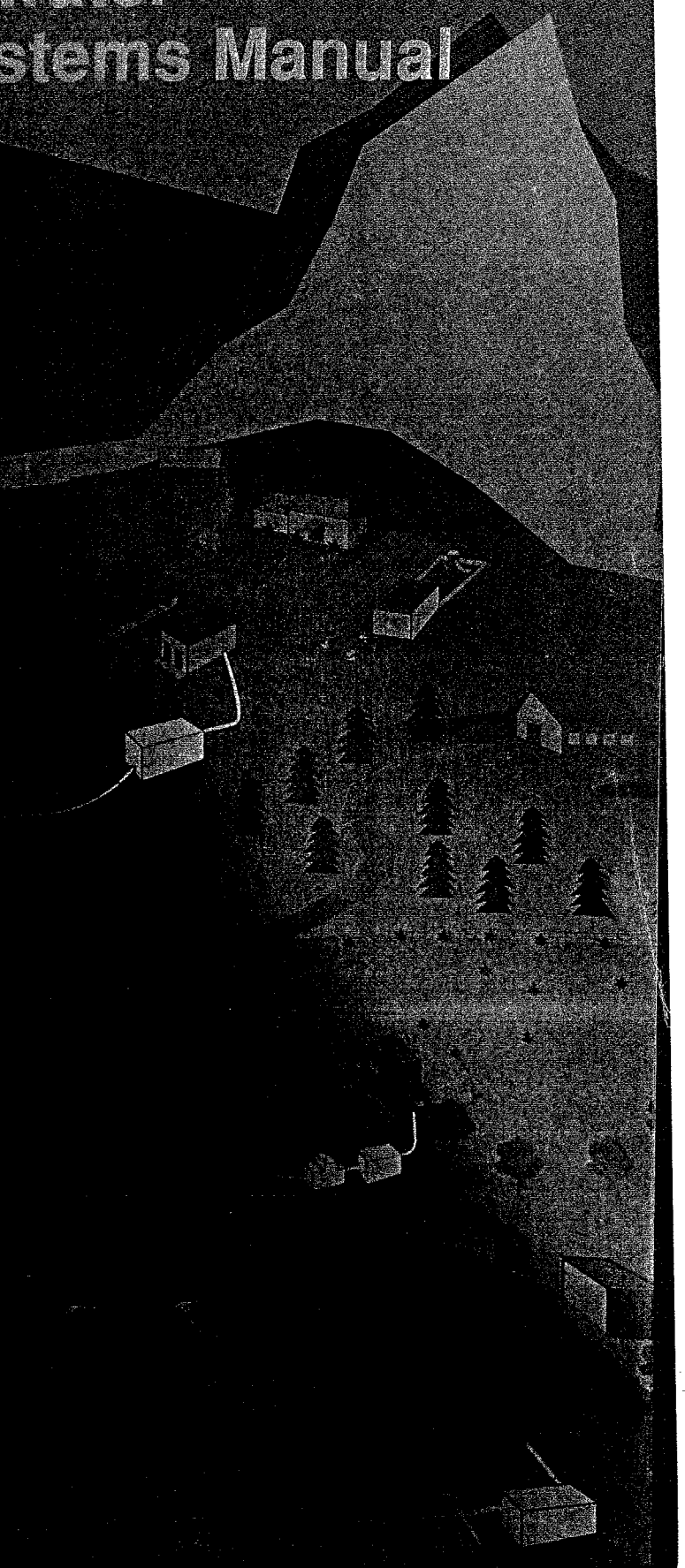

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Onsite Wastewater Treatment Systems Manual

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Notice

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Foreword

The U.S. Environmental Protection Agency is pleased to publish the "Onsite Wastewater Treatment Systems Manual". This manual provides up-to-date information on onsite wastewater treatment system (OWTS) siting, design, installation, maintenance, and replacement. It reflects significant advances that the expert community has identified to help OWTSs become more cost-effective and environmentally protective, particularly in small suburban and rural areas.

In addition to providing a wealth of technical information on a variety of traditional and new system designs, the manual promotes a performance-based approach to selecting and designing OWTSs. This approach will enable States and local communities to design onsite wastewater programs that fit local environmental conditions and communities' capabilities. Further details on the proper management of OWTSs to prevent system failures that could threaten ground and surface water quality will be provided in EPA's forthcoming "Guidelines for Management of Onsite/ Decentralized Wastewater Systems". EPA anticipates that the performance-based approach to selecting and managing appropriate OWTSs at both the watershed and site levels will evolve as States and communities develop programs based on resources that need protection and improvement.

Robert H. Wayland III, Director
Office of Wetlands, Oceans and Watersheds

E. Timothy Oppelt, Director
National Risk Management Research Laboratory

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Acknowledgments

This update of the 1980 *Design Manual: Onsite Wastewater Treatment and Disposal Systems* (see http://www.epa.gov/ORD/NRMRL/Pubs/625180012/625180012.htm) was developed to provide supplemental and new information for wastewater treatment professionals in both the public and private sectors. This manual is not intended to replace the previous manual, but rather to further explore and discuss recent developments in treatment technologies, system design, and long-term system management.

The information in the chapters that follow is provided in response to several calls for a more focused approach to onsite wastewater treatment and onsite system management. Congress has expressed interest in the status of site-level approaches for treating wastewater, and the Executive Branch has issued directives for moving forward with improving both the application of treatment technologies and management of the systems installed.

The U.S. Environmental Protection Agency (USEPA) responded to this interest by convening a team of subject matter experts from public agencies, private organizations, professional associations, and the academic community. Two representatives from the USEPA Office of Water and a representative from the Office of Research and Development coordinated the project team for this document. Close coordination with the USEPA Office of Wastewater Management and other partners at the federal, state, and local levels helped to ensure that the information in this manual supports and complements other efforts to improve onsite wastewater management across the nation.

The principal authors of the document are Richard Otis of Ayres Associates; Jim Kreissl, Rod Frederick, and Robert Goo of USEPA; Peter Casey of the National Small Flows Clearinghouse; and Barry Tonning of Tetra Tech, Inc. Other persons who made significant contributions to the manual include Robert Siegrist of the Colorado School of Mines; Mike Hoover of North Carolina State University; Jean Caudill of the Ohio Department of Health; Bob Minicucci of the New Hampshire Department of Environmental Services; Tom Groves of the New England Interstate Water Pollution Control Commission; Tom Yeager of Kennedy/Jenks Consultants; Robert Rubin of North Carolina State University; Pio Lombardo of Lombardo Associates; Dov Weitman and Joyce Hudson of USEPA; Lisa Brown, Seldon Hall, Richard Benson, and Tom Long of the Washington Department of Health; David Pask and Tricia Angoli of the National Small Flows Clearinghouse; James Davenport of the National Association of Counties; Jim Watson of the Tennessee Valley Authority; John Austin of the U.S. Agency for International Development; Pat Fleming of the U.S. Bureau of Land Management; James Jacobsen of the Maine Department of Human Services; Richard Barror of the Indian Health Service; Glendon Deal of the U.S. Department of Agriculture; Lisa Knerr, Jonathan Simpson, and Kay Rutledge of Tetra Tech; Kenneth Pankow of Pankow Engineering; Linda Stein of Eastern Research Group; Robert Adler, Charles Pycha, Calvin Terada, and Jonathon Williams of USEPA Region 10; Richard Carr of the World Health Organization; Ralph Benson of the Clermont County, Ohio, General Health District; Rich Piluk of the Anne Arundel, Maryland, county government; Jerry Nonogawa of the Hawaii Department of Health; Tony Smithson of the Lake County, Illinois, Health Department; Conrad G. Keyes, Jr., and Cecil Lue-Hing of the EWRI of ASCE; Robert E. Lee of the National Onsite Wastewater Recycling Association; Anish Jantrania, private consultant; Larry Stephens of Stephens Consultants; Bruce Douglass and Bill Heigis of Stone Engineering; Alan Hassett of Oak Hill Co.; Steven Braband of Biosolutions, Inc.; Matt Byers of Zoeller Co.; Carl Thompson, Infiltrator Systems, Inc.; Alex Mauck of EZ Drain; Bob Mayer of American Manufacturing; Rodney Ruskin of Geoflow; Fred Harned of Netafim; Don Canada of the American Decentralized Wastewater Association, and Michael Price, Norweco, Inc.

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Review Team Members for the Onsite Wastewater Treatment Systems Manual

Robert Goo, USEPA, Office of Wetlands (OW), Oceans and Watersheds
Rod Frederick, USEPA, OW, Oceans and Watersheds
Eric Slaughter, USEPA, OW, Oceans and Watersheds
Jim Kreissl, USEPA, Office of Research and Development (ORD)
Don Brown, USEPA, ORD
Robert Bastian, USEPA, Office of Wastewater Management (OWM)
Charlie Vanderlyn, USEPA, OWM
Steve Hogye, USEPA, OWM
Joyce Hudson, USEPA, OWM
Joel Salter, USEPA, Office of Science and Technology
Philip Berger, USEPA, Office of Ground Water and Drinking Water (OGWDW)
Howard Beard, USEPA, OGWDW
Robert Adler, USEPA Region 1
Charles Pycha, USEPA Region 5
Ernesto Perez, USEPA Region 6
Calvin Terada, USEPA Region 10
Danny Averett, U.S. Army Corps of Engineers
Ed Smith, USACE Research Laboratory
Rick Scholz, USACE Research Laboratory
John Austin, U.S. Agency for International Development
Patrick Fleming, National Park Service
Rick Barror, U.S. Public Health Service
Gary Morgan, USDA Rural Development Administration
Andree Duvarney, USDA Natural Resources Conservation Service
Phil Mummert, Tennessee Valley Authority
Raymond Reid, Pan American Health Organization
Homero Silva, Organización Mundial de la Salud, Costa Rica
Dennis Warner, World Health Organization
Tom Groves, New England Interstate Water Pollution Control Commission
Paul Chase, DuPage County (Illinois) Health Department
Douglas Ebelherr, Illinois Department of Public Health
Randy Clarkson, Missouri Department of Natural Resources
Anish Jantrania, Virginia Department of Health
Steve Steinbeck, North Carolina Department of Health and Natural Resources
Ron Frey, Arizona Department of Environmental Quality
Mark Soltman, Washington State Department of Health
Alex Campbell, Ontario Ministry of Environment and Approvals
Jerry Tyler, University of Wisconsin
Mike Hoover, North Carolina State University
Ruth Alfasso, Massachusetts Department of Environmental Protection
Jerry Nunogawa, Hawaii Department of Health
Robert Siegrist, Colorado School of Mines
Rick Piluk, Anne Arundel County (Maryland) Health Department
Gary Eckler, Erie County (Ohio) Sanitary Engineering Department
Janet Rickabaugh, Clermont County (Ohio) Health District
Jay Harrell, Mohave County (Arizona) Environmental Health Division
Dan Smith, Coconino County (Arizona) Environmental Health Services
Tom Yeager, Kennedy/Jenks Consultants
Richard Otis, Ayres Associates
Robert Mayer, American Manufacturing Co.
Hamilton Brown, National Association of Towns and Townships
Larry Markham, National Environmental Health Association
Robert Rubin, Water Environment Federation
Thomas McLane, American Society of Civil Engineers
Dan MacRitchie, American Society of Civil Engineers
Don Canada, American Decentralized Wastewater Association
Naomi Friedman, National Association of Counties
Peter Casey, National Small Flows Clearinghouse
Tricia Angoli, national Small Flows Clearinghouse
Thomas Bruursema, National Sanitation Foundation

Introduction

Background and Purpose

The U.S. Environmental Protection Agency (USEPA) first issued detailed guidance on the design, construction, and operation of onsite wastewater treatment systems (OWTSs) in 1980. *Design Manual: Onsite Wastewater Treatment and Disposal Systems* (USEPA, 1980) was the most comprehensive summary of onsite wastewater management since the U.S. Public Health Service had published a guidance on septic tank practice in 1967 (USPHS, 1967). The 1980 manual focused on both treatment and "disposal" of wastewater in general accordance with the approach and terminology in use at the time. The 1980 design manual stressed the importance of site-specific soil, landscape, ground water, and effluent characterization and included soil percolation tests as one of several site evaluation tools to be used in system design and placement. The manual's discussion of water conservation to reduce hydraulic flows, pollutant reduction to minimize contaminant loading, and management programs to oversee the full range of treatment activities was especially important to the developing field of onsite wastewater treatment in the United States and other countries.

Technologies explored in the 1980 manual include the conventional system (a septic tank with a subsurface wastewater infiltration system), alternating leach fields, uniform distribution systems, intermittent sand filters, aerobic units, disinfection technologies, and evapotranspiration systems. The original manual also contains guidance on dosing chambers, flow diversion methods for alternating beds, nutrient removal, and disposal of residuals. Although much of that information is still useful, advances in regional planning, improvements in ground water and surface water protection, and new technologies and management concepts necessitate further guidance for public health districts, water quality agencies, planning boards, and other audiences. In addition, the growing national emphasis on management programs that establish performance requirements rather than prescriptive codes for the design, siting, installation, operation, and maintenance of onsite systems underscores the importance of revising the manual to address these emerging issues in public health and water resource protection.

USEPA is committed to elevating the standards for onsite wastewater management practice and removing barriers that preclude widespread acceptance of onsite treatment technologies. The purpose of this update of the 1980 manual is to provide more comprehensive information on management approaches, update information on treatment technologies, and describe the benefits of performance-based approaches to system design. The management approaches suggested in this manual involve coordinating onsite system planning and management activities with land use planning and watershed protection efforts to ensure that the impacts of onsite wastewater systems are considered and controlled at the appropriate scale. The management approaches described in this manual support and are consistent with USEPA's draft *Guidelines for Management of Onsite/Decentralized Wastewater Systems* (USEPA, 2000). The incorporation of performance standards for management programs and for system design and operation can help ensure that no onsite system alternative presents an unacceptable risk to public health or water resources.

This manual contains overview information on treatment technologies, installation practices, and past performance. It does not, however, provide detailed design information and is not intended as a substitute for region- and site-specific program criteria and standards that address conditions, technologies, and practices appropriate to each individual management jurisdiction. The information in the following chapters provides an operational framework for developing and improving OWTS program structure, criteria, alternative designs, and performance requirements. The chapters describe the importance of planning to ensure that system densities are appropriate for prevailing hydrologic and geologic conditions, performance requirements to guide system design, wastewater characterization to accurately predict waste strength and flows, site evaluations that identify appropriate design and performance boundaries, technology selection to

ensure that performance requirements are met, and management activities that govern installation, operation, maintenance, and remediation of failed systems.

This manual is intended to serve as a technical guidance for those involved in the design, construction, operation, maintenance, and regulation of onsite systems. It is also intended to provide information to policy makers and regulators at the state, tribal, and local levels who are charged with responsibility for developing, administering, and enforcing wastewater treatment and management program codes. The activities and functions described herein might also be useful to other public health and natural resource protection programs. For example, properly planned, designed, installed, operated, and maintained onsite systems protect wellhead recharge areas, drinking water sources, watershed, estuaries, coastal zones, aquatic habitat, and wetlands.

Finally, this manual is intended to emphasize the need to improve cooperation and coordination among the various health, planning, zoning, development, utility, and resource protection programs operated by public and private organizations. A watershed approach to protecting public health and environmental resources requires an integrated operational framework that encourages independent partners to function cooperatively while each retains the ability to satisfy internal programmatic and management objectives. Integrating onsite wastewater management processes with other activities conducted by public and private entities can improve both the effectiveness and the efficiency of efforts to minimize the risk onsite systems might present to health and ecological resources.

Overview

Onsite wastewater treatment systems collect, treat, and release about 4 billion gallons of treated effluent per day from an estimated 26 million homes, businesses, and recreational facilities nationwide (U.S. Census Bureau, 1997). These systems, defined in this manual as those serving fewer than 20 people, include treatment units for both individual buildings and small clusters of buildings connected to a common treatment system. Recognition of the impacts of onsite systems on ground water and surface water quality (e.g., nitrate and bacteria contamination, nutrient inputs to surface waters) has increased interest in optimizing the systems' performance. Public health and environmental protection officials now acknowledge that onsite systems are not just temporary installations that will be replaced eventually by centralized sewage treatment services, but permanent approaches to treating wastewater for release and reuse in the environment. Onsite systems are recognized as potentially viable, low-cost, long-term, decentralized approaches to wastewater treatment if they are planned, designed, installed, operated, and maintained properly (USEPA, 1997). NOTE: In addition to existing state and local oversight, decentralized wastewater treatment systems that serve more than 20 people might become subject to regulation under the USEPA's Underground Injection Control Program, although EPA has proposed not to include them (64FR22971:5/7/01).

Although some onsite wastewater management programs have functioned successfully in the past, problems persist. Most current onsite regulatory programs focus on permitting and installation.

Few programs address onsite system operation and maintenance, resulting in failures that lead to unnecessary costs and risks to public health and water resources. Moreover, the lack of coordination among agencies that oversee land use planning, zoning, development, water resource protection, public health initiatives, and onsite systems causes problems that could be prevented through a more cooperative approach. Effective management of onsite systems requires rigorous planning, design, installation, operation, maintenance, monitoring, and controls.

Public health and water resource impacts

State and tribal agencies report that onsite septic systems currently constitute the third most common source of ground water contamination and that these systems have failed because of inappropriate siting or design or inadequate long-term maintenance (USEPA, 1996a). In the 1996 Clean Water Needs Survey (USEPA, 1996b), states and tribes also identified more than 500 communities as having failed septic systems that have caused public health problems. The discharge of partially treated sewage from malfunctioning onsite systems was identified as a principal or contributing source of degradation in 32 percent of all harvest-limited shellfish growing areas. Onsite wastewater treatment systems have also contributed to an overabundance of nutrients in ponds, lakes, and coastal estuaries, leading to the excessive growth of algae and other nuisance aquatic plants (USEPA, 1996b). In addition, onsite systems contribute to contamination of drinking water sources. USEPA estimates that 168,000 viral illnesses and 34,000 bacterial illnesses occur each year as a result of consumption of drinking water from systems that rely on improperly treated ground water. Malfunctioning septic systems have been identified as one potential source of ground water contamination (USEPA, 2000).

Improving treatment through performance requirements

Most onsite wastewater treatment systems are of the conventional type, consisting of a septic tank and a subsurface wastewater infiltration system (SWIS). Site limitations and more stringent performance requirements have led to significant improvements in the design of wastewater treatment systems and how they are managed. Over the past 20 years the OWTS industry has developed many new treatment technologies that can achieve high performance levels on sites with size, soil, ground water, and landscape limitations that might preclude installing conventional systems. New technologies and improvements to existing technologies are based on defining the performance requirements of the system, characterizing wastewater flow and pollutant loads, evaluating site conditions, defining performance and design boundaries, and selecting a system design that addresses these factors.

Performance requirements can be expressed as numeric criteria (e.g., pollutant concentration or mass loading limits) or narrative criteria (e.g., no odors or visible sheen) and are based on the assimilative capacity of regional ground water or surface waters, water quality objectives, and public health goals. Wastewater flow and pollutant content help define system design and size and can be estimated by comparing the size and type of facility with measured effluent outputs from similar, existing facilities. Site evaluations integrate detailed analyses of regional hydrology, geology, and water resources with site-specific characterization of soils, slopes, structures, property lines, and other site features to further define system design requirements and determine the physical placement of system components.

Most of the alternative treatment technologies applied today treat wastes after they exit the septic tank; the tank retains settleable solids, grease, and oils and provides an environment for partial digestion of settled organic wastes. Post-tank treatment can include aerobic (with oxygen) or anaerobic (with no or low oxygen) biological treatment in suspended or fixed-film reactors, physical/chemical treatment, soil infiltration, fixed-media filtration, and/or disinfection. The application and sizing of treatment units based on these technologies are defined by performance requirements, wastewater characteristics, and site conditions.

Toward a more comprehensive approach

The principles of the 1980 onsite system design manual have withstood the test of time, but much has changed over the past 20 years. This manual incorporates much of the earlier guide but includes new information on treatment technologies, site evaluation, design boundary characterization, and especially management program functions. The manual is organized by functional topics and is intended to be a comprehensive reference. Users can proceed directly to relevant sections or review background or other information (see Contents).

Although this manual focuses on individual and small, clustered onsite systems, state and tribal governments and other management entities can use the information in it to construct a framework for managing new and existing large-capacity decentralized systems (those serving more than 20 people), subject to regulation under state or local Underground Injection Control (UIC) programs. The UIC program was established by the Safe Drinking Water Act to protect underground sources of drinking water from contamination caused by the underground injection of wastes. In most parts of the nation, the UIC program, which also deals with motor vehicle waste disposal wells, large-capacity cesspools, and storm water drainage wells, is managed by state or tribal water or waste agencies with authority delegated by USEPA.

The Class V UIC program and the Source Water Protection Program established by the 1996 amendments to the federal Safe Drinking Water Act are bringing federal and state drinking water agencies into the field of onsite wastewater treatment and management. Both programs will likely require more interagency involvement and cooperation to characterize wastewater impacts on ground water resources and to develop approaches to deal with real or potential problems. States currently have permit-by-rule provisions for large-capacity septic systems.

Overview of the revised manual

The first two chapters of this manual present overview and management information of special interest to program administrators. Chapters 3, 4, and 5 contain technical information on wastewater characterization, site evaluation and selection, and treatment technologies and how to use them in develop-

ing a system design. Those three chapters are intended primarily for engineers, soil scientists, permit writers, environmental health specialists, site evaluators, and field staff. Summaries of all the chapters appear below. The level of detail provided in this manual is adequate for preliminary system design and development of a management program. References are provided for additional research and information on how to incorporate local characteristics into an optimal onsite management program.

Overview of the Onsite Wastewater Treatment Systems Manual

Chapter 1, Background and use of onsite wastewater treatment systems	Review of the history and current use of onsite treatment systems, introduction of management concepts, and brief discussion of alternative technologies.
Chapter 2, Management and regulation of onsite wastewater treatment systems	Discussion of methods to plan, institutionalize, and manage OWTS programs, including both prescriptive and performance-based approaches. If prescriptive-based management programs are used, parts of this chapter will not apply because the basic functions of prescriptive-based management are more simplified.
Chapter 3, Establishing treatment system performance requirements	Discussion of methods for estimating wastewater flow and composition, identifying pollutants of concern and their transport and fate in the environment, establishing performance requirements, and estimating watershed-scale impacts.
Chapter 4, Treatment processes and systems	Identification of conventional and alternative OWTS technologies, pollutant removal effectiveness, design parameters, operation and maintenance requirements, costs, and special issues.
Chapter 5, Treatment system selection	Discussion of strategies for establishing site-specific performance requirements and performance boundaries based on wastewater flow and composition and site characteristics, selection of treatment alternatives, and analysis of system failure and repair or replacement alternatives.
Glossary	Definitions of terms used in the manual.
Resources	Selected reference documents and Internet resources.

Chapter 1: Background and use of onsite wastewater treatment systems

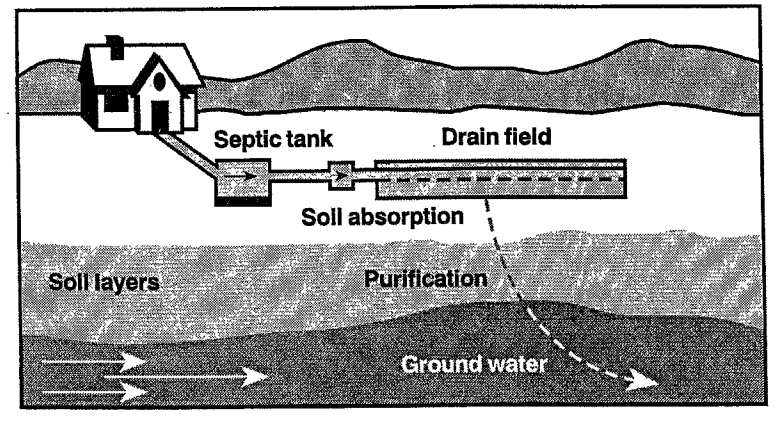
1.1 Introduction
1.2 History of onsite wastewater treatment systems
1.3 Regulation of onsite wastewater treatment systems
1.4 Onsite wastewater treatment system use, distribution, and failure rate
1.5 Problems with existing onsite wastewater management programs
1.6 Performance-based management of onsite wastewater treatment systems
1.7 Coordinating onsite system management with watershed protection efforts
1.8 USEPA initiatives to improve onsite system treatment and management
1.9 Other initiatives to assist and improve onsite management efforts

1.1 Introduction

Onsite wastewater treatment systems (OWTSs) have evolved from the pit privies used widely throughout history to installations capable of producing a disinfected effluent that is fit for human consumption. Although achieving such a level of effluent quality is seldom necessary, the ability of onsite systems to remove settleable solids, floatable grease and scum, nutrients, and pathogens from wastewater discharges defines their importance in protecting human health and environmental resources. In the modern era, the typical onsite system has consisted primarily of a septic tank and a soil absorption field, also known as a subsurface wastewater infiltration system, or SWIS (figure 1-1). In this manual, such systems are referred to as *conventional systems*. Septic tanks remove most settleable and floatable material and function as an anaerobic bioreactor that promotes partial digestion of retained organic matter. Septic tank effluent, which contains significant concentrations of pathogens and nutrients, has traditionally been discharged to soil, sand, or other media absorption fields (SWISs) for further treatment through biological processes, adsorption, filtration, and infiltration into underlying soils. Conventional systems work well if they are installed in areas with appropriate soils and hydraulic capacities; designed to treat the incoming waste load to meet public health, ground water, and surface water performance standards; installed properly; and maintained to ensure long-term performance.

These criteria, however, are often not met. Only about one-third of the land area in the United States has soils suited for conventional subsurface soil absorption fields. System densities in some areas exceed the capacity of even suitable soils to assimilate wastewater flows and retain and transform their contaminants. In addition, many systems are located too close to ground water or surface waters and others, particularly in rural areas with newly installed public water lines, are not designed to handle increasing wastewater flows. Conventional onsite system installations might not be adequate for minimizing nitrate contamination of ground water, removing phosphorus compounds, and attenuating pathogenic organisms (e.g., bacteria, viruses). Nitrates that leach into ground

Figure 1-1. Conventional onsite wastewater treatment system



Source: NSFC, 2000.

water used as a drinking water source can cause methemoglobinemia, or blue baby syndrome, and other health problems for pregnant women. Nitrates and phosphorus discharged into surface waters directly or through subsurface flows can spur algal growth and lead to eutrophication and low dissolved oxygen in lakes, rivers, and coastal areas. In addition, pathogens reaching ground water or surface waters can cause human disease through direct consumption, recreational contact, or ingestion of contaminated shellfish. Sewage might also affect public health as it backs up into residences or commercial establishments because of OWTS failure.

Nationally, states and tribes have reported in their 1998 Clean Water Act section 303(d) reports that designated uses (e.g., drinking water, aquatic habitat) are not being met for 5,281 waterbodies because of pathogens and that 4,773 waterbodies are impaired by nutrients. Onsite systems are one of many known contributors of pathogens and nutrients to surface and ground waters. Onsite wastewater systems have also contributed to an overabundance of nutrients in ponds, lakes, and coastal estuaries, leading to overgrowth of algae and other nuisance aquatic plants.

Threats to public health and water resources (table 1-1) underscore the importance of instituting management programs with the authority and resources to oversee the full range of onsite system activities—planning, siting, design, installation, operation, monitoring, and maintenance. EPA has issued draft *Guidelines for Management of Onsite/ Decentralized Wastewater Systems* (USEPA, 2000) to improve overall management of OWTSs. These guidelines are discussed in more detail in chapter 2.

1.2 History of onsite wastewater treatment systems

King Minos installed the first known water closet with a flushing device in the Knossos Palace in Crete in 1700 BC. In the intervening 3,700 years, societies and the governments that serve them have sought to improve both the removal of human wastes from indoor areas and the treatment of that waste to reduce threats to public health and ecological resources. The Greeks, Romans, British, and French achieved considerable progress in waste removal during the period from 800 BC to AD 1850, but removal often meant discharge to surface waters; severe contamination of lakes, rivers, streams, and coastal areas; and frequent outbreaks of diseases like cholera and typhoid fever.

By the late 1800s, the Massachusetts State Board of Health and other state health agencies had documented links between disease and poorly treated sewage and recommended treatment of wastewater through intermittent sand filtration and land application of the resulting sludge. The past century has witnessed an explosion in sewage treatment technology and widespread adoption of centralized wastewater collection and treatment services in the United States and throughout the world. Although broad uses of these systems have vastly improved public health and water quality in urban areas, homes and businesses without centralized collection and treatment systems often continue to depend on technologies developed more than 100 years ago. Septic tanks for primary treatment of wastewater appeared in the late 1800s, and discharge of tank effluent into gravel-lined subsurface drains became common practice during the middle of the 20th century (Kreissl, 2000).

Scientists, engineers, and manufacturers in the wastewater treatment industry have developed a wide range of alternative technologies designed to address increasing hydraulic loads and water contamination by nutrients and pathogens. These technologies can achieve significant pollutant removal rates. With proper management oversight, alternative systems (e.g., recirculating sand filters, peat-based systems, package aeration units) can be installed in areas where soils, bedrock, fluctuating ground water levels, or lot sizes limit the use of conventional systems. Alternative technologies typically are applied to the treatment train beyond the septic tank (figure 1-2). The tank is designed to equalize hydraulic flows; retain oils, grease, and settled solids; and provide some minimal anaerobic digestion of settleable organic matter. Alternative treatment technologies often provide environments (e.g., sand, peat, artificial media) that promote additional biological treatment and remove pollutants through filtration, absorption, and adsorption. All of the alternative treatment technologies in current use require more intensive management and monitoring than conventional OWTSs because of mechanical components, additional residuals generated, and process sensitivities (e.g., to wastewater strength or hydraulic loading).

Replacing gravity-flow subsurface soil infiltration beds with better-performing alternative distribution technologies can require float-switched pumps and/ or valves. As noted in chapter 4, specialized excavation or structures might be required to house some treatment system components, including the disinfection devices (e.g., chlorinators, ultraviolet lamps) used by some systems. In addition, it is often both efficient and effective to collect and treat septic tank effluent from clusters of individual sources through a community or cluster system driven by gravity, pressure, or vacuum. These devices also require specialized design, operation, and maintenance and enhanced management oversight.

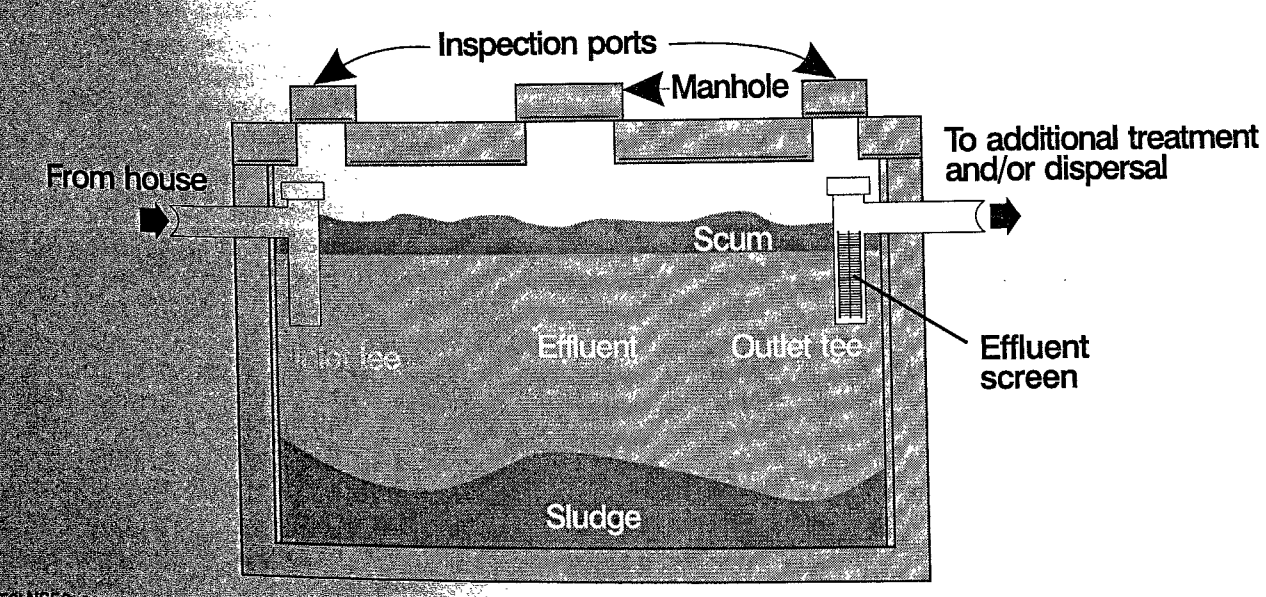
1.3 Regulation of onsite wastewater treatment systems

Public health departments were charged with enforcing the first onsite wastewater "disposal" laws, which were mostly based on soil percolation tests, local practices, and past experience. Early codes did not consider the complex interrelationships among soil conditions, wastewater characteristics, biological mechanisms, and climate and

Table 1-1. Typical pollutants of concern in effluent from onsite wastewater treatment systems

Pollutant	Public health or water resource impacts
Pathogens	Parasites, bacteria, and viruses can cause communicable diseases through direct or indirect body contact or ingestion of contaminated water or shellfish. Pathogens can be transported for significant distances in ground water or surface waters.
Nitrogen	Nitrogen is an aquatic plant nutrient that can contribute to eutrophication and dissolved oxygen loss in surface waters, especially in nitrogen-limited lakes, estuaries, and coastal embayments. Algae and aquatic weeds can contribute trihalomethane (THM) precursors to the water column that might generate carcinogenic THMs in chlorinated drinking water. Excessive nitrate-nitrogen in drinking water can cause methemoglobinemia in infants and pregnancy complications.
Phosphorus	Phosphorus is an aquatic plant nutrient that can contribute to eutrophication of phosphorus-limited inland surface waters. High algal and aquatic plant production during eutrophication is often accompanied by increases in populations of decomposer bacteria and reduced dissolved oxygen levels for fish and other organisms.

Figure 1-2. Typical single-compartment septic tank with at-grade inspection ports and effluent screen



Source: NSFC, 2000.

prescribed standard designs sometimes copied from jurisdictions in vastly different geoclimatic regions. In addition, these laws often depended on minimally trained personnel to oversee design, permitting, and installation and mostly untrained, uninformed homeowners to operate and maintain the systems. During the 1950s states began to adopt laws upgrading onsite system design and installation practices to ensure proper functioning and eliminate the threats posed by waterborne pathogens (Kreissl, 1982). Despite these improvements, many regulations have not considered cumulative ground water and surface water impacts, especially in areas with high system densities and significant wastewater discharges.

Kreissl (1982) and Plews (1977) examined changes in state onsite wastewater treatment regulations prompted by the publication of the first U.S. Public Health Service *Manual of Septic-Tank Practice* in 1959. Plews found significant code revisions under way by the late 1970s, mostly because of local experience, new research information, and the need to accommodate housing in areas not suited for conventional soil infiltration systems. Kreissl found that states were gradually increasing required septic tank and drainfield sizes but also noted that 32 states were still specifying use of the percolation test in system sizing in 1980, despite its proven shortcomings. Other differences noted among state codes included separation distances between the infiltration trench bottom and seasonal ground water tables, minimum trench widths, horizontal setbacks to potable water supplies, and maximum allowable land slopes (Kreissl, 1982).

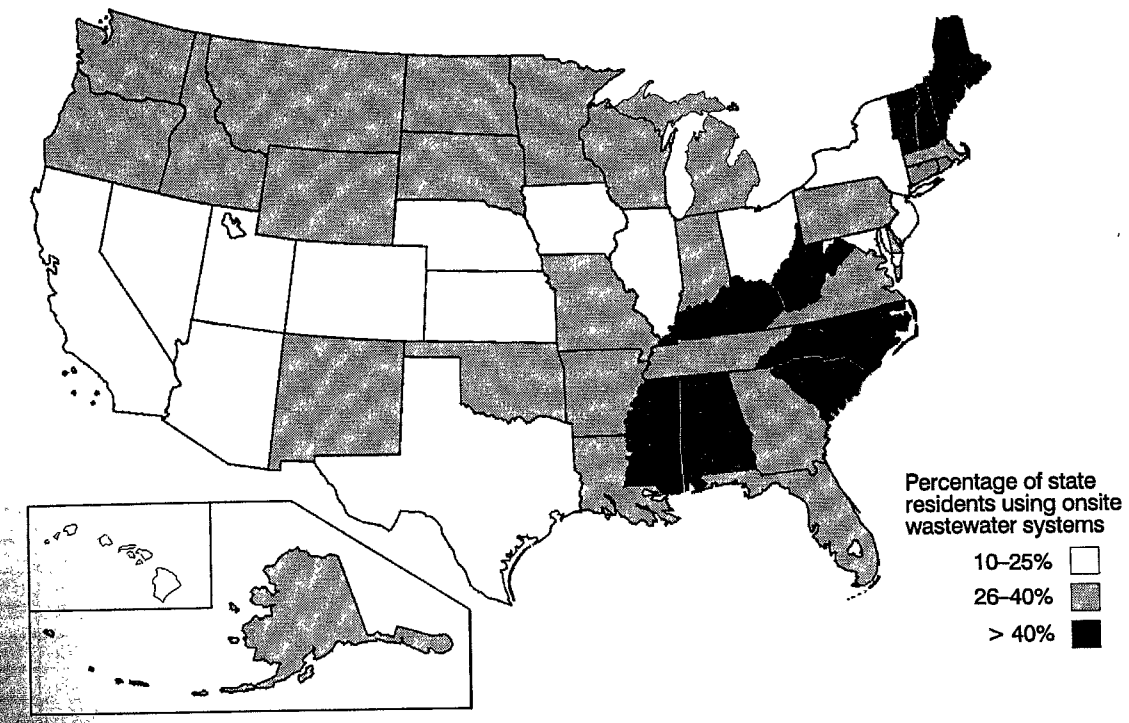
Although state lawmakers have continued to revise onsite system codes, most revisions have failed to address the fundamental issue of system performance in the context of risk management for both a site and the region in which it is located. Prescribed system designs require that site conditions fit system capabilities rather than the reverse and are sometimes incorrectly based on the assumption that centralized wastewater collection and treatment services will be available in the future. Codes that emphasize prescriptive standards based on empirical relationships and hydraulic performance do not necessarily protect ground water and surface water resources from public health threats. Devising a new regime for protecting public health and the environment in a cost-effective manner will require increased focus on system performance, pollutant transport and fate and resulting environmental impacts, and integration of the planning, design, siting, installation, maintenance, and management functions to achieve public health and environmental objectives.

1.4 Onsite wastewater treatment system use, distribution, and failure rate

According to the U.S. Census Bureau (1999), approximately 23 percent of the estimated 115 million occupied homes in the United States are served by onsite systems, a proportion that has changed little since 1970. As shown in figure 1-3 and table 1-2, the distribution and density of homes with OWTSs vary widely by state, with a high of about 55 percent in Vermont and a low of around 1 percent in California (U.S. Census Bureau, 1990). New England states have the highest proportion of homes served by onsite systems: New Hampshire and Maine both report that about half of all homes are served by individual wastewater treatment systems. More than a third of the homes in the southeastern states depend on these systems, including approximately 48 percent in North Carolina and about 40 percent in both Kentucky and South Carolina. More than 60 million people depend on decentralized systems, including the residents of about one-third of new homes and more than half of all mobile homes nationwide (U.S. Census Bureau, 1999). Some communities rely completely on OWTSs.

A number of systems relying on outdated and underperforming technologies (e.g., cesspools, drywells) still exist, and many of them are listed among failed systems. Moreover, about half of the occupied homes with onsite treatment systems are more than 30 years old (U.S. Census Bureau, 1997) and a significant number report system problems. A survey conducted by the U.S. Census Bureau (1997) estimated that 403,000 homes experienced septic system breakdowns within a 3-month period during 1997; 31,000 reported four or more breakdowns at the same home. Studies reviewed by USEPA cite failure rates ranging from 10 to 20 percent (USEPA, 2000). System failure surveys typically do not include systems that might be contaminating surface or ground water, a situation that often is detectable only through site

Figure 1-3. Onsite treatment system distribution in the United States



Source: U.S. Census Bureau, 1990.

level monitoring. Figure 1-4 demonstrates ways that effluent water from a septic system can reach ground water or surface waters.

Comprehensive data to measure the true extent of septic system failure are not currently collected by any single organization. Although estimates of system failure rates have been collected from 28 states (table 1-3), no state had directly measured its own failure rate and definitions of failure vary (Nelson et al., 1999). Most available data are the result of incidents that directly affect public health or are obtained from homeowners' applications for permits to replace or repair failing systems. The 20 percent failure rate from the Massachusetts time-of-transfer inspection program is based on an inspection of each septic system prior to home sale, which is a comprehensive data collection effort. However, the Massachusetts program only identifies failures according to code and does not track ground water contamination that may result from onsite system failures.

In addition to failures due to age and hydraulic overloading, OWTSs can fail because of design, installation, and maintenance problems. Hydraulically functioning systems can create health and ecological risks when multiple treatment units are installed at densities that exceed the capacity of local soils to assimilate pollutant loads. System owners are not likely to repair or replace aging or otherwise failing systems unless sewage backup, septage pooling on lawns, or targeted monitoring that identifies health risks occurs. Because ground and surface water contamination by onsite systems has rarely been confirmed through targeted monitoring, total failure rates and onsite system impacts over time are likely to be significantly higher than historical statistics indicate. For example, the Chesapeake Bay Program found that 55 to 85 percent of the nitrogen entering an onsite system can be discharged into ground water (USEPA, 1993). A 1991 study concluded that conventional systems accounted for 74 percent of the nitrogen entering Buttermilk Bay in Massachusetts (USEPA, 1993).

1.5 Problems with existing onsite wastewater management programs

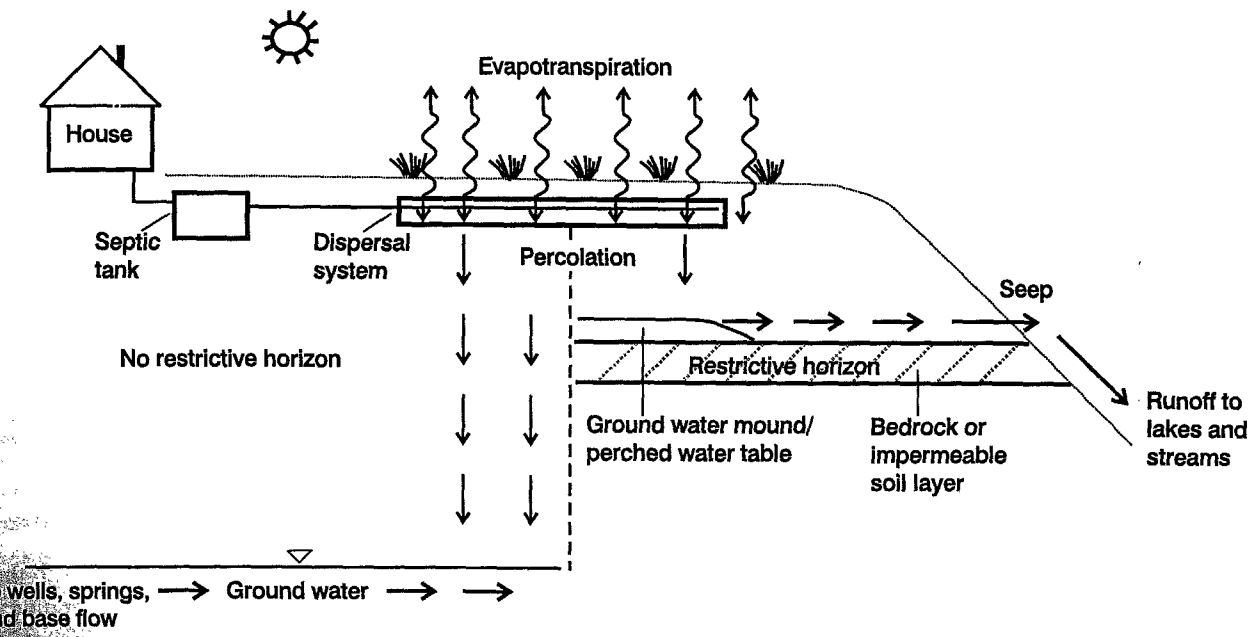
Under a typical conventional system management approach, untrained and often uninformed system owners assume responsibility for operating and

Table 1-2. Census of housing tables: sewage disposal, 1990

	Public sewer		Septic tank or cesspool		Other means	
	Number	Percent	Number	Percent	Number	Percent
United States	76,455,211	74.8	24,670,877	24.1	1,137,590	1.1
Alabama	910,782	54.5	728,690	43.6	30,907	1.9
Alaska	144,905	62.3	59,886	25.7	27,817	12.0
Arizona	1,348,836	81.3	282,897	17.0	27,697	1.7
Arkansas	601,188	60.1	382,467	38.2	17,012	1.7
California	10,022,843	89.6	1,092,174	9.8	67,865	0.6
Colorado	1,283,186	86.9	183,817	12.4	10,346	0.7
Connecticut	935,541	70.8	378,382	28.6	6,927	0.5
Delaware	212,793	73.4	74,541	25.7	2,585	0.9
District of Columbia	276,481	99.3	575	0.2	1,433	0.5
Florida	4,499,793	73.8	1,559,113	25.6	41,356	0.7
Georgia	1,638,979	62.1	970,686	36.8	28,753	1.1
Hawaii	312,812	80.2	72,940	18.7	4,058	1.0
Idaho	264,618	64.0	142,879	34.6	5,830	1.4
Illinois	3,885,689	86.2	598,125	13.3	22,461	0.5
Indiana	1,525,810	67.9	703,032	31.3	17,204	0.8
Iowa	869,056	76.0	264,889	23.2	9,724	0.9
Kansas	847,767	81.2	187,398	17.9	8,947	0.9
Kentucky	849,491	56.4	600,182	39.8	57,172	3.8
Louisiana	1,246,678	72.6	442,758	25.8	26,805	1.6
Maine	266,344	45.4	301,373	51.3	19,328	3.3
Maryland	1,533,799	81.1	342,523	18.1	15,595	0.8
Massachusetts	1,803,176	72.9	659,120	26.7	10,415	0.4
Michigan	2,724,408	70.8	1,090,481	28.3	33,037	0.9
Minnesota	1,356,520	73.4	467,936	25.3	23,989	1.3
Mississippi	585,185	57.9	387,406	38.3	37,832	3.7
Missouri	1,617,996	73.6	532,844	24.2	48,289	2.2
Montana	218,372	60.5	135,371	37.5	7,412	2.1
Nebraska	534,692	80.9	117,460	17.8	8,469	1.3
Nevada	456,107	87.9	60,508	11.7	2,243	0.4
New Hampshire	250,060	49.6	246,692	49.0	7,152	1.4
New Jersey	2,703,489	87.9	357,890	11.6	13,931	0.5
New Mexico	452,934	71.7	161,068	25.5	18,056	2.9
New York	5,716,917	79.1	1,460,873	20.2	49,101	0.7
North Carolina	1,403,033	49.8	1,365,632	48.5	49,528	1.8
North Dakota	204,328	73.9	66,479	24.1	5,533	2.0
Ohio	3,392,785	77.6	940,943	21.5	38,217	0.9
Oklahoma	1,028,594	73.1	367,197	26.1	10,708	0.8
Oregon	835,545	70.0	349,122	29.3	8,900	0.7
Pennsylvania	3,670,338	74.3	1,210,054	24.5	57,748	1.2
Rhode Island	293,901	70.9	118,410	28.6	2,261	0.5
South Carolina	825,754	58.0	578,129	40.6	20,272	1.4
South Dakota	207,996	71.1	78,435	26.8	6,005	2.1
Tennessee	1,213,934	59.9	781,616	38.6	30,517	1.5
Texas	5,690,550	81.2	1,266,713	18.1	51,736	0.7
Utah	528,864	88.4	65,403	10.9	4,121	0.7
Vermont	115,201	42.5	149,125	55.0	6,888	2.5
Virginia	1,740,787	69.7	707,409	28.3	48,138	1.9
Washington	1,387,396	68.3	630,646	31.0	14,336	0.7
West Virginia	427,930	54.8	318,697	40.8	34,668	4.4
Wisconsin	1,440,024	70.0	580,836	28.3	34,914	1.7
Wyoming	151,004	74.2	49,055	24.1	3,352	1.6

Source: U.S. Census Bureau, 1990.

Figure 1-4. Fate of water discharged to onsite wastewater treatment systems.



Source: Adapted from Venhuizen, 1995.

Table 1-3. Estimated onsite treatment system failure rates in surveyed states

State	Estimated system failure rate (percentage)	Failure definition
Alabama	20	Not given
Arizona	0.5	Surfacing, backup, surface or ground water contamination
California	1–4	Surfacing, backup, surface or ground water contamination
Florida	1–2	Surfacing, backup, surface or ground water contamination
Georgia	1.7	Public hazard
Hawaii	15–35	Improper construction, overflow
Idaho	20	Backup, surface or ground water contamination
Kansas	10–15	Surfacing, nuisance conditions (for installations after 1980)
Louisiana	50	Not given
Maryland	1	Surfacing, surface or ground water contamination
Massachusetts	25	Public health
Minnesota	50–70	Cesspool, surfacing, inadequate soil layer, leaking
Missouri	30–50	Backup, surface or ground water contamination
Nebraska	40	Nonconforming system, water quality
New Hampshire	<5	Surfacing, backup
New Mexico	20	Surfacing
New York	4	Backup, surface or ground water contamination
North Carolina	15–20	Not given
North Dakota	28	Backup, surfacing
Ohio	25–30	Backup, surfacing
Oklahoma	5–10	Backup, surfacing, discharge off property
Rhode Island	25	Not given
South Carolina	6–7	Backup, surface or ground water contamination
Texas	10–15	Surfacing, surface or ground water contamination
Utah	0.5	Surfacing, backup, exceed discharge standards
Washington	33	Public health hazard
West Virginia	60	Backup, surface or ground water contamination
Wyoming	0.4	Backup, surfacing, ground water contamination

* Failure rates are estimated and vary with the definition of failure.

Source: Nelson et al., 1999.

maintaining their relatively simple, gravity-based systems. Performance results under this approach can vary significantly, with operation and maintenance functions driven mostly by complaints or failures. In fact, many conventional system failures have been linked to operation and maintenance failures. Typical causes of failure include unpumped and sludge-filled tanks, which result in clogged absorption fields, and hydraulic overloading caused by increased occupancy and greater water use following the installation of new water lines to replace wells and cisterns. Full-time or high use of vacation homes served by systems installed under outdated practices or designed for part-time occupancy can cause water quality problems in lakes, coastal bays, and estuaries. Landscape modification, alteration of the infiltration field surface, or the use of outdated technologies like drywells and cesspools can also cause contamination problems.

Newer or "alternative" onsite treatment technologies are more complex than conventional systems and incorporate pumps, recirculation piping, aeration, and other features (e.g., greater generation of residuals) that require ongoing or periodic monitoring and maintenance. However, the current management programs of most jurisdictions do not typically oversee routine operation and maintenance activities or detect and respond to changes in wastewater loads that can overwhelm a system. In addition, in many cases onsite system planning and siting functions are not linked to larger ground water and watershed protection programs. The challenge for onsite treatment regulators in the new millennium will be to improve traditional health-based programs for ground water and surface water protection while embracing a vigorous role in protecting and restoring the nation's watersheds.

The challenge is significant. Shortcomings in many management programs have resulted in poor system performance, public health threats, degradation of surface and ground waters, property value declines, and negative public perceptions of onsite treatment as an effective wastewater management option. (See examples in section 1.1.) USEPA (1987) has identified a number of critical problems associated with programs that lack a comprehensive management program:

- Failure to adequately consider site-specific environmental conditions.
- Codes that thwart adaptation to difficult local site conditions and are unable to accommodate effective innovative and alternative technologies.
- Ineffective or nonexistent public education and training programs.
- Failure to include conservation and potential reuse of water.
- Ineffective controls on operation and maintenance of systems, including residuals (septage, sludge).
- Failure to consider the special characteristics and requirements of commercial, industrial, and large residential systems.
- Weak compliance and enforcement programs.
- These problems can be grouped into three primary areas: (1) insufficient funding and public involvement; (2) inappropriate system design and selection processes; and (3) poor inspection, monitoring, and program evaluation components. Management programs that do not address these problems can directly and indirectly contribute to significant human health risks and environmental degradation.

1.5.1 Public involvement and education

Public involvement and education are critical to successful onsite wastewater management. Engaging the public in wastewater treatment issues helps build support for funding, regulatory initiatives, and other elements of a comprehensive program. Educational activities directed at increasing general awareness and knowledge of onsite management efforts can improve the probability that simple, routine operation and maintenance tasks (e.g., inspecting for pooled effluent, pumping the tank) are carried out by system owners. Specialized training is required for system managers responsible for operating and maintaining systems with more complex components. Even conventional, gravity-based systems require routine pumping, monitoring, and periodic inspection of sludge and scum buildup in septic tanks. Failing systems can cause public health risks and environmental damage and are expensive to repair. System owners should be made aware of the need for periodically removing tank sludge, maintaining system components, and operating systems within their design limitations to help maximize treatment effectiveness and extend the life of the systems.

Information regarding regular inspections, pumping, ground water threats from chemicals, hydraulic overloading from roof runoff or other clear water sources, pollutant loads from garbage disposal units, drain field protection, and warning signs of failing systems can be easily communicated. Flyers, brochures, posters, news media articles, and other materials have proven effective in raising awareness and increasing public knowledge of onsite wastewater management issues (see Resources section). Meetings with stakeholders and elected officials and face-to-face training programs for homeowners can produce better results when actions to strengthen programs are required (USEPA, 1994). Public involvement and education programs are often overlooked because they require resources, careful planning, and management and can be labor-intensive. However, these efforts can pay rich dividends in building support for the management agency and improving system performance. Public education and periodic public input are also needed to obtain support for developing and funding a wastewater utility or other comprehensive management program (see chapter 2).

1.5.2 Financial support

Funding is essential for successful management of onsite systems. Adequate staff is required to implement the components of the program and objectively enforce the regulations. Without money to pay for planning, inspection, and enforcement staff, these activities will not normally be properly implemented. Financial programs might be needed to provide loans or cost-share grants to retrofit or replace failing systems. Statewide public financing programs for onsite systems like the PENNVEST initiative in Pennsylvania provide a powerful incentive for upgrading inadequate or failed systems (Pennsylvania Infrastructure Investment Authority, 1997). Regional cost-share programs like the Triplett Creek Project in Kentucky, which provided funding for new septic tanks and drain field repairs, are also effective approaches for addressing failed systems (USEPA, 1997). Chapter 2 and the Resources section provide more information on funding options for onsite systems and management programs.

Managing onsite systems is particularly challenging in small, unincorporated communities without paid staff. Programs staffed by trained volunteers and regional "circuit riders" can help deliver technical expertise at a low cost in these situations. Developing a program uniquely tailored to each community requires partnerships, ingenuity, commitment, and perseverance.

1.5.3 Support from elected officials

In most cases the absence of a viable oversight program that addresses the full range of planning, design, siting, permitting, installation, operation, maintenance, and monitoring activities is the main reason for inadequate onsite wastewater system management. This absence can be attributed to a number of factors, particularly a political climate in which the value of effective onsite wastewater management is dismissed as hindering economic development or being too restrictive on rural housing development. In addition, low population densities, low incomes, underdeveloped management entities, a history of neglect, or other unique factors can impede the development of comprehensive management programs. Focusing on the public health and water resource impacts associated with onsite systems provides an important perspective for public policy discussions on these issues.

Sometimes state and local laws prevent siting or design options that could provide treatment and recycling of wastewater from onsite systems. For example, some state land use laws prohibit using lands designated as resource lands to aid in the development of urban uses. Small communities or rural developments located near state resource lands are unable to use those lands to address onsite problems related to space restrictions, soil limitations, or other factors (Fogarty, 2000).

The most arbitrary siting requirement, however, is the minimum lot size restriction incorporated into

Note: This manual is not intended to be used to determine appropriate or inappropriate uses of land. The information the manual presents is intended to be used to select appropriate technologies and management strategies that minimize risks to human health and water resources in areas that are not connected to centralized wastewater collection and treatment systems.

many state and local codes. Lot size limits prohibit onsite treatment system installations on nonconforming lots without regard to the performance capabilities of the proposed system. Lot size restrictions also serve as an inappropriate but de facto approach to land use planning in many localities because they are often seen as establishing the allowable number of housing units in a development without regard to other factors that might increase or decrease that number.

When developing a program or regulation, the common tendency is to draw on experience from other areas and modify existing management plans or codes to meet local needs. However, programs that are successful in one area of the country might be inappropriate in other areas because of differences in economic conditions, environmental factors, and public agency structures and objectives. Transplanting programs or program components without considering local conditions can result in incompatibilities and a general lack of effectiveness. Although drawing on the experience of others can save time and money, local planners and health officials need to make sure that the programs and regulations are appropriately tailored to local conditions.

Successful programs have site evaluation, inspection, and monitoring processes to ensure that regulations are followed. Programs that have poor inspection and monitoring components usually experience low compliance rates, frequent complaints, and unacceptable performance results. For example, some states do not have minimum standards applicable to the various types of onsite systems being installed or do not require licensing of installers (Suhrer, 2000). Standards and enforcement practices vary widely among the states, and until recently there has been little training for local officials, designers, or installers.

USEPA has identified more effective management of onsite systems as a key challenge for efforts to improve system performance (USEPA, 1997). In its *Response to Congress on Use of Decentralized Wastewater Treatment Systems,* USEPA noted that "adequately managed decentralized wastewater treatment systems can be a cost-effective and long-term option for meeting public health and water quality goals, particularly for small towns and rural areas."

In addition, the Agency found that properly managed onsite systems protect public health and water quality, lower capital and maintenance costs for low-density communities, are appropriate for varying site conditions, and are suitable for ecologically sensitive areas (USEPA, 1997). However, USEPA identified several barriers to the increased use of onsite systems, including the lack of adequate management programs. Although most communities have some form of management program in place, there is a critical lack of consistency. Many management programs are inadequate, underdeveloped, or too narrow in focus, and they might hinder widespread public acceptance of onsite systems as viable treatment options or fail to protect health and water resources.

1.6 Performance-based management of onsite wastewater treatment systems

Performance-based management approaches have been proposed as a substitute for prescriptive requirements for system design, siting, and operation. In theory, such approaches appear to be both irresistibly simple and inherently logical. In practice, however, it is often difficult to certify the performance of various treatment technologies under the wide range of climates, site conditions, hydraulic loads, and pollutant outputs they are subjected to and to predict the transport and fate of those pollutants in the environment. Despite these difficulties, research and demonstration projects conducted by USEPA, the National Small Flows Clearinghouse, the National Capacity Development Project, private consultants and engineering firms, academic institutions, professional associations, and public agencies have collectively assembled a body of knowledge that can provide a framework for developing performance-based programs. Performance ranges for many alternative systems operating under a given set of climatic, hydrological, site, and wastewater load conditions have been established. The site evaluation process is becoming more refined and comprehensive (see chapter 5) and has moved from simple percolation tests to a more comprehensive analysis of soils, restrictive horizons, seasonal water tables, and other factors. New technologies that incorporate lightweight media, recirculation of effluent, or disinfection processes have been developed based on performance.

A performance-based management program makes use of recent developments to select and size system technologies appropriate for the estimated flow and strength of the wastewater at the site where treatment is to occur. For sites with appropriate soils, ground water characteristics, slopes, and other features, systems with subsurface wastewater infiltration systems (SWISs) might be the best option. Sites with inadequate soils, high seasonal water tables, or other restrictions require alternative approaches that can achieve performance objectives despite restrictive site features. Selecting proven system designs that are sized to treat the expected wastewater load is the key to this approach. Installing unproven technologies on provisional sites is risky even if performance monitoring is to be conducted because monitoring is often expensive and sometimes inconclusive.

1.6.1 Prescriptive management programs

Onsite system management has traditionally been based on prescriptive requirements for system design, siting, and installation. Installation of a system that "complies" with codes is a primary goal. Most jurisdictions specify the type of system that must be installed and the types and depth of soils that must be present. They also require mandatory setbacks from seasonally high water tables, property lines, wells, surface waters, and other landscape features. Some of these requirements (e.g., minimum setback distances from streams and reservoirs) are arbitrary and vary widely among the states (Curry, 1998). The prescriptive approach has worked well in some localities but has severely restricted development options in many areas. For example, many regions do not have appropriate soils, ground water tables, slopes, or other attributes necessary for installation of conventional onsite systems. In Florida, 74 percent of the soils have severe or very severe limitations for conventional system designs, based on USDA Natural Resources Conservation Service criteria (Florida HRS, 1993).

1.6.2 Hybrid management programs

Some jurisdictions are experimenting with performance-based approaches while retaining prescriptive requirements for technologies that have proven effective under a known range of site conditions. These prescriptive/performance-based or "hybrid" programs represent a practical approach to onsite system management by prescribing specific sets of technologies or proprietary systems for sites where they have proven to be effective and appropriate. Regulatory entities review and evaluate alternative systems to see if they are appropriate for the site and the wastewater to be treated. Performance-based approaches depend heavily on data from research, wastewater characterization processes, site evaluations, installation practices, and expected operation and maintenance activities, and careful monitoring of system performance is strongly recommended. Programs that allow or encourage a performance-based approach must have a strong management program to ensure that preinstallation research and design and postinstallation operation, maintenance, and monitoring activities are conducted appropriately.

Representatives from government and industry are supporting further development of management programs that can adequately oversee the full range of OWTS activities, especially operation and maintenance. The National Onsite Wastewater Recycling Association (NOWRA) was founded in 1992 to promote policies that improve the market for onsite wastewater treatment and reuse products. NOWRA has developed a model framework for onsite system management that is based on performance rather than prescriptive regulations. The framework endorses the adoption and use of alternative technologies that achieve public health and environmental protection objectives through innovative technologies and comprehensive program management. (NOWRA, 1999)

1.7 Coordinating onsite system management with watershed protection efforts

During the past decade, public and private entities involved in protecting and restoring water resources have increasingly embraced a watershed approach to assessment, planning, and management. Under this approach, all the land uses and other activities and attributes of each drainage basin or ground water recharge zone are considered when conducting monitoring, assessment, problem targeting, and remediation activities (see figure 1-5). A watershed

approach incorporates a geographic focus, scientific principles, and stakeholder partnerships.

Because onsite systems can have significant impacts on water resources, onsite/decentralized wastewater management agencies are becoming more involved in the watershed protection programs that have developed in their regions. Coordinating onsite wastewater management activities with programs and projects conducted under a watershed approach greatly enhances overall land use planning and development processes. A cooperative, coordinated approach to protecting health and water resources can achieve results that are greater than the sum of the individual efforts of each partnering entity. Onsite wastewater management agencies are important components of watershed partnerships, and their involvement in these efforts provides mutual benefits, operating efficiencies, and public education opportunities that can be difficult for agencies to achieve individually.

1.8 USEPA initiatives to improve onsite system treatment and management

In 1996 Congress requested USEPA to report on the potential benefits of onsite/decentralized wastewater treatment and management systems, the potential costs or savings associated with such systems, and the ability and plans of the Agency to implement additional alternative wastewater system measures within the current regulatory and statutory regime. A year later USEPA reported that properly managed onsite/decentralized systems offer several advantages over centralized wastewater treatment facilities (USEPA, 1997; see **http://www.epa.gov/owm/decent/response/index.htm**). The construction and maintenance costs of onsite/decentralized systems can be significantly lower, especially in low-density residential areas, making them an attractive alternative for small towns, suburban developments, remote school and institutional facilities, and rural regions. Onsite/decentralized wastewater treatment systems also avoid potentially large transfers of water from one watershed to another via centralized collection and treatment (USEPA, 1997).

USEPA reported that both centralized and onsite/decentralized systems need to be considered when upgrading failing systems. The report concluded that onsite/decentralized systems can protect public health and the environment and can lower capital and maintenance costs in low-density communities. They are also appropriate for a variety of site conditions and can be suitable for ecologically sensitive areas (USEPA, 1997). However, the Agency also cited several barriers to implementing more effective onsite wastewater management programs, including the following:

- Lack of knowledge and public misperceptions that centralized sewage treatment plants perform better, protect property values, and are more acceptable than decentralized treatment systems.
- Legislative and regulatory constraints and prescriptive requirements that discourage local jurisdictions from developing or implementing effective management and oversight functions.

Model framework for onsite wastewater management

- ✔ Performance requirements that protect human health and the enviro ment
- ✔ System management to maintain performance within the established performa ce requirements.
- ✔ Compliance monitoring and enforcement to ensure system performance is achieved and maintained.
- ✔ Technical guidelines for site evaluation, design, construction, and operation and acceptable prescriptive design for specific site conditions and use.
- ✔ Education/training f a ctitioners, planners, and owners.
- ✔ Certification/licensing for all practitioners to maintain standards of competence and conduct
- ✔ Program reviews to identify knowledge gaps, implementatio shortcomings, and necessary corrective actions.

Source: NOWRA, 1999.

Splitting of regulatory authority, which limits the evaluation of alternatives, and a lack of management programs that consolidate planning, siting, design, installation, and maintenance activities under a single entity with the resources and authority to ensure that performance requirements are met and performance is maintained.

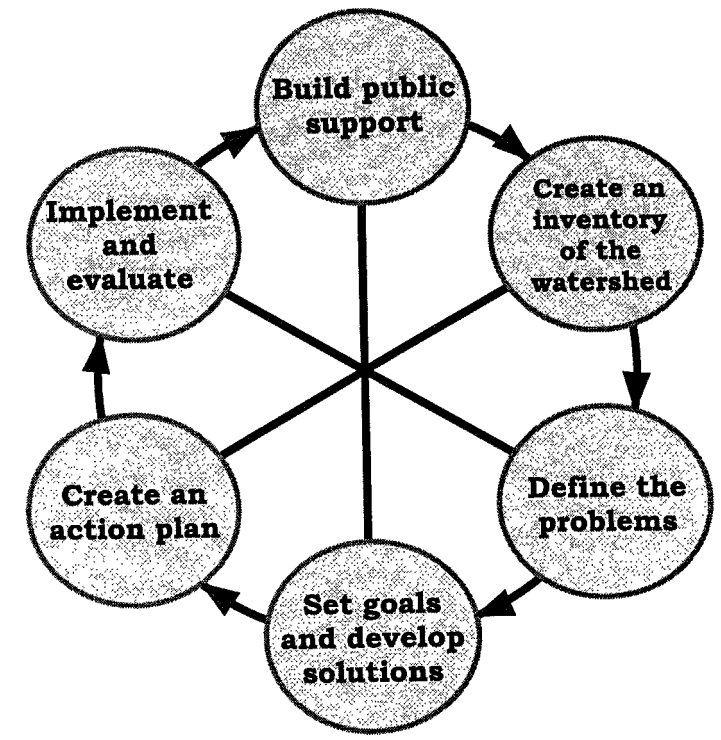
Liability laws that discourage innovation, as well as cost-based engineering fees that discourage investment in designing innovative, effective, low-cost systems.

Grant guidelines, loan priorities, and other financial or institutional barriers that prevent rural communities from accessing funds, considering alternative wastewater treatment approaches, or creating management entities that span the jurisdictions of multiple agencies.

USEPA is committed to elevating the standards of onsite wastewater management practice and removing barriers that preclude widespread acceptance of onsite treatment technologies. In addition, the Agency is responding to calls to reduce other barriers to onsite treatment by improving access to federal funding programs, providing performance information on alternative onsite wastewater treatment technologies through the Environmental Technology Verification program (see **http://www.epa.gov/etv/**) and other programs, partnering with other agencies to reduce funding barriers, and providing guidance through cooperation with other public agencies and private organizations. USEPA supports a number of efforts to improve onsite treatment technology design, application, and funding nationwide. For example, the National Onsite Demonstration Project (NODP), funded by USEPA and managed by the National Small Flows Clearinghouse at West Virginia University, was established in 1993 to encourage the use of alternative, decentralized wastewater treatment technologies to protect public health and the environment in small and rural communities (see **http://www.nesc.wvu.edu**).

In addition, USEPA is studying ground water impacts caused by large-capacity septic systems, which might be regulated under the Class V Underground Injection Control (UIC) program. Large-capacity septic systems serve multiple dwellings, business establishments, and other facilities and are used to dispose of sanitary and other wastes through

Figure 1-5. The watershed approach planning and management cycle

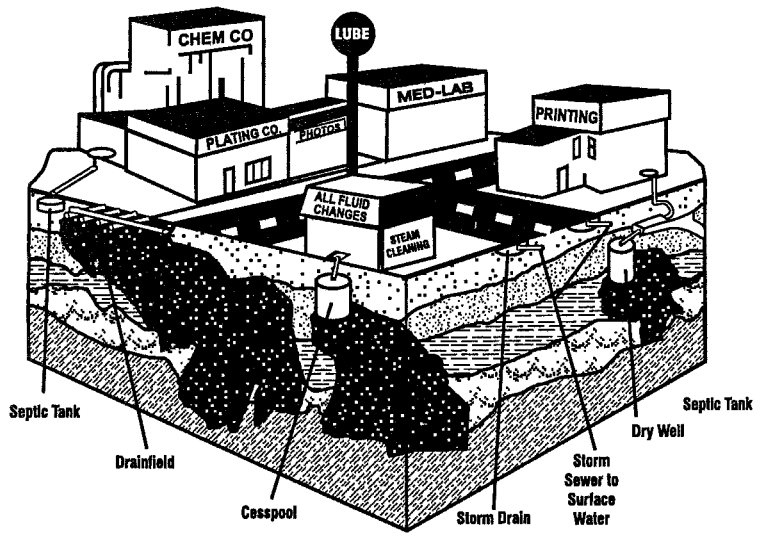


Source: Ohio EPA, 1997.

subsurface application (figure 1-6). Domestic and most commercial systems serving fewer than 20 persons are not included in the UIC program (see **http://www.epa.gov/safewater/uic/classv.html** for exceptions and limitations), but some commercial facilities serving fewer than 20 people may be regulated. States and tribes with delegated authority are studying possible guidance and other programs that reduce water resource impacts from these systems. USEPA estimates that there are more than 350,000 large-capacity septic systems nationwide.

USEPA also oversees the management and reuse or disposal of septic tank residuals and septage through the Part 503 Rule of the federal Clean Water Act. The Part 503 Rule (see **http://www.epa.gov/ owm/bio/503pe/**) established requirements for the final use or disposal of sewage sludge when it is applied to land to condition the soil or fertilize crops or other vegetation, deposited at a surface disposal site for final disposal, or fired in a biosolids incinerator. The rule also specifies other requirements for sludge that is placed in a municipal solid waste landfill under Title 40 of the Code of Federal Regulations (CFR), Part 258. The Part 503 Rule is designed to protect public health

Figure 1-6. Large-capacity septic tanks and other subsurface discharges subject to regulation under the Underground Injection Control Program and other programs



and the environment from any reasonably anticipated adverse effects of certain pollutants and contaminants that might be present in sewage sludge, and it is consistent with USEPA's policy of promoting the beneficial uses of biosolids.

USEPA has also issued guidance for protecting wellhead recharge areas and assessing threats to drinking water sources under the 1996 amendments to the Safe Drinking Water Act (see **http://www.epa.gov/safewater/protect.html** and **http://www.epa.gov/safewater/whpnp.html**). State source water assessment programs differ because they are tailored to each state's water resources and drinking water priorities. However, each assessment must include four major elements:

- Delineating (or mapping) the source water assessment area
- Conducting an inventory of potential sources of contamination in the delineated area
- Determining the susceptibility of the water supply to those contamination sources
- Releasing the results of the determinations to the public

Local communities can use the information collected in the assessments to develop plans to protect wellhead recharge areas and surface water used as drinking water sources. These plans can include local or regional actions to reduce risks associated with potential contaminant sources, prohibit certain high-risk contaminants or activities in the source water protection area, or specify other management measures to reduce the likelihood of source water contamination. Improving the performance and management of onsite treatment systems can be an important component of wellhead and source water protection plans in areas where nitrate contamination, nutrient inputs, or microbial contaminants are identified as potential risks to drinking water sources.

Integrating public and private entities with watershed management

In 1991 the Keuka Lake Association established a watershed project to address nutrient, pathogen, and other pollutant loadings to the upstate New York lake, which provides drinking water for more than 20,000 people and borders eight municipalities and two counties. The project sought to assess watershed conditions, educate the public on the need for action, and foster interjurisdictional cooperation to address identified problems. The project team established the Keuka Watershed Improvement Cooperative as an oversight committee composed of elected officials from the municipalities and counties. The group developed an 8-page intermunicipal agreement under the state home rule provisions (which allow municipalities to do anything collectively that they may do individually) to formalize the cooperative and recommend new laws and policies for onsite systems and other pollutant sources.

Voters in each municipality approved the agreement by landslide margins after an extensive public outreach program. The cooperative developed regulations governing onsite system permitting, design standards, inspection, and enforcement. The regulations carry the force of law in each town or village court and stipulate that failures must be cited and upgrades required. Inspections are required every 5 years for systems within 200 feet of the lake, and alternative systems must be inspected annually. The cooperative coordinates its activities with state and county health agencies and maintains a geographic information system (GIS) database to track environmental variables and the performance of new technologies. The program is financed by onsite system permit fees, some grant funds, and appropriations from each municipality's annual budget.

Source: Shephard, 1996.

1.9 Other initiatives to assist and improve onsite management efforts

Financing the installation and management of onsite systems can present a significant barrier for homeowners and small communities. USEPA and other agencies have developed loan, cost-share, and other programs to help homeowners pay for new systems, repairs, or upgrades (see chapter 2). Some of the major initiatives are the Clean Water State Revolving Fund (CWSRF), the Hardship Grant Program, the Nonpoint Source Pollution Program, USDA Rural Development programs, and the Community Development Block Grant (CDBG) program.

The ***CWSRF*** is a low-interest or no-interest loan program that has traditionally financed centralized, publicly owned treatment works across the nation (see **http://www.epa.gov/owm/finan.htm**). The program guidance, issued in 1997, emphasizes that the fund can be used as a source of support for the installation, repair, or upgrading of OWTSs in small-town, rural, and suburban areas. The CWSRF programs are administered by states and the territory of Puerto Rico and operate like banks. Federal and state contributions are used to capitalize the fund, which makes low- or no-interest loans for important water quality projects. Funds are then repaid to the CWSRFs over terms as long as 20 years. Repaid funds are recycled to support other water quality projects. Projects that might be eligible for CWSRF funding include new system installations and replacement or modification of existing systems. Also covered are costs associated with establishing a management entity to oversee onsite systems in a region, including capital outlays (e.g., for pumper trucks or storage buildings). Approved management entities include city and county governments, special districts, public or private utilities, and private for profit or nonprofit corporations.

The ***Hardship Grant Program*** of the CWSRF was developed in 1997 to provide additional resources for improving onsite treatment in low-income regions experiencing persistent problems with onsite treatment because of financial barriers. The new guidance and the grant program responded to priorities outlined in the Safe Drinking Water Act Amendments of 1996 and the Clean Water Action Plan, which was issued in 1998.

The ***Nonpoint Source Pollution Program*** provides funding and technical support to address a wide range of polluted runoff problems, including contamination from onsite systems. Authorized under section 319 of the federal Clean Water Act and financed by federal, state, and local contributions, the program provides cost-share funding for individual and community systems and supports broader watershed assessment, planning, and management activities. Demonstration projects funded in the past have included direct cost-share for onsite system repairs and upgrades, assessment of watershed-scale onsite wastewater contributions to polluted runoff, regional remediation strategy development, and a wide range of other projects dealing with onsite wastewater issues. (See **http://www.epa.gov/OWOW/NPS** for more information.)

The USEPA ***Office of Wastewater Management*** supports several programs and initiatives related to onsite treatment systems, including development of guidelines for managing onsite and cluster systems (see **http://www.epa.gov/own/bio.htm**). The disposition of biosolids and septage pumped from septic tanks is also subject to regulation by state and local governments (see chapter 4).

The ***U.S. Department of Agriculture*** provides grant and loan funding for onsite system installations through USDA ***Rural Development*** programs. The Rural Housing Service program (see **http://www.rurdev.usda.gov/rhs/Individual/ind_splash.htm**) provides direct loans, loan guarantees, and grants to low or moderate-income individuals to finance improvements needed to make their homes safe and sanitary. The Rural Utilities Service (**http:www.usda.gov/rus/water/programs.htm**) provides loans or grants to public agencies, tribes, and nonprofit corporations seeking to develop water and waste disposal services or decrease their cost.

The ***U.S. Department of Housing and Urban Development*** (HUD) operates the ***Community Development Block Grant Program***, which provides annual grants to 48 states and Puerto Rico. The states and Puerto Rico use the funds to award grants for community development to small cities

and counties. CDBG grants can be used for numerous activities, including rehabilitation of residential and nonresidential structures, construction of public facilities, and improvements to water and sewer facilities, including onsite systems. USEPA is working with HUD to improve system owners' access to CDBG funds by raising program awareness, reducing paperwork burdens, and increasing promotional activities in eligible areas. (More information is available at **http://www.hud.gov/cpd/cdbg.html**.)

The ***Centers for Disease Control and Prevention*** (CDC) of the U.S. Public Health Service (see **http://www.cdc.gov**) conduct research and publish studies on waterborne infectious disease outbreaks and illness linked to nitrate contamination of ground water, both of which have been linked to OWTSs, among other causes. Disease outbreaks associated with contaminated, untreated ground water and recreational contact with water contaminated by pathogenic organisms are routinely reported to the CDC through state and tribal infectious disease surveillance programs.

Individual ***Tribal Governments*** and the ***Indian Health Service*** (IHS) handle Indian wastewater management programs. The IHS ***Sanitation Facilities Construction Program***, within the Division of Facilities and Environmental Engineering of the Office of Public Health, is supported by engineers, sanitarians, technicians, clerical staff, and skilled construction workers. Projects are coordinated through the headquarters office in Rockville, Maryland, and implemented through 12 area offices across the nation. The program works cooperatively with tribes and tribal organizations, USEPA, HUD, the USDA's Rural Utilities Service, and other agencies to fund sanitation and other services throughout Indian Country (see **http://www.ihs.gov/nonmedicalprograms/dfee/reports/rpt1998.pdf**).

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Chapter 2: Management of Onsite Wastewater Treatment Systems

2.1 Introduction
2.2 Elements of a successful program
2.3 Types of management entities
2.4 Management program components
2.5 Financial assistance for management programs and system installation

2.1 Introduction

Effective management is the key to ensuring that the requisite level of environmental and public health protection for any given community is achieved. It is the single most important factor in any comprehensive wastewater management program. Without effective management, even the most costly and advanced technologies will not be able to meet the goals of the community. Numerous technologies are currently available to meet a broad range of wastewater treatment needs. Without proper management, however, these treatment technologies will fail to perform as designed and efforts to protect public health and the environment will be compromised.

> In recognition of the need for a comprehensive management framework that communities can use in developing and improving OWTS management programs, USEPA is publishing *Guidelines for Management of Decentralized Wastewater Systems* (see **http://www.epa.gov/owm/decent/index.htm**). At the time of the publication of this manual, the final guidelines and accompanying guidance manual are almost complete. USEPA envisions that tribes, states, local governments, and community groups will use the management guidelines as a reference to strengthen their existing onsite/decentralized programs. The guidelines include a set of recommended program elements and activities and model programs that OWTS program managers can refer to in evaluating their management programs.

The literature on OWTSs is replete with case studies showing that adequate management is critical to ensuring that OWTSs are sited, designed, installed, and operated properly. As USEPA pointed out in its *Response to Congress on Use of Decentralized Wastewater Treatment Systems* (1997), "Few communities have developed organizational structures for managing decentralized wastewater systems, although such programs are required for centralized wastewater facilities and for other services (e.g., electric, telephone, water, etc)."

Good planning and management are inseparable. The capacity of the community to manage any given technology should be factored into the decision-making process leading to the planning and selection of a system or set of systems appropriate for the community. As Kreissl and Otis noted in *New Markets for Your Municipal Wastewater Services: Looking Beyond the Boundaries* (1999), appropriate technologies should be selected based on whether they are affordable, operable, and reliable. The selection of individual unit processes and systems should, at a minimum, be based on those three factors. Although managing OWTSs is obviously far more complicated than assessing whether the systems are affordable, operable and reliable, an initial screening using these criteria is a critical element of good planning.

Historically, the selection and siting of OWTSs has been an inconsistent process. Conventional septic tank and leach field systems were installed based on economic factors, the availability of adequate land area, and simple health-based measures aimed only at preventing direct public contact with untreated wastewater. Little analysis was devoted to understanding the dynamics of OWTSs and the potential impacts on ground water and surface waters. Only recently has there been an understanding of the issues and potential problems associated with

failing to manage OWTSs in a comprehensive, holistic manner.

Many case studies and reports from across the country provide documentation that a significant number of OWTSs lack adequate management oversight, which results in inadequate pollutant treatment (USEPA, 2000). The lack of system inventories in many communities makes the task of system management even more challenging.

As a result of the perception that onsite/decentralized systems are inferior, old-fashioned, less technologically advanced, and not as safe as centralized wastewater treatment systems from both an environmental and public health perspective, many communities have pursued the construction of centralized systems (collection systems and sewage treatment plants). Centralized wastewater collection and treatment systems, however, are not the most cost-effective or environmentally sound option for all situations (e.g., sewage treatment plants can discharge high point source loadings of pollutants into receiving waters). They are costly to build and operate and are often infeasible or cost-prohibitive, especially in areas with low populations and dispersed households. Many communities lack both the revenue to fund these facilities and the expertise to manage the treatment operations. In addition, centralized treatment systems can contribute to unpredicted growth and development that might threaten water quality.

As development patterns change and increased development occurs in rural areas and on the urban fringe, many communities are evaluating whether they should invest in centralized sewage treatment plants or continue to rely on OWTSs. The availability of innovative and alternative onsite technologies and accompanying management strategies now provides small communities with a practical, cost-effective alternative to centralized treatment plants. For example, analysis included in USEPA's *Response to Congress on Use of Decentralized Wastewater Treatment Systems* (1997) shows that the costs of purchasing and managing an OWTS or a set of individual systems can be significantly (22 to 80 percent) less than the cost of purchasing and managing a centralized system.

Regardless of whether a community selects more advanced decentralized systems, centralized systems, or some combination of the two, a comprehensive management program is essential. As USEPA noted in *Wastewater Treatment/Disposal for Small Communities* (1992), effective management strategies depend on carefully evaluating all feasible technical and management alternatives and selecting appropriate solutions based on the needs of the community, the treatment objectives, the economic capacity, and the political and legislative climate.

The management tasks listed have become increasingly complex, especially given the need to develop a management strategy based on changing priorities primarily driven by new development activities. Rapid urbanization and suburbanization, the presence of other sources that might discharge nutrients and pathogens, water reuse issues, increasingly stringent environmental regulations, and recognition of the need to manage on a watershed basis increase the difficulty of this task. Multiple objectives (e.g., attainment of water quality criteria, protection of ground water, efficient and affordable wastewater treatment) now must be achieved to reach the overarching goal of maintaining economically and ecologically sound communities. Investment by small communities in collection and treatment systems increases taxes and costs to consumers—costs that might be reduced substantially by using decentralized wastewater treatment systems. From a water resource perspective achieving these goals means that public health, contact recreation activities, fisheries, shellfisheries, drinking water resources, and wildlife need to be protected or restored. From a practical standpoint, achieving these goals requires that the management entity develop and implement a program that is consistent with the goal of simultaneously meeting and achieving the requirements of the Safe Drinking Water Act, the Clean Water Act, the Endangered Species Act, and other applicable federal, state, tribal, and local requirements.

Changing regulatory contexts point to scenarios in which system selection, design, and replacement will be determined by performance requirements tied to water quality standards or maximum contamination limits for ground water. Cumulative effects analyses and antidegradation policies may be used to determine the level of technology and management needed to meet the communities' resource management goals. Comprehensive coordinated management programs are needed to meet this challenge. These programs require interdisciplinary consultations among onsite system management entities, water quality agencies, land use planners, engineers, wildlife biologists, public health specialists, and others to ensure that these goals and objectives are efficiently achieved with a minimum of friction or program overlap.

Fortunately, there are solutions. Technologies that can provide higher levels of pollutant reduction than were practical in the past appear to be emerging. Better monitoring and assessment methods are now available to determine the effectiveness of specific technologies. Remote sensing is possible to help monitor and understand system operation, and more sophisticated inspection tools are available to complement visual septic tank/SWIS inspections.

2.2 Elements of a successful program

The success or failure of an onsite wastewater management program depends significantly on public acceptance and local political support; adequate funding; capable and trained technical and field staff; and clear and concise legal authority, regulations, and enforcement mechanisms (Ciotoli and Wiswall, 1982). Management programs should include the following critical elements:

- Clear and specific program goals
- Public education and outreach
- Technical guidelines for site evaluation, design, construction, and operation/maintenance
- Regular system inspections, maintenance, and monitoring
- Licensing or certification of all service providers
- Adequate legal authority, effective enforcement mechanisms, and compliance incentives
- Funding mechanisms
- Adequate record management
- Periodic program evaluations and revisions

Although all of these elements should be present in a successful management program, the responsibility for administering the various elements might fall on a number of agencies or entities. Regardless of the size or complexity of the program, its components must be *publicly accepted, politically feasible, fiscally viable, measurable,* and *enforceable.*

Many of the program elements discussed in this chapter are described in more detail in the other chapters of this manual. The elements described in detail in this chapter are those essential to the selection and adoption of a management program.

2.2.1 Clear and specific program goals

Developing and meeting program goals is critical to program success. Management programs typically focus on two goals—*protection of public health* and *protection of the environment.* Each onsite system must be sited, designed, and managed to achieve these goals.

Public health protection goals usually focus on preventing or severely limiting the discharge of pathogens, nutrients, and toxic chemicals to ground water. Surface water bodies, including rivers, lakes, streams, estuaries, and wetlands, can also be adversely affected by OWTSs. Program goals should be established to protect both surface and ground water resources.

Public participation opportunities during program planning and implementation

- Agreement on basic need for program
- Participation on committees, e.g., finance, technical, educational
- Selection of a consultant or expert (request for proposal, selection committee, etc.)
- Choosing the most appropriate options from the options identified by a consultant or expert
- Obtaining financing for the preferred option
- Identifying and solving legal questions and issues
- Providing input for the enforcement/compliance plan
- Implementation and construction

2.2.2 Public education and outreach

Public education

Public participation in and support for planning, design, construction, and operation and maintenance requirements are essential to the acceptance and success of an onsite wastewater management program. Public meetings involving state and local officials, property owners, and other interested parties are an effective way to garner support for the program. Public meetings should include discussions about existing OWTS problems and cover issues like program goals, costs, financing, inspection, and maintenance. Such meetings provide a forum for identifying community concerns and priorities so that they can be considered in the planning process. Public input is also important in determining management and compliance program structure, defining the boundaries of the program, and evaluating options, their relative requirements and impacts, and costs.

Public outreach

Educating homeowners about the proper operation and maintenance of their treatment systems is an essential program activity. In most cases, system owners or homeowners are responsible for some portion of system operation and maintenance or for ensuring that proper operation and maintenance occurs through some contractual agreement. The system owner also helps to monitor system performance. Increased public support and program effectiveness can be promoted by educating the public about the importance of OWTS management in protecting public health, surface waters, ground water resources, and property values.

Onsite system owners are often uninformed about how their systems function and the potential for ground water and surface water contamination from poorly functioning systems. Surveys show that many people have their septic tanks pumped only after the system backs up into their homes or yards. Responsible property owners who are educated in proper wastewater disposal and maintenance practices and understand the consequences of system failure are more likely to make an effort to ensure their systems are in compliance with operation and maintenance requirements. Educational materials for homeowners and training courses for designers, site evaluators, installers, inspectors, and operation/maintenance personnel can help reduce the impacts from onsite systems by reducing the number of failing systems, which potentially reduces or eliminates future costs for the system owner and the management program.

2.2.3 Technical guidelines for site evaluation, design, and construction

The regulatory authority (RA) should set technical guidelines and criteria to ensure effective and functioning onsite wastewater systems. Guidelines for site evaluation, system design, construction, operation/maintenance, and inspection are necessary to maintain performance consistency. Site evaluation guidelines should be used to determine the site's capability to accept the expected wastewater volume and quality. Guidelines and standards for system design ensure the system compatibility with the wastewater characteristics to be treated and its structural integrity over the life of the system. Construction standards should require that systems conform to the approved plan and use appropriate construction methods, materials, and equipment.

2.2.4 Regular system operation, maintenance, and monitoring

An OWTS should be operated and maintained to ensure that the system performs as designed for its service life. Both individual systems and sets of systems within a delineated management area should be monitored to ensure proper performance and the achievement of public health and environmental goals. A combination of visual, physical, bacteriological, chemical, and remote monitoring approaches can be used to assess system performance. Specific requirements for reporting to the appropriate regulatory agency should also be defined in a management program. The right to enter private property to access and inspect components of the onsite system is also an essential element of an effective management program.

2.2.5 Licensing or certification of service providers

Service providers include system designers, site evaluators, installers, operation/maintenance personnel, inspectors, and septage pumpers/haulers. A qualifications program that includes certification or licensing procedures for service providers should be incorporated into a management program. Licensing can be based on examinations that assess basic knowledge, skills, and experience necessary to perform services. Other components include requirements for continuing education, defined service protocols, and disciplinary guidelines or other mechanisms to ensure compliance and consistency. Many states already have, or are planning, certification programs for some service providers. These and other existing licensing arrangements should be incorporated when they complement the objectives of the management program.

2.2.6 Adequate legal authority, effective enforcement mechanisms, and compliance incentives

Onsite wastewater management programs need a combination of legal authorities, enforcement mechanisms, and incentives to ensure compliance and achievement of program goals. To ensure program effectiveness, some program mechanisms should be enforceable. Although the types of mechanisms management entities use will vary by program, the following mechanisms should be enforceable: construction and operating permits, requirements for performance bonds to ensure proper construction or system operation and maintenance, and licensing/certification requirements to ensure that service providers have the necessary skills to perform work on treatment systems. Management entities should also have the authority to carry out repairs or replace systems and, ultimately, to levy civil penalties. Enforcement programs, however, should not be based solely on fines if they are to be effective. Information stressing public health protection, the monetary benefits of a clean environment, and the continued functioning of existing systems (avoidance of system replacement costs) can provide additional incentives for compliance. Finally, it should be recognized that the population served by the management program must participate in and support the program to ensure sustainability.

2.2.7 Funding mechanisms

Funding is critical to the functioning of an effective OWTS management program. Management entities should ensure that there is adequate funding available to support program personnel, education and outreach activities, monitoring and evaluation, and incentives that promote system upgrades and replacement. Funding might also be needed for new technology demonstrations and other program enhancements.

2.2.8 Adequate record management

Keeping financial, physical, and operational records is an essential part of a management program. Accurate records of system location and type, operation and maintenance data, revenue generated, and compliance information are necessary to enhance the financial, operational, and regulatory health of the management program. Electronic databases, spreadsheets, and geographic information systems can help to ensure program effectiveness and appropriate targeting of program resources. At a minimum, program managers should maintain records of system permits, design, size, location, age, site soil conditions, complaints, inspection results, system repairs, and maintenance schedules. This information should be integrated with land use planning at a watershed or wellhead protection zone scale.

2.2.9 Periodic program evaluations and revisions

Management programs for onsite systems are dynamic. Changing community goals, resources, environmental and public health concerns, development patterns, and treatment system technologies require that program managers—with public involvement—regularly evaluate program effectiveness and efficiency. Program managers might need to alter management strategies because of suburban sprawl and the close proximity of centralized collection systems. Resource and staff limitations might also necessitate the use of service providers or designated management entities to

Twelve problems that can affect OWTS management programs

1. Failure to adequately consider site-specific environmental conditions (site evaluations)
2. Codes that thwart system selection or adaptation to difficult local site conditions and that do not allow the use of effective innovative or alternative technologies
3. Ineffective or nonexistent public education and training programs
4. Failure to include water conservation and reuse
5. Ineffective controls on operation and maintenance of systems
6. Lack of control over residuals management
7. Lack of OWTS program monitoring and evaluation, including OWTS inspection and monitoring
8. Failure to consider the special characteristics and requirements of commercial, industrial, and large residential systems
9. Weak compliance and enforcement programs
10. Lack of adequate funding
11. Lack of adequate legal authority
12. Lack of adequately trained and experienced personnel

Source: Adapted from USEPA, 1986.

ensure that systems in a jurisdiction are adequately managed.

2.3 Types of management entities

Developing, implementing, and sustaining a management program requires knowledge of the political, cultural, and economic context of the community, the current institutional structure, and available technologies. Also required are clearly defined environmental and public health goals and adequate funding. A management program should be based on the administrative, regulatory, and operational capacity of the management entity and the goals of the community. In many localities, partnerships with other entities in the management area (watershed, county, region, state, or tribal lands) are necessary to increase the capacity of the management program and ensure that treatment systems do not adversely affect human health or water resources. The main types of management entities are federal, state, and tribal agencies; local government agencies; special-purpose districts and public utilities; and privately owned and operated management entities. Descriptions of the various types of management entities are provided in the following subsections.

2.3.1 Federal, state, tribal, and local agencies

Federal, state, tribal, and local governments have varying degrees of authority and involvement in development and implementation of onsite wastewater management programs. In the United States tribal, state, and local governments are the main entities responsible for the promulgation and enforcement of OWTS-related laws and regulations. Many these entities provide financial and technical assistance. Tribal, state, and local authority determines degree of control these entities have in managing onsite systems. General approaches and responsibilities are shown in table 2-1.

At the federal level, USEPA is responsible for protecting water quality through the implementation of the Clean Water Act (CWA), the Safe Drinking Water Act (SDWA), and the Coastal Zone Act Reauthorization Amendments (CZARA). Under these statutes, USEPA administers a number of programs that affect onsite system management. The programs include the Water Quality Standards Program, the Total Maximum Daily Load Program, the Nonpoint Source Management Program, the National Pollutant Discharge Elimination System (NPDES) Program, the Underground Injection Control (UIC) Program, and the Source Water Protection Program. Under the CWA and

Table 2-1. Organizational approaches, responsibilities, and other considerations for managing onsite systems

	State Agency	County	Municipality	Special district	Improvement district	Public authority	Public nonprofit corporation	Private nonprofit corporation	Private for-profit corporation
Responsibilities	Enforcement of state laws and regulations	Enforcement of state codes, county ordinances	Enforcement of municipal ordinances; might enforce state/county codes	Powers defined; might include code enforcement (e.g., sanitation district)	State statutes define extent of authority	Fulfilling duties specified in enabling instrument	Role specified in articles of incorporation (e.g., homeowner association)	Role specified in articles of incorporation (e.g., homeowner association)	Role specified in articles of incorporation
Financing capabilities	Usually funded through appropriations and grants	Able to charge fees, assess property, levy taxes, issue bonds, appropriate general funds	Able to charge fees, assess property, levy taxes, issue bonds, appropriate general funds	Able to charge fees, assess property, levy taxes, issue bonds	Can apply special property assessments, user charges, other fees; can sell bonds	Can issue revenue bonds, charge user and other fees	Can charge fees, sell stock, issue bonds, accept grants/loans	Can charge user fees, accept grants/ loans	Can charge fees, sell stock, accept some grants/ loans
Advantages	Authority level and code enforceability are high; programs can be standardized; scale efficiencies	Authority level and code enforceability are high; programs can be tailored to local conditions	Authority level and code enforceability are high; programs can be tailored to local conditions	Flexible; renders equitable service (only those receiving services pay); simple and independent approach	Can extend public services without major expenditures; service recipients usually supportive	Can provide service when government unable to do so; autonomous, flexible	Can provide service when government unable to do so; autonomous, flexible	Can provide service when government unable to do so; autonomous, flexible	Can provide service when government unable to do so; autonomous, flexible
Disadvantages	Sometimes too remote; not sensitive to local needs and issues; often leaves enforcement up to local entities	Sometimes unwilling to provide service, conduct enforcement; debt limits could be restrictive	Might lack administrative, financial, other resources; enforcement might be lax	Can promote proliferation of local government, duplication/ fragmentation of public services	Contributes to fragmentation of government services; can result in administrative delays	Financing ability limited to revenue bonds; local government must cover debt	Local governments might be reluctant to apply this concept	Services could be of poor quality or could be terminated.	No enforcement powers; company might not be fiscally viable; not eligible for major grant/loan programs

Source: Ciotoli and Wiswall, 1982.

SDWA, USEPA has the authority to directly regulate specific categories of onsite systems under the UIC and NPDES programs. The CZARA section 6217 Coastal Nonpoint Source Program requires the National Oceanic and Atmospheric Administration (NOAA) and USEPA to review and approve upgraded state coastal nonpoint source programs to meet management measures for new and existing OWTSs. These measures address siting, designing, installing, maintaining, and protecting water quality. See chapter 1 for additional information and Internet web sites.

State and tribes might manage onsite systems through various agencies. Typically, a state or tribal public health office is responsible for managing onsite treatment systems. Regulation is sometimes centralized in one state or tribal government office and administered from a regional or local state office. In most states, onsite system management responsibilities are delegated to the county or municipal level. Where such delegation occurs, the state might exercise varying degrees of local program oversight.

Leadership and delegation of authority at the state level are important in setting technical, management, and performance requirements for local programs. In states where local governments are responsible for managing onsite systems, state authority often allows flexibility for local programs to set program requirements that are appropriate for local conditions and management structures as long as the local program provides equal or greater protection than that of state codes. Statewide consistency can be promoted by establishing

- Administrative, managerial, and technological requirements
- Performance requirements for natural resource and public health protection
- Requirements for monitoring and laboratory testing
- Education and training for service providers
- Technical, financial, and administrative support
- Periodic program reviews and evaluations
- Enforcement of applicable regulations

Many states set minimum system design and siting requirements for onsite systems and are actively involved in determining appropriate technologies. Other states delegate some or all of this authority to local governments. Some states retain the responsibility for the administrative or technical portions of the onsite management program; in these states, the local governments' primary role is to implement the state requirements.

2.3.2 Local government agencies

In many states, local governments have the responsibility for onsite wastewater program management. These local management programs are administered by a variety of municipal, county, or district-level agencies. The size, purpose, and authority of county, township, city, or village government units vary according to each state's statutes and laws. Depending on the size of the jurisdiction and the available resources, an onsite wastewater management program can be administered by a well-trained, fully staffed environmental or public health agency or by a board composed of local leaders. In some states, some or most of the responsibility for onsite system management is delegated by the legislature to local governments. In states with "home rule" provisions, local units of government have the authority to manage onsite systems without specific delegation by the state legislature. Some local home rule governments have the power to enter into multiple agency or jurisdictional agreements to jointly accomplish a home rule function without any special authority from the state (Shephard, 1996).

County governments can be responsible for a variety of activities regarding the management of onsite systems. A county can assume responsibility for specific activities, such as OWTS regulation within its jurisdiction, or it can supplement and support existing state, city, town, or village wastewater management programs with technical, financial, or administrative assistance. Counties provide these services through their normal operational mechanisms (e.g., a county department or agency), or they can establish a special district to provide designated services to a defined service area. County agency responsibilities might include

- Adoption of state minimal requirements or development of more stringent requirements
- Planning, zoning, and general oversight of proposed development
- Review of system designs, plans, and installation practices
- Permitting of systems and construction oversight
- Inspection, monitoring, and enforcement
- Reports to public and elected officials

Township, city, or village governments can be responsible for planning, permitting, and operating onsite wastewater facilities and enforcing applicable regulations. The precise roles and responsibilities of local governments depend on the preferences, capabilities, and circumstances of each jurisdiction. Because of the variability in state enabling legislation and organizational structures, the administrative capacity, jurisdiction, and authority of local entities to manage onsite wastewater systems vary considerably.

2.3.3 Special-purpose districts and public utilities

The formation of special-purpose districts and public utilities is usually enabled by state law to provide public services that local governments do not or cannot provide. A special-purpose district or public utility is a quasigovernmental entity established to provide specific services or to conduct activities specified by the enabling legislation. Special districts (e.g., sanitation districts) provide single or multiple services, such as managing planning and development activities, conducting economic development programs, improving local conditions, and operating drinking water and wastewater treatment facilities. The territory serviced by this entity is variable and can include a single community, a portion of a community, a group of communities, parts of several communities, an entire county, or a regional area. State enabling legislation usually outlines the authority, structure, and operational scope of the district, including service area, function, organizational structure, financial authority, and performance criteria.

Special-purpose districts and public utilities are usually given sufficient financial authority to apply for or access funds, impose service charges, collect fees, impose special assessments on property, and issue revenue or special assessment bonds. Some special-purpose districts have the same financing authority as municipalities, including the authority to levy taxes and incur general obligation debt. These districts are usually legal entities that might enter into contracts, sue, or be sued. There might be situations where eminent domain authority is needed to effectively plan and implement onsite programs. Special-purpose districts and public

Sanitation district management of onsite systems: New Mexico

Onsite systems in the community of Peña Blanca, New Mexico, are managed by the Peña Blanca Water and Sanitation District, which is organized under state statutes that require a petition signed by 25 percent of the registered voters and a public referendum before a district may be formed. Once formed, water and sanitation districts in New Mexico are considered subdivisions of the state and have the power to levy and collect *ad valorem* taxes and the right to issue general obligation and revenue bonds.

Residents and public agency officials in Peña Blanca sought to improve the management of systems in the community after a 1985 study found that 86 percent of existing systems required upgrades, repair, or replacement. The water and sanitation district was designated as the lead agency for managing OWTSs because it already provided domestic water service to the community and had an established administrative structure. The sanitation district relies on the New Mexico Environment Department to issue permits and monitor installation, while the district provides biannual pumping services through an outside contractor for a monthly fee of $10.64 for a 1,000-gallon tank. The district also supervises implementation of the community's onsite system ordinance, which prohibits untreated and unauthorized discharges, lists substances that might not be discharged into onsite systems (e.g., pesticides, heavy metals), and provides for sampling and testing. Penalties for noncompliance are set at $300 per violation and not more than 90 days imprisonment. Liens might be placed on property for nonpayment of pumping fees.

The program has been in operation since 1991 and serves nearly 200 homes and businesses. Septage pooling on ground surfaces, a problem identified in the 1985 study, has been eliminated.

Source: Rose, 1999.

utilities will most likely have to work closely with state or local authorities when program planning or implementation requires the use of this authority.

Special districts and public utilities can be an effective option for managing onsite systems. The special district and public utility models have been adopted successfully in many states. A good example is the creation of water districts and sanitation districts, which are authorized to manage and extend potable water lines and extend sewerage service in areas near centralized treatment plants. The development of onsite system management functions under the authority of existing sanitation districts provides support for planning, installation, operation, maintenance, inspection, enforcement, and financing of these programs. Traditional onsite management entities (e.g., health departments) can partner with sanitation or other special districts to build a well-integrated program. For example, a health department could retain its authority to approve system designs and issue permits while the sanitation district could assist with regional planning and conduct inspection, maintenance, and remediation/repair activities.

In some areas, special districts or public utilities have been created to handle a full range of management activities, from regional planning and system permitting to inspection and enforcement. In 1971 the City of Georgetown, California, developed and implemented a comprehensive, community-wide onsite management program in the Lake Auburn Trails subdivision (Shephard, 1996). The district does not own the onsite systems in the subdivision but is empowered by the state and county governments to set performance requirements, review and approve system designs, issue permits, oversee construction, access treatment system sites to conduct monitoring, and provide routine maintenance. The initial permit fees were approximately $550. Annual fees in 1995 were approximately $170 per dwelling and $80 for undeveloped lots (Shephard, 1996).

Onsite management districts or public utilities, whether wholly or partially responsible for system oversight, can help ensure that treatment systems are appropriate for the site and properly planned, designed, installed, and maintained. Typical goals for the management district or utility might include

- Providing appropriate wastewater collection/treatment service for every residence or busin
- Integrating wastewater management with land use and development policies
- Managing the wastewater treatment program a reasonable and equitable cost to users

Management districts and public utilities general are authorized to generate funds from a variety sources for routine operation and maintenance, inspections, upgrades, and monitoring and for future development. Sources of funds can inclu initial and renewable permit fees, monthly servi charges, property assessments, and special fees. Onsite wastewater management districts that are operated by or closely allied with drinking wate supply districts can coordinate collection of syst service charges with monthly drinking water bill in a manner similar to that used by centralized wastewater treatment plants. Although some hom owners might initially resist fees and other char that are necessary to pay for wastewater manag ment services, outreach information on the eff ciencies, cost savings, and other benefits of coo erative management (e.g., financial support fo system repair, upgrade, or replacement and no pumping and maintenance) can help to build support for comprehensive programs. Such sup is especially needed if a voter referendum is required to create the management entity. Whe creating a new district, public outreach and sta holder involvement should address the followi topics:

- Proposed boundaries of the management di
- Public health and natural resource protectio issues
- Problems encountered under the current ma agement system
- Performance requirements for treatment sy
- Onsite technologies appropriate for specific conditions
- Operation and maintenance requirements fo specific system types
- Septage treatment and sewage treatment p capacity to accept septage
- Cost estimates for management program nents
- Program cost and centralized system man ment cost comparisons
- Potential program partners and inventory of available resources
- Proposed funding source(s)
- Compliance and enforcement strategies
- Legal, regulatory, administrative, and managerial actions to create, develop, or establish the management entity

Another type of special district is the public authority. A public authority is a corporate body chartered by the state legislature with powers to own, finance, construct, and operate revenue-producing public facilities. A public authority can be used in a variety of ways to construct, finance, and operate public facilities, including OWTSs.

It should be noted that some state codes restrict or disallow a managed group of special districts from managing onsite systems. In other cases, clear legal authority for program staff to enter private property to perform inspections and correct problems has not been provided. These limitations can be addressed through special legislation authorizing the creation of entities with explicit onsite management responsibilities. Laws and regulations can also be changed to provide special districts the authority to manage onsite systems and to conduct inspection, maintenance, and remediation activities.

2.3.4 Privately owned and operated management entities

Private sector management entities are another option for ensuring OWTS are properly managed. These entities are often responsible for system design, installation, operation, and maintenance. In some cases, these private firms also serve as the sole management entity; for example, a firm might manage an onsite system program for a residential subdivision as a part of a public-private partnership. Several options exist for public/private partnerships in the management of onsite systems. OWTS management programs can contract with private firms to perform clearly defined tasks for which established protocols exist, such as site evaluation, installation, monitoring/inspection, or maintenance. An example of such an arrangement would be to contract with a licensed/certified provider, such as a trained septage pumper/hauler who could be responsible for system inspection, maintenance, and record keeping. Another example would be the case where treatment systems in residential subdivisions are serviced by a private entity and operated under a contract with the subdivision or neighborhood association.

Private for-profit corporations or utilities that manage onsite systems are often regulated by the state public utility commission to ensure continu-

Development company creates a service district in Colorado

The Crystal Lakes Development Company has been building a residential community 40 miles northwest of Fort Collins, Colorado, since 1969. In 1972 the company sponsored the creation of the Crystal Lakes Water and Sewer Association to provide drinking water and sewage treatment services. Membership in the association is required of all lot owners, who must also obtain a permit for onsite systems from the Larimer County Health Department. The association enforces county health covenants, aids property owners in the development of onsite water and wastewater treatment systems, monitors surface and ground water, and has developed guidelines for inspecting onsite water and wastewater systems. System inspections are conducted at the time of property transfer.

The association conducts preliminary site evaluations for proposed onsite systems, including inspection of a backhoe pit excavated by association staff with equipment owned by the association. The county health department has also authorized the association to design proposed systems. The association currently manages systems for more than 100 permanent dwellings and 600 seasonal residences. Management services are provided for all onsite systems in the development, including 300 holding tanks, 7 community vault toilets, recreational vehicle dump stations, and a cluster system that serves 25 homes on small lots and the development's lodge, restaurant, and office buildings. The association is financed by annual property owner dues of $90 to $180 and a $25 property transfer fee, which covers inspections.

Source: Mancl, 1999.

Responsibilities of a Comprehensive Onsite Wastewater Management Program

- Power to propose legislation and establish and enforce program rules and regulations
- Land use planning involvement, review and approval of system designs, permit issuance
- Construction and installation oversight
- Routine inspection and maintenance of all systems
- Management and regulation of septage handling and disposal
- Local water quality monitoring
- Administrative functions (e.g., bookkeeping, billing)
- Grant writing, fund raising, staffing, outreach
- Authority to set rates, collect fees, levy taxes, acquire debt, issue bonds, make purchases
- Authority to obtain easements for access to property, enforce regulations, require repairs
- Education, training, certification, and licensing programs for staff and contractors
- Record keeping and database maintenance

Source: NSFC, 1996.

ous, acceptable service at reasonable rates. Service agreements are usually required to ensure private organizations will be financially secure, provide adequate service, and be accountable to their customers. These entities can play a key role in relieving the administrative and financial burden on local government by providing system management services. It is likely that in the future private firms will build, own, and operate treatment systems and be subject only to responsible administrative oversight of the management entity.

2.3.5 Regulatory authorities and responsible management entities

Most regulatory authorities (e.g., public health departments and water quality authorities) lack adequate funding, staff, and technical expertise to develop and implement comprehensive onsite system management programs. Because of this lack of resources and trained personnel, program managers across the country are considering or implementing alternative management structures that delegate responsibility for specified management program elements to other entities. Hoover and Beardsley (2000) recommend that management entities develop alliances with public and private organizations to establish environmental quality goals, evaluate treatment system performance information, and promote activities that ensure onsite system management programs meet performance requirements.

English and Yeager (2001) have proposed the formation of responsible management entities (RMEs) to ensure the performance of onsite and other decentralized (cluster) wastewater treatment systems. RMEs are defined as legal entities that have the technical, managerial, and financial capacity to ensure viable, long-term, cost-effective centralized management, operation, and maintenance of all systems within the RME's jurisdiction. Viability is defined as the capacity of the RME to protect public health and the environment efficiently and effectively through programs that focus on system performance rather than adherence to prescriptive guidelines (English and Yeager). RMEs can operate as fully developed management programs under existing oversight programs (e.g., health departments, sanitation districts) in states with performance-based regulations, and they are usually defined as comprehensive management entities that have the managerial, technical, and financial capacity to ensure that proposed treatment system applications will indeed achieve clearly defined performance requirements. System technology performance information can be ranked on a continuum that gives greater weight to laboratory studies, peer-reviewed assessments, and third-party analysis of field applications. Under this approach, unsupported performance assertions by vendors and results from limited field studies

receive less emphasis in management entity evaluations of proposed treatment technologies (Hoover and Beardsley, 2001).

Management responsibilities can be assigned to an entity designated by the state or local government to manage some or all of the various elements of onsite wastewater programs. The assignment of management responsibilities to a comprehensive RME or to some less-comprehensive management entity (ME) appears to be a practical solution to the dilemma of obtaining adequate funding and staffing to ensure that critical management activities occur. The use of an RME, however, makes developing and implementing an onsite management program more complex. Increased coordination and planning are necessary to establish an effective management program. All of the management program activities described below can be performed by an RME; some may be executed by a management entity with a smaller scope of capabilities. In jurisdictions where management program responsibilities are delegated to an RME, the regulatory authority (RA; e.g., local health department) must oversee the RME to ensure that the program achieves the comprehensive public health and environmental goals of the community. Depending on state and local codes, a formal agreement or some other arrangement between the RME and the RA might be required for RME execution of some program elements, such as issuing permits.

The accompanying text insert, adapted from the National Small Flows Clearinghouse (1996), contains an example of activities that a comprehensive RME typically must incorporate into its management program. It should be noted that the involvement of an ME to perform some management program tasks or an RME to perform the full range of management tasks should be tailored to each local situation. Given the evolving nature of onsite wastewater management programs, activities in some cases might be performed by an RME, such as an onsite system utility or private service provider. In other cases, these responsibilities might be divided among several state or local government agencies, such as the local public health department, the regional planning office, and the state water quality agency. Changes in management practice (movement toward performance-based management, institution of model management [illegible]) have resulted in the addition of other responsibilities, which are discussed later in this section.

When a less-comprehensive ME conducts a specified set of these activities, the RA usually retains the responsibility for managing some or all of the following activities:

- Defining management responsibilities for the RA and the ME
- Overseeing the ME
- Issuing permits
- Inspecting onsite systems
- Responding to complaints
- Enforcement and compliance actions
- Monitoring receiving water quality (surface and ground water)
- Regulation of septage handling and disposal
- Licensing and certification programs
- Keeping records and managing databases for regulatory purposes
- Coordinating local and regional planning efforts

The RA, however, will often delegate to the ME the responsibility for implementing some of the activities listed above. The activities delegated to the ME will be determined by the capacity of the ME to manage specific activities, the specific public health and environmental problems to be addressed by the ME, and the RA's legal authority to delegate some of those activities. For example, if the ME is an entity empowered to own and operate treatment systems in the service area, the ME typically would be responsible for all aspects of managing individual systems, including setting fees, designing and installing systems, conducting inspections, and monitoring those systems to ensure that the RA's performance goals are met. Otis, McCarthy, and Crosby (2001) have presented a framework appropriate for performance management that illustrates the concepts discussed above.

2.4 Management program components

Developing and implementing an effective onsite wastewater management program requires that a systematic approach be used to determine necessary program elements. Changes and additions to the

management program should be based on evaluations of the program to determine whether the program has adequate legal authorities, funding, and management capacity to administer both existing and new OWTSs and respond to changing environmental and public health priorities and advances in OWTS technologies.

The management program elements described in the following sections are common to the most comprehensive onsite management programs (e.g., RMEs). USEPA recognizes that states and local governments are at different stages along the continuum of developing and implementing comprehensive management programs that address their communities' fiscal, institutional, environmental, and public health goals.

2.4.1 Authority for regulating and managing onsite treatment systems

Onsite wastewater program managers should identify all legal responsibilities of the RA that might affect the implementation of an effective program. Legal responsibilities can be found in state and local statutes, regulations, local codes, land use laws, and planning requirements. Other legal mechanisms such as subdivision covenants, private contracts, and homeowner association rules might also affect the administration of the program. In many jurisdictions, legal authorities that do not specifically refer to onsite programs and authorities, such as public nuisance laws, state water quality standards, and public health laws, might be useful in implementing the program. A typical example would be a situation where the public health agency charged with protecting human health and preventing public nuisances interprets this mandate as sufficient authorization to require replacement or retrofit of onsite systems that have surface seepage or discharges.

The extent and interpretation of authority assigned to the RA will determine the scope of its duties, funding required for operation, and the personnel necessary to perform its functions. In many jurisdictions, the authority to perform some of these activities might be distributed among multiple

Typical Authorities of a Regulatory Authority

- Develop and implement policy and regulations
- Provide management continuity
- Enforce regulations and program requirements through fines or incentives
- Conduct site and regional-scale evaluations
- Require certification or licensing of service providers
- Oversee system design review and approval
- Issue installation and operating permits
- Oversee system construction
- Access property for inspection and monitoring
- Inspect and monitor systems and the receiving environment
- Finance the program through a dedicated funding source
- Charge fees for management program services (e.g., permitting, inspections)
- Provide financial or cost-share assistance
- Issue and/or receive grants
- Develop or disseminate educational materials
- Provide training for service providers and staff
- Conduct public education and involvement programs
- Hire, train, and retain qualified employees

here this is the case, the organizations involved ould have the combined authority to perform all cessary activities and should coordinate their tivities to avoid program gaps, redundancy, and efficiency. In some cases, the RA might delegate me of these responsibilities to an ME. When a mprehensive set of responsibilities are delegated an RME, the RA should retain oversight and forcement authority to ensure compliance with gal, performance, and other requirements.

ach state or local government has unique organi- ational approaches for managing onsite wastewater ystems based on needs, perceptions, and circum- ances. It is vitally important that the authorizing gislation, regulations, or codes allow the RAs and MEs to develop an institutional structure capable of ulfilling mandates through adoption of appropriate echnical and regulatory programs. A thorough valuation of authorized powers and capabilities at arious levels and scales is necessary to determine he scope of program authority, the scale at which RAs and MEs can operate, and the processes they must follow to enact and implement the manage- ment program. Involving stakeholders who repre- ent public health entities, environmental groups, economic development agencies, political entities, and others in this process can ensure that the lines and scope of authority for an onsite management program are well understood and locally supported. In some cases, new state policies or regulations must be implemented to allow for recognition of onsite MEs.

2.4.2 Onsite wastewater management program goals

Developing and implementing an effective manage- ment program requires first establishing program goals. Program goals should be selected based on public health, environmental, and institutional factors and public concerns. Funding availability, institutional capability, and the need to protect consumers and their interests typically affect the selection of program goals and objectives. One or more entities responsible for public health and environmental protection, such as public health and water quality agencies, can determine the goals. The development of short- and long-term compre- hensive goals will most likely require coordination among many entities. Community development and planning agencies as well as residents should also play a role in helping to determine appropriate goals.

Traditionally, the main goals of most onsite management programs have been to reduce risks to public health (e.g., prevent direct public contact with sewage and avoid pathogenic contamination of ground water and surface waters); abate public nuisances (e.g., odors from pit privies and cesspools); and provide cost-effective wastewater treatment systems and management programs. More recently, there has been an increased focus on preventing OWTS-related surface and ground water quality degradation and impacts on aquatic habitat. Program goals have been expanded to address nutrients, toxic substances, and a broader set of public health issues regarding pathogens. Onsite wastewater-related nutrient enrichment leading to algae blooms and eutrophication or low dissolved oxygen levels in surface waters is of concern, especially in waters that lack adequate assimilative capacity, such as lakes and coastal embayments or estuaries. The discharge of toxic substances into treatment systems and eventually into ground water has also become a more prominent concern, especially in situations where onsite/decentralized treatment systems are used by commercial or institutional entities like gasoline service stations and nursing homes. The potential impacts from pathogens discharged from OWTS on shellfisheries and contact recreation activities have also moved some OWTS program managers to adopt goals to protect these resources.

Historically, in many jurisdictions the public health agency has had the primary role in setting program goals. Without documented health problems implicating onsite systems as the source of problem(s), some public health agencies have had little incentive to strengthen onsite management programs beyond the goals of ensuring there was no direct public contact with sewage or no obvious drinking water-related impacts, such as bacterial or chemical illnesses like methemoglobinemia ("blue baby syndrome"). The availability of more advanced assessment and monitoring methodologies and technologies and a better understanding of surface water and ground water interactions, however, has led to an increased focus on protecting water quality and aquatic habitat. As a result, in many states and localities, water quality agencies have become more involved in setting onsite

program goals and managing onsite wastewater programs. Some water quality agencies (e.g., departments of natural resources), however, lack direct authority or responsibility to regulate onsite systems. This lack of authority points to the need for increased coordination and mutual goal setting among health agencies that have such authority. Regardless of which agency has the legal authority to manage onsite systems, there is the recognition that both public health and water quality goals need to be incorporated into the management program's mission. Achievement of these goals requires a comprehensive watershed-based approach to ensure that all of the program's goals are met. Partnerships with multiple agencies and other entities are often required to integrate planning, public health protection, and watershed protection in a meaningful way. Because of the breadth of the issues affecting onsite system management, many programs depend on cooperative relationships with planning authorities, environmental protection and public health agencies, universities, system manufacturers, and service providers to help determine appropriate management goals and objectives.

2.4.3 Public health and resource protection goals

OWTS programs should integrate the following types of goals: public health protection, abatement of nuisances, ground and surface water resource protection, and aquatic ecosystem protection. Setting appropriate program goals helps onsite program managers determine desired performance goals for treatment systems and influence siting, design, and management criteria and requirements. Examples of more detailed goals follow.

Public health protection goals:

- Reduce health risk due to sewage backup in homes.
- Prevent ground water and well water contamination due to pathogens, nitrates, and toxic substances.
- Prevent surface water pollution due to pathogens, nutrients, and toxic substances.
- Protect shellfish habitat and harvest areas from pathogenic contamination and excessive nutrients
- Prevent sewage discharges to the ground surface to avoid direct public contact.
- Minimize risk from reuse of inadequately treated effluent for drinking water, irrigation, other uses.
- Minimize risk from inadequate management septic tank residuals.
- Minimize risk due to public access to system components.

Public nuisance abatement goals:

- Eliminate odors caused by inadequate plumb and treatment processes.
- Eliminate odors or other nuisances related to transportation, reuse, or disposal of OWTS residuals (septage).

Environmental protection goals:

- Prevent and reduce adverse impacts on wate resources due to pollutants discharged to on systems, e.g., toxic substances.
- Prevent and reduce nutrient overenrichment surface waters.
- Protect sensitive aquatic habitat and biota

2.4.4 Comprehensive planning

Comprehensive planning for onsite systems ha three important components: (1) establishing a implementing the management entity, (2) estab ing internal planning processes for the manage entity, and (3) coordination and involvement in broader land-use planning process. Comprehe

The Department of Environmental Resources an Health Department in Maryland's Prince George County worked together to develop geographic information system (GIS) tools to quantify and mitigate nonpoint source nutrient loadings to the lower Patuxent River, which empties into the Chesapeake Bay. The agencies developed a database of information on existing onsite syste including system age, type, and location, with additional data layers for depth to ground wate and soils. The resulting GIS framework allows to quantify nitrogen loadings and visualize likely impacts under a range of management scenar Information from GIS outputs is provided to decision makers for use in planning developm and devising county management strategies.

Source: County Environmental Quarterly, 199

anning provides a mechanism to ensure that the rogram has the necessary information to function ffectively.

is necessary to ensure that onsite management ssues are integrated into decisions regarding future rowth and development. An effective onsite wastewater management program should be represented n the ongoing land use planning process to ensure chievement of the goals of the program and to ssist planners in avoiding the shortcomings of past planning efforts, which generally allowed the imitations of conventional onsite technologies to drive some land use planning decisions. Such considerations are especially important in situations where centralized wastewater treatment systems are being considered as an alternative or adjunct to onsite or cluster systems. Comprehensive planning and land use zoning are typically interrelated and integrated: the comprehensive planning process results in the development of overarching policies and guidance, and the land use zoning process provides the detailed regulatory framework to implement the comprehensive plan. Honachefsky (2000) provides a good overview of comprehensive planning processes from an ecological perspective. In general, the comprehensive plan can be used to set the broad environmental protection goals of the community, and the zoning ordinance(s) can be used to:

- Specify performance requirements for individual or clustered systems installed in unsewered areas, preferably by watershed and/or subwatershed.
- Limit or prevent development on sensitive natural resource lands or in critical areas.
- Encourage development in urban growth areas serviced by sewer systems, if adequate capacity exists.
- Factor considerations such as system density, hydraulic and pollutant loadings, proximity to water bodies, soil and hydrogeological conditions, and water quality/quantity into planning and zoning decisions.
- Restore impaired resources.

Integrating comprehensive planning and zoning programs with onsite wastewater program management also can provide a stronger foundation for determining and requiring the appropriate level of treatment needed for both the individual site and the surrounding watershed or subwatershed. The integrated approach thus allows the program manager to manage both existing and new onsite systems from a cumulative loadings perspective or performance-based approach that is oriented toward the protection of identified resources. Local health departments (regulatory authorities) charged with administering programs based on prescriptive codes typically have not had the flexibility or the re-

Comprehensive planning program elements

- Define management program boundaries.
- Select management entity(ies).
- Establish human health and environmental protection goals.
- Form a planning team composed of management staff and local stakeholders.
- Identify internal and external planning resources and partners.
- Collect information on regional soils, topography, rainfall, and water quality and quantity.
- Identify sensitive ecological areas, recreational areas, and water supply protection areas.
- Characterize and map past, current, and future development where OWTSs are necessary.
- Coordinate with local sewage authorities to identify current and future service areas and determine treatment plant capacity to accept septage.
- Identify documented problem areas and areas likely to be at risk in the future.
- Prioritize and target problem areas for action or future action.
- Develop performance requirements and strategies to deal with existing and possible problems.
- Implement strategy, monitor progress and modify strategy if necessary.

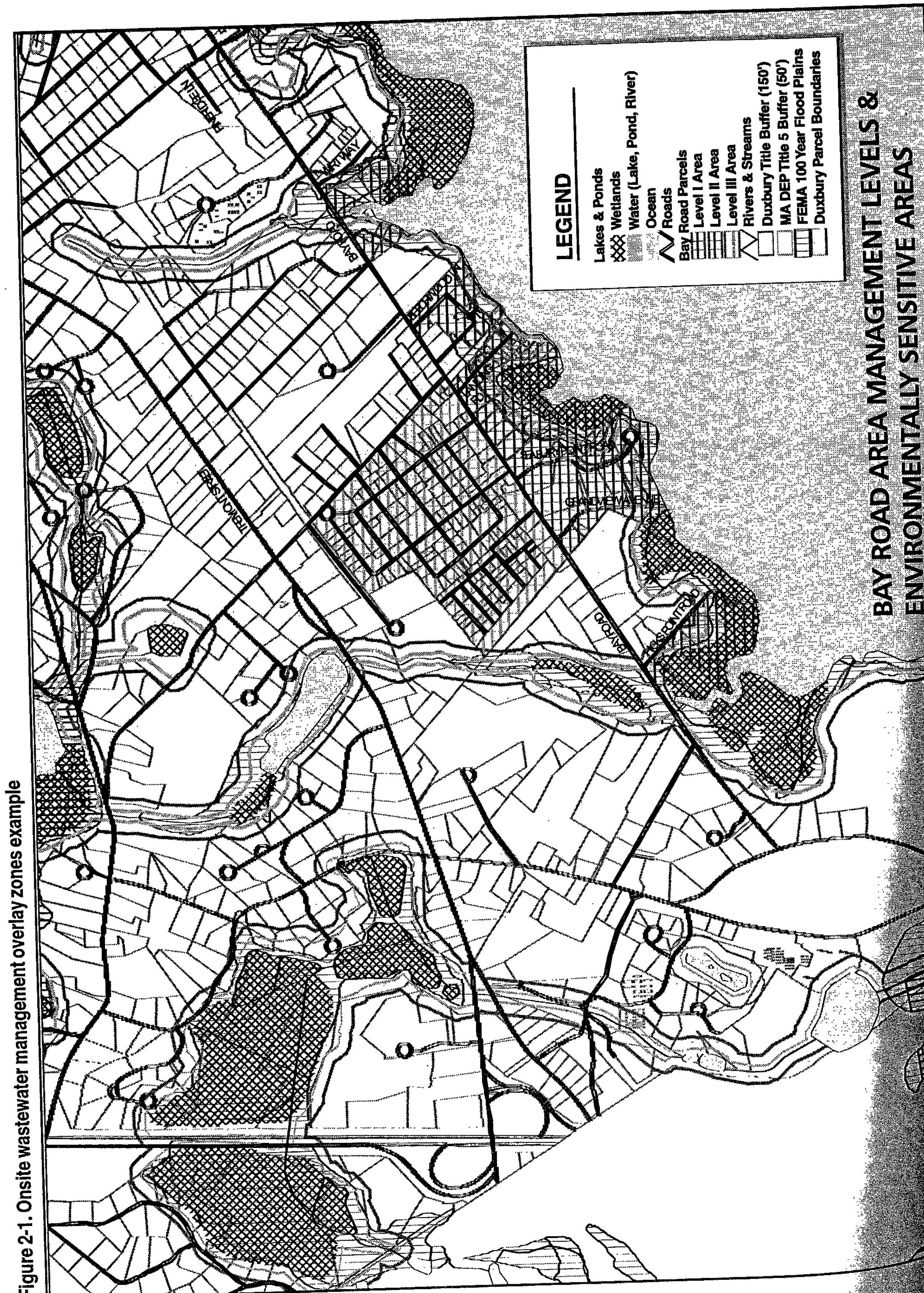


Figure 2-1. Onsite wastewater management overlay zones example

sources to deviate from zoning designations and as a result often have had to approve permits for developments where onsite system-related impacts were anticipated. Coordinating onsite wastewater management with planning and zoning activities can ensure that parcels designated for development are permitted based on a specified level of onsite system performance that considers site characteristics and watershed-level pollutant loading analyses. To streamline this analytical process, some management programs designate overlay zones in which specific technologies or management strategies are required to protect sensitive environmental resources. These overlay zones may be based on soil type, topography, geology, hydrology, or other site characteristics (figure 2-1). Within these overlay zones, the RA may have the authority to specify maximum system densities, system design requirements, performance requirements, and operation/maintenance requirements. Although the use of overlay zones may streamline administrative efforts, establishing such programs involves the use of assumptions and generalizations until a sufficient number of site-specific evaluations are available to ensure proper siting and system selection.

Internally, changes in program goals, demographics, and technological advances require information and coordination to ensure that the short- and long-term goals of the program can continue to be met. Many variables affect the internal planning process, including factors such as the locations and types of treatment systems within the jurisdictional area, the present or future organizational and institutional structure of the management entity, and the funding available for program development and implementation.

The box "Performance-based program elements" (page 2-21) provides guidance for planning processes undertaken by an onsite/decentralized wastewater management entity. At a minimum, the onsite management entity should identify and delineate the planning region, develop program goals, and coordinate with the relevant public health, resource protection, economic development, and land-use planning agencies.

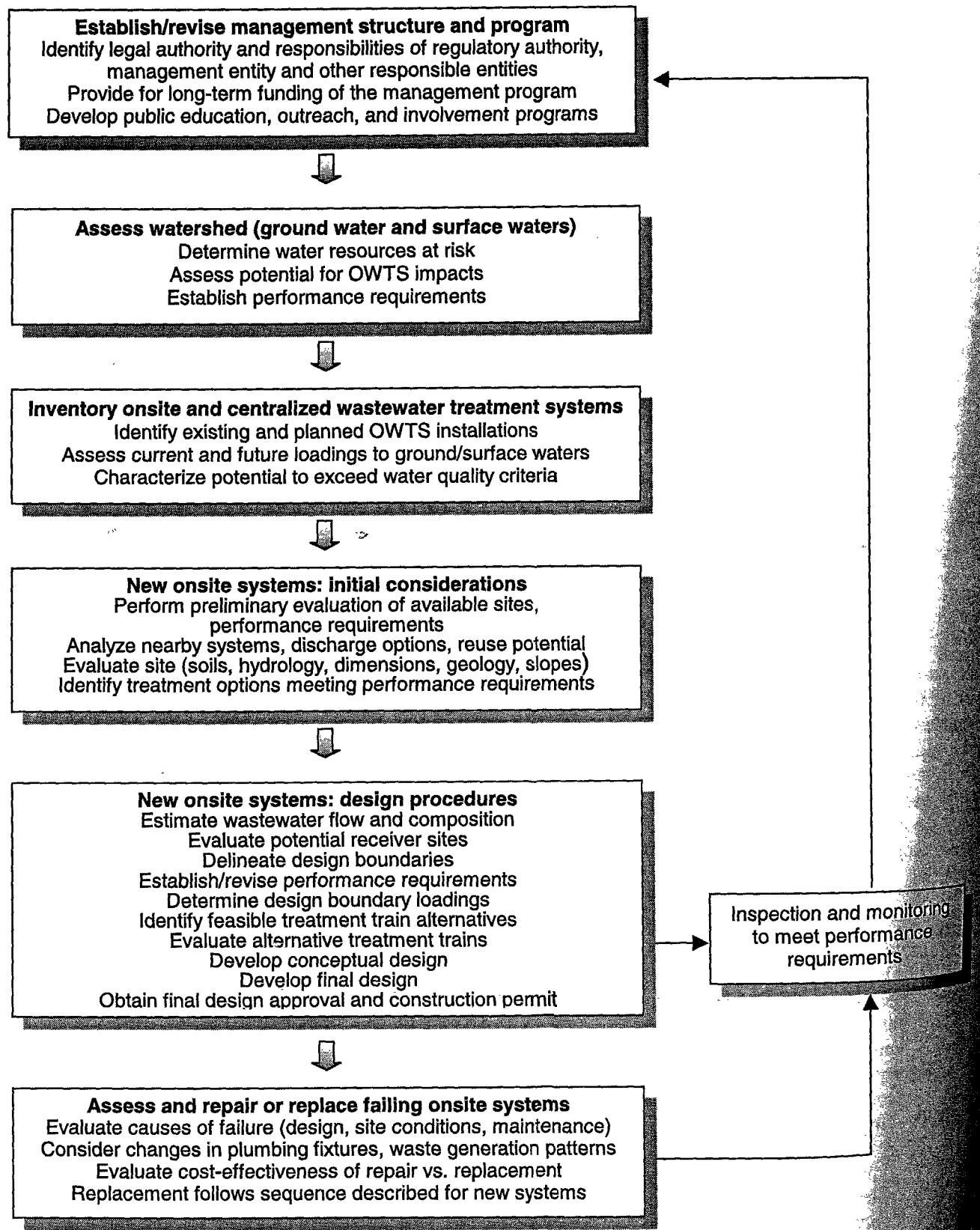
Figure 2-2 shows a process that might be useful in [illegible] and implementing a performance-based [illegible] whose objectives are to protect specific [illegible] achieve stated public health objectives.

2.4.5 Performance requirements

Many state and local governments are currently adopting or considering the use of performance requirements to achieve their management goals. The management entity can use performance requirements to establish specific and measurable standards for the performance of onsite systems that are necessary to achieve the required level of environmental or public health protection for an identified management area and resource. All onsite wastewater management programs are based to varying degrees on this concept. Traditional programs have elected to use prescriptive siting, design, and setback requirements to dictate where and when conventional septic tank/SWIS systems are appropriate. The prescriptive standards were based on the presumption that systems sited and designed to these standards would protect public health. In most cases, this assumption provided an adequate level of protection, but the prescriptions often were based on standards adopted by others and not based on scientific evaluations of the site conditions of the community using them. As a result, many programs based on prescriptive requirements do not adequately protect the resource. (See chapter 5 for more detailed information about performance-based approaches.) The *NOWRA Model Framework for Unsewered Wastewater Infrastructure*, discussed in chapter 1, also provides a model for the development of performance-based programs (Walsh et al., 2001; see **http://www.nowra.org**).

Performance requirements provide the onsite system regulatory agency with an objective basis to oversee siting, system selection and design, installation, maintenance, and monitoring of OWTS in order to protect an identified resource or achieve a stated public health goal. In jurisdictions where performance requirements are used, the regulatory agency should not conduct site evaluations and specify system designs because of potential conflict of interest issues regarding enforcement and compliance; that is, the agency would be evaluating the performance of systems it designed and sited. The role of the regulatory agency in such a situation should be to establish performance requirements and provide oversight of management, operation, maintenance, and other activities conducted by private contractors or other entities.

Figure 2-2. Process for developing onsite wastewater management



Where appropriate, prescriptive guidelines for siting, design, and operation that are accepted by the management entity as meeting specific performance requirements for routine system applications can be appended to local codes or retained to avoid cost escalation and loss of qualified service providers (Otis et al., 2001). Designating performance requirements for areas of a management district with similar environmental sensitivities and site conditions can provide property owners with valuable information on performance expectations and their rationale (Otis et al., 2001). Performance standards can be determined based on the need to protect a site-specific resource, such as residential drinking wells, or they can be based on larger-scale analyses intended to manage cumulative OWTS pollutant loadings (e.g., to protect a lake or estuary from nutrient enrichment).

Implementation of performance-based programs might result in increased management expenditures due to the need for staff to conduct site or areawide (e.g., watersheds, subwatersheds, or other geographic areas) evaluations, inspect, and monitor system performance as necessary. Service provider training, the evaluation and approval of new or alternative system designs, public outreach efforts to establish public support for this approach, and new certification/licensing or permit programs will also increase program costs. These increases can usually be recovered through permit/license fees. Also, system owners will be responsible for operation and maintenance costs. The following box contains a recommended list of elements for a performance-based program.

2.4.6 Performance requirements and the watershed approach

USEPA encourages the use of performance requirements on a watershed, subwatershed, or source water protection zone basis. These are useful natural units on which to develop and implement performance-based management strategies. In situations where jurisdictional boundaries cross watershed, subwatershed, or source water recharge boundaries, interagency coordination might be needed. Setting performance requirements for individual watersheds, subwatersheds, or source water areas allows the program manager to determine and allocate cumulative hydraulic and pollutant loads to ensure that the goals of the community can be met. To do so, an analysis to determine whether the cumulative pollutant or hydraulic loadings can be assimilated by the receiving environment without degrading the quality of the resource or use is necessary. There is some uncertainty in this process, and program managers should factor in a margin of safety to account for errors in load and treatment effectiveness estimates. (Refer to chapter 3 for more information on estimating treatment effectiveness.)

Onsite systems are typically only one of many potential sources of pollutants that can negatively affect ground or surface waters. In most cases other

Performance-based program elements

- Obtain or define legal authority to enact management regulations.
- Identify management area.
- Identify program goals.
- Identify specific resource areas that need an additional level of protection, e.g., drinking water aquifers, areas with existing water quality problems, and areas likely to be at risk in the future.
- Establish performance goals and performance requirements for the management area and specific watersheds, subwatersheds, or source water protection areas.
- Define performance boundaries and monitoring protocols.
- Determine and set specific requirements for onsite systems based on protecting specific management areas and achieving of a specified level of treatment (e.g., within a particular watershed there will be no discharge that contains more than 1.0 mg/L of total phosphorus).
- Be able to acquire information on alternative technologies, including effectiveness information and operation and maintenance requirements (see chapter 4).
- Develop a review process to evaluate system design and system components (see chapter 5).

Establishing performance requirements at a watershed scale

Establishing performance requirements involves a sequential set of activities at both the landscape level and the site level. The following steps describe the general process of establishing performance requirements for onsite systems:

- Identify receiving waters (ground water, surface waters) for OWTS effluent.
- Define existing and planned uses for receiving waters (e.g., drinking water, recreation, habitat).
- Identify water quality standards associated with designated uses (check with state water agency).
- Determine types of OWTS-generated pollutants (e.g., nutrients, pathogens) that might affect use.
- Identify documented problem areas and areas likely to be at risk in the future.
- Determine whether OWTS pollutants pose risks to receiving waters.
- If there is a potential risk,
  - Estimate existing and projected OWTS contributions to total pollutant loadings.
  - Determine whether OWTS pollutant loadings will cause or contribute to violations of water quality or drinking water standards.
  - Establish maximum output level (mass or concentration in the receiving water body) for specified OWTS effluent pollutants based on the cumulative load analysis of all sources of pollutant(s) of concern.
  - Define performance boundaries for measurement of OWTS effluent and pollutant concentrations to achieve watershed- and site-level pollutant loading goals.

sources of OWTS-generated pollutants (primarily nutrients and pathogens), such as agricultural activities or wildlife, are also present in the watershed or subwatershed. To properly calculate the cumulative acceptable OWTS-generated pollutant loadings for a given watershed or subwatershed, all other significant sources of the pollutants that might be discharged by onsite systems should be identified. This process requires coordination between the onsite program manager and the agencies responsible for assessing and monitoring both surface waters and ground water. Once all significant sources have been identified, the relative contributions of the pollutants of concern from these sources should be determined and pollutant loading allocations made based on factors the community selects. State water quality standards and drinking source water protection requirements are usually the basis for this process. Once loading allocations have been made for all of the significant contributing sources, including onsite systems, the OWTS program manager needs to develop or revise the onsite program to ensure that the overall watershed-level goals of the program are met. Cumulative loadings from onsite systems must be within the parameters set under the loading allocations, and public health must be protected at the site level; that is, the individual OWTS must [illegible] the performance requirements at the treatment [illegible] performance boundary or the point of compl[illegible]

It should be noted that the performance-based approach is a useful program tool both to pre[illegible] degradation of a water resource and to restor[illegible] degraded resource. Additional information [illegible] antidegradation is available in USEPA's *Water Quality Standards Handbook*. (See **http://www.epa.gov/waterscience/library/wqstandhandbook.pdf**. For general information on [illegible] USEPA Water Quality Standards Program [illegible] **http://www.epa.gov/OST/standards/**.) The Water Act Section 303(d) program (Total Maximum Daily Load [TMDL] program) has [illegible] numerous documents and technical tools [illegible] the development and implementation of [illegible] load allocations. This information can be [illegible] **http://www.epa.gov/owow/tmdl/**. (NOTE: [illegible] identification of other pollutant sources [illegible] analyses of loadings and modeling related [illegible] TMDL are beyond the scope of this docu[illegible]

The text above contains a list of steps that [illegible] program manager should consider in deve[illegible] performance requirements at a watershed [illegible]

The use of a watershed-based approach also affords the water quality and onsite program managers some flexibility in determining how to most cost-effectively meet the goals of the community. Given the presence of both onsite systems and other sources of pollutants of concern, evaluations can be made to determine the most cost-effective means of achieving pollutant load reductions. For example, farmer or homeowner nutrient management education might result in significant loading reductions of nitrogen that could offset the need to require expensive, more technically advanced onsite systems designed for nitrogen removal.

Watershed-level evaluations, especially in cases where new and refined monitoring methods are employed, might also negate the need for system upgrade or replacement in some watersheds. For example, new genetic tracing methods can provide the water quality program manager with a reliable tool to differentiate between human sources of fecal coliform and animal contributions, both domestic and wild (see chapter 3). The use of these new methods can be expensive, but they might provide onsite program managers with a means of eliminating onsite systems as a significant contributing source of pathogens.

Onsite program managers have legitimate concerns regarding the adoption of a performance-based approach. The inherent difficulty of determining cumulative loadings and their impacts on a watershed, the technical difficulties of monitoring the impacts of OWTS effluent, the evaluation of new technologies and the potential costs, staffing and expertise needed to implement a performance-based program can make this option more costly and difficult to implement. (NOTE: In general, the RA should not [illegible] the responsibility for monitoring systems other than conducting random quality assurance inspections. Likewise, the RA should not have the primary responsibility of evaluating new or alternative technologies. Technologies should be evaluated by an independent entity certified or licensed to conduct such evaluations, such as an RME.)

Prescriptive regulatory codes that specify technologies for installation under a defined set of site conditions have worked reasonably well in the past in many localities. The use of this approach, in which baseline design requirements and treatment effectiveness are estimated based on the use of the specified technology at similar sites, will continue to be a key component of most management programs because it is practical, efficient, and easy to implement. Programs based purely on prescriptive requirements, however, might not consistently provide the level of treatment needed to protect community water resources and public health. Many programs using prescriptive requirements are based on empirical relationships that do not necessarily result in appropriate levels of treatment. Site-specific factors can also result in inadequate treatment of OWTS effluent where a prescriptive approach is used. Political pressure to approve specific types of systems for use on sites where

Performance requirements in Texas

[illegible] eliminated percolation test requirements [illegible] systems and instituted new performance [illegible] for alternative systems (e.g., drip [illegible] intermittent sand filters, leaching chambers). [illegible] in Texas are now based on soil and site [illegible] service providers must be certified. These [illegible] after onsite system installations [illegible] between 1990 and 1997.

[illegible] Resource Conservation [illegible]

Arizona's performance-based technical standards

In 2001 Arizona adopted a rule containing technical standards for onsite systems with design flows less than 24,000 gallons per day (Arizona Administrative Code, Title 18, Chapters 5, 9, 11, and 14). Key provisions of the rule include site investigation requirements, identification of site limitations, design adjustments for better-than-primary treatment to overcome site limitations, and design criteria and nominal performance values for more than 20 treatment or effluent dispersal technologies. Applications for proposed systems are required to contain wastewater characterization information, technology selections that address site limitations, soil treatment calculations, and effluent dispersal area information. Technology-specific general ground water discharge permits required under the new rule specify design performance values for TSS, BOD, total coliforms, and TN. Products with satisfactory third-party performance verification data might receive additional credits for continuing performance improvement. The Arizona rule contains important elements of performance-based and hybrid approaches through adoption of performance values and specific use criteria for certain systems.

Source: Swanson, 2001.

Florida's performance-based permit program

Florida adopted provisions for permitting residential performance-based treatment systems in September 2000. The permit regulations, which can be substituted for provisions governing the installation of onsite systems under existing prescriptive requirements, apply to a variety of alternative and innovative methods, materials, processes and techniques for treating onsite wastewaters statewide. Discharges under the performance-based permit program must meet treatment performance criteria for secondary, advanced secondary, and advanced wastewater treatment, depending on system location and the proximity of protected water resources. Performance requirements for each category of treatment are as follows:

- *Secondary treatment:* annual arithmetic mean for BOD and TSS ≤ 20 mg/L, annual arithmetic mean for fecal coliform bacteria ≤ 200 cfu/100 mL.
- *Advanced secondary treatment:* annual arithmetic mean for BOD and TSS ≤ 10 mg/L, annual arithmetic mean for total nitrogen ≤ 20 mg/L, annual arithmetic mean for total phosphorus ≤ 10 mg/L, annual arithmetic mean fecal coliform bacteria ≤ 200 cfu/100 mL.
- *Advanced wastewater treatment:* annual arithmetic mean for BOD and TSS ≤ 5 mg/L, annual arithmetic mean for total nitrogen ≤ 3 mg/L, annual arithmetic mean for total phosphorus ≤ 1 mg/L, fecal coliform bacteria count for any one sample ≤ 25 cfu/100 mL.

Operation and maintenance manuals, annual operating permits, signed maintenance contracts, and biannual inspections are required for all performance-based systems installed under the new regulation. The operating permits allow for property entry, observation, inspection, and monitoring of treatment systems by state health department personnel.

Source: Florida Administrative Code, 2000.

prescriptive criteria are not met is another factor that leads to the installation of inadequate systems.

2.4.7 Implementing performance requirements through a hybrid management approach

RAs often adopt a "hybrid" approach that includes both prescriptive and performance elements. To set appropriate performance requirements, cumulative load analyses should be conducted to determine the assimilative capacity of the receiving environment(s). This process can be costly, time-consuming, and controversial when water resource characterization data are incomplete, absent, or contested. Because of these concerns, jurisdictions might elect to use prescriptive standards in areas where it has been determined that onsite systems are not a significant contributing source of pollutants or in areas where onsite systems are not likely to cause water quality problems. Prescriptive designs might also be appropriate and practical for sites where previous experience with specified OWTS designs has resulted in the demonstration of adequate performance (Ayres Associates, 1993).

In those areas where problems due to pollutants typically found in OWTS discharges have been identified and in areas where there is a significant threat of degradation due to OWTS discharges (e.g., source water protection areas, recreational swimming areas, and estuaries), performance requirements might be appropriate. The use of a performance-based approach allows jurisdictions to prioritize their resources and efforts to target collections of systems within an area or subwatershed or individual sites within a jurisdiction.

2.4.8 Developing and implementing performance requirements

OWTS performance requirements should be developed using risk-based analyses on a [illegible] or site level. They should be clear and quantifiable to allow credible verification of system performance through compliance monitoring. Performance requirements should at a minimum include stipulations that no plumbing backups or surface seepage may occur and that a specified level of ground/surface water quality must be maintained at some performance boundary at the terminus of the treatment train, [illegible]

[illegible]rface, property line, or point of use [illegible]g., water supply well, recreational surface water, [illegible]quatic habitat area; see chapter 5).

[illegible] prescriptive designs are allowed under a performance-based program, these systems should be proven capable of meeting the same performance requirements as a system specifically designed for that site. Under this approach, the management [illegible]nity should determine through experience (monitoring and evaluation of the prescribed systems on [illegible]ites with similar site characteristics) that the system will perform adequately to meet stated performance requirements given sufficiently frequent operating inspections and maintenance.

[illegible] performance monitoring might be difficult and [illegible]sly. Although plumbing backups and ground surface seepage can be easily and inexpensively observed through visual monitoring, monitoring the receiving environment (surface receiving waters and ground water) might be expensive and complicated. Monitoring of ground water is confounded by the difficulty of locating and sampling subsurface effluent plumes. Extended travel times, [illegible]ologic factors, the presence of other sources of ground water recharge and pollutants, and the dispersal of OWTS pollutants in the subsurface all complicate ground water monitoring.

To avoid extensive sampling of ground water and surface waters, especially where there are other contributing sources of pollutants common to OWTS discharges, performance requirements can be set for the treated effluent at a designated performance boundary before release into the receiving environment (refer to chapters 3 and 5). [illegible] for the additional treatment, dispersion and dilution that will occur between the [illegible] boundary and the resource to be [illegible] should be factored into the performance [illegible]. For example, pretreated wastewater [illegible] discharged to unsaturated soil, through [illegible] percolates before it reaches ground water. [illegible] requirement should take into [illegible] treatment due to physical (filtration), [illegible] chemical processes in the soil, as [illegible] and dilution that will occur [illegible] soil and ground water prior to [illegible] the standard is applied.

[illegible] performance verification of [illegible] be relaxed for identified types of systems that the RA knows will perform as anticipated. Service or maintenance contracts or other legal mechanisms might be prerequisites to waiving or reducing monitoring requirements or inspections. The frequency and type of monitoring will depend on the management program, the technologies employed, and watershed- and site-specific factors. Monitoring and evaluation might occur at or near the site and include receiving environment or water quality monitoring and monitoring to ascertain hydraulic performance and influent flows. In addition, the OWTS management program needs to be evaluated to ascertain whether routine maintenance is occurring and whether individual systems and types of systems are operating properly.

Chapter 4 contains descriptions of most of the onsite wastewater treatment processes currently in use. OWTS program managers developing and implementing performance-based programs will often need to conduct their own site-specific evaluations of these treatment options. The text box that follows documents one approach used to cooperatively evaluate innovative or alternative wastewater treatment technologies. Many tribal, state, and local programs lack the capability to continually evaluate new and innovative technology alternatives and thus depend on regional evaluations and field performance monitoring to provide a basis on which to develop their programs.

2.4.9 Public education, outreach, and involvement

Public education and outreach are critical aspects of an onsite management program to ensure public support for program development, implementation, and funding. In addition, a working understanding of the importance of system operation and maintenance is necessary to help ensure an effective program. In general the public will want to know the following:

- How much will it cost the community and the individual?
- Will the changes mean more development in my neighborhood? If so, how much?
- Will the changes prevent development?
- Will the changes protect our resources (drinking waters, shellfisheries, beaches)?

A cooperative approach for approving innovative/alternative designs in New England

The New England Interstate Water Pollution Control Commission is a forum for consultation and cooperative a among six New England state environmental agencies. NEIWPCC has adopted an interstate process for revie proposed wastewater treatment technologies. A technical review committee composed of representatives from England state onsite wastewater programs and other experts evaluates innovative or alternative technologies system components that replace part of a conventional system, modify conventional operation or performance provide a higher level of treatment than conventional onsite systems.

Three sets of evaluation criteria have been developed to assess proposed replacement, modification, or adva treatment units. Review teams from NEIWPCC assess the information provided and make determinations that referred to the full committee. The criteria are tailored for each category but in general include:

- Treatment system or treatment unit size, function, and applicability or placement in the treatment tra
- Structural integrity, composition, durability, strength, and corresponding independent test results
- Life expectancy and costs including comparisons with conventional systems/units.
- Availability and cost of parts, service, and technical assistance.
- Test data on prior installations or uses, test conditions, failure analysis, and tester identity.

Source: New England Interstate Water Pollution Control Commission, 2000.

- How do the proposed management alternatives relate to the above questions?

A public outreach and education program should focus on three components—program audience, information about the program, and public outreach media. An effective public outreach program makes information as accessible as possible to the public by presenting the information in a nontechnical format. The public and other interested parties should be identified, contacted, and consulted early in the process of making major decisions or proposing significant program changes. Targeting the audience of the public outreach and education program is important for both maximizing public participation and ensuring public confidence in the management program. For onsite wastewater system management programs, the audiences of a public outreach and education program can vary and might include:

- Homeowners
- Manufacturers
- Installers
- System operators and maintenance contractors
- Commercial or industrial property owner
- Public agency planners
- Inspectors
- Site evaluators
- Public
- Students

- Citizen groups and homeowner neighborh associations
- Civic groups such as the local Chamber o Commerce
- Environmental groups

Onsite management entities should also prom and support the formation of citizen advisory groups composed of community members to or enhance public involvement in the manage program. These groups can play a crucial ro representing community interests and promo support for the program.

Typical public outreach and education progr information includes:

- Promoting water conservation
- Preventing household and commercial/i hazardous waste discharges
- Benefits of the onsite management prog

Public outreach and education programs u variety of media options available for info dissemination, including:

- Local newspapers
- Radio and TV
- Speeches and presentations
- Exhibits and demonstrations
- Conferences and workshops
- Public meetings

Site evaluation program elements

- Establish administrative processes for permit/site evaluation applications.
- Establish processes and policies for evaluating site conditions (e.g., soils, slopes, water resources).
- Develop and implement criteria and protocols for wastewater characterization.
- Determine level of skill and training required for site evaluators.
- Establish licensing/certification programs for site evaluators.
- Offer training opportunities as necessary.

School programs
Local and community newsletters
Reports
Direct mailings, e.g., flyers with utility bills

2.5.10 Site evaluation

aluating a proposed site in terms of its environmental conditions (climate, geology, slopes, soils/ scape position, ground water and surface water ects), physical features (property lines, wells, ydrologic boundaries structures), and wastewater acteristics (anticipated flow, pollutant content, ase strength) provides the information needed to ose, select, and site the appropriate wastewater atment system. In most cases (i.e., under current ase codes and lower-level management entity ctices) RAs issue permits—legal authorizations to install and operate a particular system at a specific site—based on the information collected and analyses performed during the site evaluation. (NOTE: Detailed wastewater characterization procedures are discussed in chapter 3; site evaluation procedures are presented in section 5.5.)

2.5.11 System design criteria and approval process

requirements for onsite systems can two general categories—numeric narrative criteria. Numeric measurable concentration or mass for specific pollutants (e.g., nitrogen concentrations). Narrative requirescribe qualitative aspects of the wastewater (e.g., sewage surface pooling, odor). A numerical performance requirement might be that all septic systems in environmentally sensitive areas must discharge no more than 5 pounds of nitrogen per year, or that concentrations of nitrogen in the effluent may be no greater than 10 mg/L. Some of the parameters for which performance requirements are commonly set for OWTSs include:

- Fecal coliform bacteria (an indicator of pathogens)
- Biochemical oxygen demand (BOD)
- Nitrogen (total of all forms, i.e., organic, ammonia, nitrite, nitrate)
- Phosphorus (for surface waters)
- Nuisance parameters (e.g., odor, color)

Under a performance-based approach, performance requirements, site conditions, and wastewater characterization information drive the selection of treatment technologies at each site. For known technologies with extensive testing and field data, the management agency might attempt to institute performance requirements prescriptively by designating system type, size, construction practices, materials to be used, acceptable site conditions, and siting requirements. For example, the Arizona Department of Environmental Quality has adopted a rule that establishes definitions, permit requirements, restrictions, and performance criteria for a wide range of conventional and alternative treatment systems. (Swanson, 2001). Alaska requires a 2-foot-thick sand liner when the receiving soil percolates at a rate faster than 1 minute per inch (Alaska Administrative Code, 1999). At a minimum, prescriptive system design criteria

Performance requirements and system design in Massachusetts

Massachusetts onsite regulations identify certain wellhead protection areas, public water supply recharge zones, and coastal embayments as nitrogen-sensitive areas and require OWTSs in those areas to meet nitrogen loading limitations. For example, recirculating sand filters or equivalent technologies must limit total nitrogen concentrations in effluent to no more than 25 mg/L and remove at least 40 percent of the influent nitrogen load. All systems in nitrogen-sensitive areas must discharge no more than 440 gallons of design flow per acre per day unless system effluent meets a nitrate standard of 10 mg/L or other nitrogen removal technologies or attenuation strategies are used.

Source: Massachusetts Environmental Code, Title V.

should consider the following. (See chapter 5 for details.)

- Wastewater characterization and expected effluent volumes.
- Site conditions (e.g., soils, geology, ground water, surface waters, topography, structures, property lines).
- System capacity, based on estimated peak and average daily flows.
- Location of tanks and appurtenances.
- Tank dimensions and construction materials.
- Alternative tank effluent treatment units and configuration.
- Required absorption field dimensions and materials.
- Requirements for alternative soil absorption field areas.
- Sizing and other acceptable features of system piping.
- Separation distances from other site features.
- Operation and maintenance requirements (access risers, safety considerations, inspection points).
- Accommodations required for monitoring.

2.4.12 Construction and installation oversight authority

A comprehensive construction management program will ensure that system design and specifications are followed during the construction process. If a system is not constructed and installed properly, it is unlikely to function as intended. For example, if the natural soil structure is not pr[illegible] served during the installation process (if equip[illegible] compacts infiltration field soils), the percolati[illegible] potential of the infiltration field can be signif[illegible] cantly reduced. Most early failures of conven[illegible] onsite systems' soil absorption fields have be[illegible] attributed to hydraulic overloading (USEPA, [illegible] 1980). Effective onsite system management programs ensure proper system construction [illegible] installation through construction permitting, inspection, and certification programs.

Construction should conform to the approve[illegible] and use appropriate methods, materials, and equipment. Mechanisms to verify compliance [illegible] performance requirements should be establi[illegible] ensure that practices meet expectations. Ty[illegible] existing regulatory mechanisms that ensure [illegible] installation include reviews of site evaluati[illegible] procedures and findings and inspections of [illegible] during and after installation, i.e., before co[illegible] and final grading. A more effective revie[illegible] inspection process should include

- Predesign meeting with designer, own[illegible] contractor
- Preconstruction meeting with design[illegible] and contractor
- Field verification and staking of each [illegible] component
- Inspections during and after constru[illegible]
- Issuance of a permit to operate syste[illegible] designed and built

Construction oversight program elements

- Establish preconstruction review procedure for site evaluation and system design.
- Determine training and qualifications of system designers and installers.
- Establish designer and installer licensing and certification programs.
- Define and codify construction oversight requirements.
- Develop certification process for overseeing and approving system installation.
- Arrange training opportunities for service provide[illegible] as necessary

Simplified incorporation of system design requirements into a regulatory program: the Idaho approach

Idaho bypasses cumbersome legislative processes when making adjustments to its onsite system design guidelines by referencing a technical manual in the regulation that is not part of the state regulation. Under this approach, new research findings, new technologies, or other information needed to improve system design and performance can be incorporated into the technical guidance without invoking the regulatory rulemaking process. The regulations contain information on legal authority, responsibilities, permit processes, septic tanks, and conventional systems. The reference guidance manual outlines types of alternative systems that can be installed, technical and design considerations, soil considerations, and operation and maintenance requirements.

Source: Adapted from NSFC, 1995b.

onstruction oversight inspections should be con-ucted at several stages during the system installa-on process to ensure compliance with regulatory quirements. During the construction process, spections before and after backfilling should verify ompliance with approved construction documents nd procedures. An approved (i.e., licensed or ertified) construction oversight inspector, prefer-bly the designer of the system, should oversee stallation and certify that it has been conducted nd recorded properly. The construction process for oil-based systems must be flexible to accommo-ate weather events because construction during et weather can compact soils in the infiltration eld or otherwise alter soil structure.

2.4.13 Operation and maintenance requirements

ecurring weakness of many existing OWTS anagement programs has been the failure to sure proper operation and maintenance of stalled systems. Few existing oversight agencies ormal inspections to verify basic system perfor-ance, and many depend on uninformed, untrained stem owners to monitor tank residuals buildup, hedule pumping, ensure that flow distribution is rming properly, check pumps and float ches, inspect filtration media for clogging, and rform other monitoring and maintenance tasks. mplaints to the regulatory authority or severe bvious system failures often provide the only ans of notification of problems under present ces. Inspection and other programs that monitor stem performance (e.g., Critical Point Monitor-g, see chapter 3) can help reduce the risk of premature system failure, decrease long-term investment costs, and lower the risk of ground water or surface water contamination (Eliasson et al., 2001; Washington Department of Health, 1994).

Various options are available to implement operation and maintenance oversight programs. These range from purely voluntary (e.g., trained homeowners responsible for their system operation and maintenance activities) to more sophisticated operating permit programs and ultimately to programs administered by designated RMEs that conduct all management/maintenance tasks. In general, voluntary maintenance is possible only where systems are nonmechanical and gravity-based and located in areas with very low population densities. The level of management should increase if the system is more complex or the resource(s) to be protected require a higher level of performance.

Alarms (onsite and remote) should be considered to alert homeowners and service providers that system malfunction might be occurring. In addition to simple float alarms, several manufacturers have developed custom-built control systems that can program and schedule treatment process events, remotely monitor system operation, and notify technicians by pager or the Internet of possible problems. New wireless and computer protocols, cellular phones, and personal digital assistants are being developed to allow system managers to remotely monitor and assess operation of many systems simultaneously (Nawathe, 2000), further enhancing the centralized management of OWTSs in outlying locations. Using such tools can save considerable travel and inspection time and focus

Operation, maintenance, and residuals management program elements

- [illegible] guidelines or permit program for operation and maintenance of systems.
- [illegible] reporting system for operation and maintenance activities.
- [illegible] operation and maintenance information and reminders to system owners.
- [illegible] operation and maintenance inspection and compliance verification program.
- [illegible] licensing/certification programs for service providers.
- [illegible] training opportunities as necessary.
- [illegible] procedures for follow-up notices or action when appropriate.
- [illegible] reporting and reminder system for monitoring system effluent.
- [illegible] residuals (septage) management requirements, manifest system, and disposal/use

Onsite system disclosure requirements in Minnesota

Minnesota law requires that before signing an agreement to sell or transfer real property, a seller must disclose to a buyer in writing the status and location of all septic systems on the property, including existing or abandoned systems. If there is no onsite treatment system on the property, the seller can satisfy the disclosure requirement by making such a declaration at the time of property transfer. The disclosure must indicate whether the system is in use and whether it is, to the seller's knowledge, in compliance with applicable laws and rules. A map indicating the location of the system on the property must also be included. A seller who fails to disclose the existence or known status of a septic system at the time of sale and who knew or had reason to know the existence or known status of a system might be liable to the buyer for costs relating to bringing the system into compliance, as well as reasonable attorney's fees incurred in collecting the costs from the seller. An action for collection of these sums must be brought within 2 years of the closing date.

Source: Minnesota Statutes, 2000.

field personnel on systems that require attention or regular maintenance. Telemetry panels at the treatment site operating through existing or dedicated phone lines can be programmed to log and report information such as high/low water alarm warnings, pump run and interval times, water level readings in tanks/ponds, amperage drawn by system pumps, and other conditions. Operators at a centralized monitoring site can adjust pump run cycles, pump operation times, alarm settings, and high-level pump override cycles (Stephens, 2000).

Some management entities have instituted comprehensive programs that feature renewable/revocable operating permits, mandatory inspections or disclosure (notification/inspection) upon property transfer (e.g., Minnesota, Wisconsin, Massachusetts), and/or periodic monitoring by licensed inspectors. Renewable operating permits might require system owners to have a contract with a certified inspection/maintenance contractor or otherwise demonstrate that periodic inspection and maintenance procedures have been performed for permit renewal (Wisconsin Department of Commerce, 2001). Minnesota, Wisconsin, Massachusetts, and some counties (e.g., Cayuga and other counties in New York, Washtenaw County in Michigan) require that sellers of property disclose or verify system performance (e.g., disclosure statement, inspection by the local oversight entity or other approved inspector) prior to property transfer. Financial incentives usually aid compliance and can vary from small fines for poor system maintenance to preventing the sale of a house if the OWTS is not functioning properly. Inspection fees might be one way to cover or defray these program costs. Lending institutions nationwide have influenced the adoption of a more aggressive approach toward requiring system inspections before home or property transfers are approved. In some areas, inspections at the time of property transfer are common despite the absence of regulatory requirements. This practice is incorporated into the loan and asset protection policies of local banks and lending firms.

RAs, however, should recognize that reliance on lending institutions to ensure that proper inspections occur can result in gaps. Property transfers without lending institution involvement might occur without inspections. In addition, in cases where inspections are conducted by private individuals reporting to the lending agents, inspectors might not have the same degree of accountability that would occur in jurisdictions that have mandatory requirements for state or local licensing or certification of inspectors. RAs should require periodic inspections of systems based on system design life, system complexity, and changes in ownership.

Wisconsin's new Private Onsite Wastewater Treatment System rule (see **http://www.commerce.state.wi.us/SB/SB-POWTSProgram.html**) requires management plans for all onsite treatment systems. The plans must include information on procedures for maintaining the systems in accordance with the standards of the code as designed and approved. Any new or existing system not maintained in accordance with the approved management plan is considered a human health hazard and subject to enforcement action. Specific maintenance requirements are specified. All septic tanks are to be pumped when the combined sludge and scum volume equals one-half the tank volume. Existing systems have a requirement of visual inspections every

Requiring pump-outs to ensure proper maintenance

Periodic pumping of septic tanks is now required by law in some jurisdictions and is becoming established practice for many public and private management entities. In 1991 Fairfax County, Virginia, amended its onsite systems management code to require pumping at least every 5 years. The action, which was based on provisions of the Chesapeake Bay Preservation Act, was accompanied by public outreach notices and news articles. System owners must provide the county health department with a written notification within 10 days of pumpout. A receipt from the pumpout contractor, who must be licensed to handle septic tank residuals, must accompany the notification.

Source: Fairfax County Health Department, 1995.

wastewater ponding on the ground surface. Only persons certified by the department may perform the inspections or maintenance. Systems requiring maintenance more than once annually require signed maintenance contracts and a notice of maintenance requirements on the property deed. The system owner or designated agent of the owner must report to the department each inspection or maintenance action specified in the management plan at its completion (Wisconsin Department of Commerce, 2001).

2.4.14 Residuals management requirements

The primary objective of residuals management is to establish procedures and rules for handling and disposing of accumulated wastewater treatment system residuals to protect public health and the environment. These residuals can include septage removed from septic tanks and other by-products of the treatment process (e.g., aerobic-unit-generated sludge). When planning a program a thorough knowledge of legal and regulatory requirements regarding handling and disposal is important. In general, state and local septage management programs that incorporate land application or burial of septage must comply with Title 40 of the U.S. *Code of Federal Regulations* (CFR), Parts 503 and 257. Detailed guidance for identifying, selecting, developing, and operating reuse or disposal sites for septage can be found in the USEPA *Process Design Manual: Land Application of Sewage Sludge and Domestic Septage* (USEPA, 1995c), which is posted on the Internet at **http://www.epa.gov/ORD/WebPubs/sludge.pdf**. Additional information is provided in *Domestic Septage Regulatory Guidance* (USEPA, 1993b), posted at **http://www.epa.gov/oia/tips/scws.htm**. Another document useful to practitioners and small communities is the *Guide to Septage Treatment and Disposal* (USEPA, 1994).

States and municipalities typically establish other public health and environmental protection regulations for residuals handling, transport, treatment, and reuse/disposal. In addition to regulations, practical

Installer and designer permitting in New Hampshire

System designers and installers in New Hampshire have been required to obtain state-issued permits since 1991. The New Hampshire's Department of Environmental Services Subsurface Systems Bureau issues the permits, which must be renewed annually. Permits are issued after successful completion of written examinations. The test consists of three written sections and a field test for soil analysis and interpretation. The must pass only one written examination.

The broad and comprehensive, and they assess the candidate's knowledge of New Hampshire's codified regulatory setbacks, methods of construction, types of effluent disposal systems, and new Completing the three tests designers must take requires about 5 hours. The passing grade is The field test measures competency in soil science through an analysis of a backhoe pit, of hydric soils, and recognition of other wetland conditions. The 2-hour written exam for installers understanding of topography, regulatory setbacks, seasonal high water table determination, and methods of system construction.

Source: New Hampshire Department of Environmental Services, 1991.

RA/ME activities for training, certifying, and licensing service providers

- Identify tasks that require in-house or contractor certified/licensed professionals.
- Develop certification and/or licensing program based on performance requirements.
- Establish process for certification/licensing applications and renewals if necessary.
- Develop database of service providers, service provider qualifications and contact information.
- Establish education, training, and experience requirements for service providers.
- Develop or identify continuing training opportunities for service providers.
- Circulate information on available training to service providers.
- Update service provider database to reflect verified training participation/performance.

limitations such as land availability, site conditions, buffer zone requirements, hauling distances, fuel costs, and labor costs play a major role in evaluating septage reuse/disposal options. These options generally fall into three basic categories—land application, treatment at a wastewater treatment plant, and treatment at a special septage treatment plant (see chapter 4). The initial steps in the residuals reuse/disposal decision-making process are characterizing the quality of the septage and determining potential adverse impacts associated with various reuse/disposal scenarios. In general, program officials strive to minimize exposure of humans, animals, ground water, and ecological resources to the potentially toxic or hazardous chemicals and pathogenic organisms found in septage. Other key areas of residuals management programs include tracking or man systems that identify septage sources, pumpers, transport equipment, final destinations, and tre ment methods, as well as procedures for contro human exposure to residuals, including vector control, wet weather runoff management, and limits on access to disposal sites. (Refer to chap ter 4 for more details.)

2.4.15 Certification and licensing of service providers and progra staff

Certification and licensing of service providers as septage haulers, designers, installers, and ma nance personnel can help ensure management pr gram effectiveness and compliance and reduce t administrative burden on the RA. Certification licensing of service providers is an effective me ensuring that a high degree of professionalism a experience is necessary to perform specified act Maine instituted a licensing program for site ev tors in 1974 and saw system failure rates drop t insignificant levels (Kreissl, 1982). The text b follows provides a list of activities that manage entities should consider in setting up certificatio licensing programs or requirements.

RAs should establish minimum criteria for li ing/certification of all service providers to e protection of health and water resources. M requires that site evaluators be licensed (cert and that designers of systems treating more 2,000 gallons per day or systems with unusual wastewater characteristics be registered professional engineers. Prerequisites for applying for a site evaluator permit and taking the certification examination are either a degree in engineering, soils, geology, or a similar field plus 1 year of experience or a high school diploma or equivalent and 4 years of experience (Maine Department of Human Services, 1996). State certification and licensing programs are summarized in table 2-2.

Statewide training institute for onsite professionals in North Carolina

North Carolina State University and other partners in the state developed the Subsurface Wast System Operator Training School (see **http://www.soil.ncsu.edu/swetc/subsurface/subsurface.htm**) in response to state rules requiring operators of some systems (e.g., large s and those using low-pressure pipe, drip irrigation, pressure-dosed sand filter, or peat biofilter technologies) to be certified. The school includes classroom sessions on wastewater charac laws, regulations, permit requirements, and the theory and concepts underlying subsurface tr and dispersal systems. Training units also cover the essential elements of operating small and mechanical systems, with field work in alternative system operation at NCSU's field laborato Participants receive a training manual before they arrive for the 3-day training course. Certifi those successfully completing the educational program is handled by the Water Pollution Co System Operators Certification Commission, an independent entity that tests and certifies operators throughout North Carolina.

Source: NCSU, 2001

Table 2-2. Survey of state certification and licensing programs

State	Contractors	Installers	Inspectors	Pumpers	Designers	Engineers	Geologists	Operators
Alabama	Y	Y	Y	Y	N	Y	Y	Y
Alaska	Y	Y	NA	NA	NA	Y	NA	NA
Arizona	Y	Y	NA	Y	NA	Y	Y	NA
Arkansas	N	Y	N	Y	Y	N	N	N
California	N	N	N	N	N	N	N	N
Colorado	N	N	N	N	N	Y	N	Y
Connecticut	NA	Y	Y	Y	NA	Y	NA	NA
Delaware	Y	Y	N	Y	Y	Y	Y	Y
Florida	Y	Y	Y	Y	N	N	N	N
Georgia	Y	Y	Y	Y	N	N	N	N
Hawaii	N	N	N	N	N	Y	N	Y
Idaho	N	Y	Y	Y	N	N	N	N
Illinois	Y	Y	NA	Y	NA	NA	NA	NA
Indiana	N	N	N	N	N	N	N	N
Iowa	N	N	N	Y	N	N	N	N
Kansas	NA	NA	NA	NA	NA	Y	Y	Y
Kentucky	Y	Y	Y	Y	N	N	N	N
Louisiana	NA	Y	NA	NA	NA	NA	NA	NA
Maine	N	Y	Y	N	Y	Y	Y	N
Maryland	N	Y	Y	N	N	N	N	N
Massachusetts	Y	Y	Y	Y	Y	Y	N	Y
Michigan	N	N	N	N	N	N	N	N
Minnesota	NA	Y	Y	Y	Y	NA	NA	Y
Mississippi	NA	Y	Y	Y	NA	NA	NA	NA
Missouri	Y	N	N	Y	N	Y	N	N
Montana	N	N	N	N	N	N	N	N
Nebraska	N	N	N	N	N	N	N	N
Nevada	NA	NA	NA	NA	NA	NA	NA	NA
New Hampshire	N	Y	N	N	Y	Y	N	Y
New Jersey	N	N	N	N	N	N	N	N
New Mexico	Y	Y	N	N	N	N	N	N
New York	N	N	N	Y	N	N	N	N
North Carolina	N	N	Y	Y	N	N	N	Y
North Dakota	Y	Y	Y	N	N	N	N	N
Ohio	N	N	N	N	N	N	N	N
Oklahoma	Y	Y	N	Y	Y	N	N	Y
Oregon	Y	Y	Y	Y	Y	Y	Y	Y
Pennsylvania	N	N	Y	N	N	Y	Y	N
Rhode Island	Y	Y	Y	N	Y	Y	N	Y
South Carolina	Y	Y	NA	Y	NA	NA	NA	NA
South Dakota	N	Y	N	N	N	N	N	N
Tennessee	N	Y	N	Y	N	Y	Y	Y
Texas	N	Y	Y	Y	N	N	N	Y
Utah	N	N	N	N	N	N	N	N
Vermont	N	N	N	N	Y	N	N	Y
Virginia	N	N	N	N	N	Y	Y	Y
Washington	N	N	Y	N	Y	N	N	N
West Virginia	N	Y	N	Y	N	N	N	N
Wisconsin	N	Y	Y	Y	Y	Y	Y	N
Wyoming	N	N	N	N	Y	Y	Y	N

2.4.16 Education and training programs for service providers and program staff

Onsite system RAs, RMEs, and service provider staff should have the requisite level of training and experience to effectively assume necessary program responsibilities and perform necessary activities. Professional programs are typically the mechanism for ensuring the qualifications of these personnel. They usually include licensing or certification elements, which are based on required coursework or training; an assessment of knowledge, skills, and professional judgment; past experience; and demonstrated competency. Most licensing programs require continuing education through recommended or required workshops at specified intervals. For example, the Minnesota program noted previously requires 3 additional days of training every 3 years. Certification programs for inspectors, installers, and septage haulers provide assurance that systems are installed and maintained properly. States are beginning to require such certification for all service providers to ensure that activities the providers conduct comply with program requirements. Violation of program requirements or poor performance can lead to revocation of certification and prohibitions on installing or servicing onsite systems. This approach, which links professional performance with economic incentives, is highly effective in maintaining compliance with onsite program requirements. Programs that simply register service providers or fail to take discipli action against poor performers cannot provide same level of pressure to comply with professio and technical codes of behavior.

Some certification and licensing programs for implementing regulations and performing site evaluations require higher educational achieve For example, Kentucky requires a 4-year colle degree with 24 hours of science coursework, completion of a week-long soils characterizatio class, and another week of in-service training all permit writers and site evaluators (Kentuck Revised Statutes, 2001). Regular training sessio are also important in keeping site evaluators permit writers, designers, and other service p nel effective. For example, the Minnesota Co tive Extension Service administers 3-day wor shops on basic and advanced inspection and m nance practices, which are now required for certification in 35 counties and most cities in state (Shephard, 1996). Comprehensive trai programs have been developed in other state including West Virginia and Rhode Island.

Sixteen states have training centers. For mo information on training programs for onsite wastewater professionals, including a calend planned training events and links to trainin providers nationwide, visit the web site of t National Environmental Training Center fo Communities at West Virginia University a **www.estd.wvu.edu/netc/**

NSF onsite wastewater inspector accreditation program

NSF International has developed an accreditation program designed to verify the proficiency of persons performing inspections of existing OWTSs. The accreditation program includes written and field tests and p credit for continuing education activities. Inspectors who pass the tests and receive accreditation are listed o NSF International web site and in the NSF Listing Book, which is circulated among industry, government a other groups.

The accreditation process includes four components. A written examination, conducted at designated loca around the country, covers a broad range of topics related to system inspections, including equipment, a procedures, troubleshooting, and the NSF International Certification Policies. The field examination includ evaluation of an existing OWTS. An ethics statement, required as part of the accreditation, includes a pl the applicant to maintain a high level of honesty and integrity in the performance of evaluation activities. T the continuing education component requires requalification every 5 years through retesting or earning requalification credits by means of training or other activities.

To pass the written examination, applicants must answer correctly at least 75 of the 100 multiple-choice and score at least 70 percent on the field evaluation. A 30-day wait is required for retesting if the applic either the written or field examination.

Source: Noah, 2000

Inspection and monitoring program elements

- Develop/maintain inventory of all systems in management area (e.g., location, age, owner, type, size).
- Establish schedule, parameters, and procedures for system inspections.
- Determine knowledge level required of inspectors and monitoring program staff.
- Ensure training opportunities for all staff and service providers.
- Establish licensing/certification program for inspectors.
- Develop inspection program (e.g., owner inspection, staff inspection, contractor inspection)
- Establish right-of-entry provisions to gain access for inspection or monitoring.
- Circulate inspection program details and schedules to system owners.
- Establish reporting system and database for inspection and monitoring program.
- Identify existing ground water and surface water monitoring in area and determine supplemental monitoring required.

Providing legal access for inspections in Colorado

Colorado regulations state that "the health officer or his/her designated agent is authorized to enter upon private property at reasonable times and upon reasonable notice . . . to conduct required tests, take samples, monitor compliance, and make inspections."

Source: NSFC, 1995a.

CSC_curricula.html. For links to state onsite regulatory agencies, codes, and other information, visit http://www.estd.wvu.edu/nsfc/links.html.

2.4.17 Inspection and monitoring programs to verify and assess system performance

Inspections should be performed to ascertain effectiveness. The type and frequency should be determined by the size of conditions, resource sensitivity, the number of systems, and the re- RA or RME. The RA should ensure procedures are followed.

Inspections during seasonal rises in can allow monitoring of "worst case" conditions. A site can be implemented as a system program, an owner/operator con- certified operators, or a routine by an RME. A combination of visual, physical, bacteriological, chemical, and remote monitoring and modeling can be used to assess system performance. Specific requirements for reporting to the appropriate regulatory agency should be clearly defined for the management program. Components of an effective inspection, monitoring, operation, and maintenance program include

- Specified intervals for required inspections (e.g., every 3 months, every 2 years, at time of property transfer or change of use).
- Legal authority to access system components for inspections, monitoring, and maintenance.
- Monitoring of overall operation and performance, including remote sensing and failure reporting for highly mechanical and complex systems.
- Monitoring of receiving environments at compliance boundaries to meet performance requirements.
- Review of system use or flow records, (e.g., water meter readings).
- Required type and frequency of maintenance for each technology.
- Identification, location, and analysis of system failures.
- Correction schedules for failed systems through retrofits or upgrades.
- Record keeping on systems inspected, results, and recommendations.

Inspection programs are often incorporated into comprehensive management programs as part of a

seamless approach that includes planning site evaluation, design, installation, operation, maintenance, and monitoring. For example, the Town of Paradise, California, established an onsite wastewater management program in Butte County in 1992 after voters rejected a sewage plant proposal for a commercial area (NSFC, 1996). The program manages 16,000 systems through a system of installation permits, inspections, and operating permits with terms up to 7 years. Operating permit fees are less than $15 per year and are included in monthly water bills. Regular inspections, tank pumping, and other maintenance activities are conducted by trained, licensed service providers, who report their activities to program administrators. Paradise is one of the largest unsewered incorporated towns in the nation.

Outreach programs to lending institutions on the benefits of requiring system inspections at the time of property transfer can be an effective approach for identifying and correcting potential problems and avoiding compliance and enforcement actions. Many lending institutions across the nation require system inspections as part of the disclosure requirements for approving home or property loans. For example, Washington State has disclosure provisions for realtors at the point of sale, and many lending institutions have incorporated onsite system performance disclosure statements into their loan approval processes (Soltman, 2000)

Table 2-3. Components of an onsite system regulatory program

Regulatory component	Description/function
Legal authority	State and local laws, regulations, ordinances, and the like that assign authority to enact specific onsite wastewater system management regulations and operate management program.
Administration	Processes, procedures, and operational practices for system planning, design approval, permitting, inspection, reporting, enforcement, and other functions. Includes licensing, certification, or registration of service providers, training requirements, and so forth.
Definitions	Definitions of the terms used in the regulations.
Location/separation guidelines	Guidelines for siting system components at specified minimum distances from wells, residences, property lines, surface waters, and ground water (e.g., perched water table, seasonal high water table).
Site evaluation	Analyses and evaluations of soil classification, depth, and structure. Assessment of hydrogeology, slopes, vegetation, and other features for each site proposed for system installation.
System selection and design criteria	Criteria for proposed systems based on site conditions, wastewater characterization, anticipated flow, public health and resource protection goals, and treatment technology.
Construction and permitting	Mandatory approval processes for constructing a designated system at a particular site on site evaluation and system design and selection criteria (see above).
Performance requirements	Numeric or narrative requirements for system effluent discharges. Based on health and resource protection goals.
Operation and maintenance	Requirements for proper operation (e.g., no solvent discharges to onsite system) and maintenance (e.g., tank pumped every 3 years) of system components.
Enforcement	Incentives (e.g., operating permit renewed) and disincentives (e.g., fines, water service suspended) to ensure compliance with onsite system regulations.
Licensing and certification	Training, licensing, and certification programs for system designers and service providers, especially those operating and servicing alternative or mechanized systems.
Septage disposal	Requirements for licensing/registration of pumpers and haulers, storage and handling of septage, disposal or reuse of septage.

Source: Adapted from Ciotoli and Wiswall, 1982; USEPA, 2000.

2.4.18 Compliance, enforcement, and corrective action programs

Requiring corrective action when onsite systems fail or proper system maintenance does not occur helps to ensure that performance goals and requirements will be met. Compliance and enforcement measures are more acceptable to system owners and the public when the RA is clear and consistent regarding its mission, regulatory requirements, and how the mission relates to public health and water resource protection. An onsite wastewater compliance and enforcement program should be based on reasonable and scientifically defensible regulations, promote fairness, and provide a credible deterrent to those who might be inclined to skirt its provisions. Regulations should be developed with community involvement and provided in summary or detailed form to all stakeholders and the public at large through education and outreach efforts. Service provider training programs are most effective if they are based on educating contractors and staff on technical and ecological approaches for complying with regulations and avoiding known and predictable enforcement actions. Table 2-3 describes the components of a regulatory program for onsite/decentralized systems.

Four types of legal instruments are available to formulate or enact onsite system regulations. Regulatory programs can be enacted as ordinances, management constituency agreements, or local or state codes, or simply as guidelines. Often, local boards or other units of government can modify state code requirements to better address local conditions. Local ordinances that promote performance based approaches can reference technical design manuals for more detailed criteria on system design and operation. Approaches for enforcing requirements and regulations of a management program can include

- Response to complaints
- Performance inspections
- Review of required documentation and reporting
- Issuance of violation notices
- Consent orders and court orders
- Formal and informal hearings
- Civil and criminal actions or injunctions
- Condemnation of systems and/or property
- Correcting system failures
- Restriction of real estate transactions (e.g., placement of liens)
- Issuance of fines and penalties

Some of these approaches can become expensive or generate negative publicity and provide little in terms of positive outcomes if public support is not present. Involvement of stakeholders in the development of the overall management program helps ensure that enforcement provisions are appropriate for the management area and effectively protect human health and water resources. Stakeholder involvement generally stresses restoration of performance compliance rather than more formal punitive approaches.

Information on regional onsite system performance, environmental conditions, management approaches by other agencies, and trends analyses might be needed if regulatory controls are increased. Most states establish regulatory programs and leave enforcement of these codes up to the local agencies. Table 2-4 contains examples of enforcement options for onsite management programs.

A regulatory program focused on achieving performance requirements rather than complying with prescriptive requirements places greater responsibilities on the oversight/permitting agency, service providers (site evaluator, designer, contractor, and operator), and system owners. The management entity should establish credible performance standards and develop the competency to review and approve proposed system designs that a manufacturer or engineer claims will meet established standards. Continuous surveillance of the performance of newer systems should occur

Corrective action program elements

- A process for reporting and responding to [illegible] (e.g., complaint reporting, inspections).
- [illegible] conditions that constitute a violation of [illegible] requirements.
- [illegible] inspection procedures for reported [illegible] and corrective action schedule.
- [illegible] system for issuing violation notices, [illegible] schedules, contingencies, fines, or other [illegible] to address uncorrected violations.

Table 2-4. Compliance assurance approaches

Collection method	Description	Advantages	Disadvantages
Liens on property	Local governing entity (with taxing powers) might add the costs of performing a service or past unpaid bills as a tax on the property.	Has serious enforcement ramifications and is enforceable.	Local government might be reluctant to apply this appro unless the amount owed is substantial.
Recording violations on property deed	Copies of violations can, through administrative or legislature requirement, be attached to the property title (via registrar of deed).	Relatively simple procedure. Effectively limits the transfer of property ownership.	Can be applied to enforce sanitary code violations; mi be ineffective in collecting unpaid bills.
Presale inspections	Inspections of onsite wastewater systems are conducted prior to transfer of property or when property use changes significantly	Notice of violation might be given to potential buyer at the time of system inspection; seller might be liable for repairs	Can be difficult to implemen because of additional resources needed. Inspec fees can help cover costs
Termination of public services	A customer's water, electric, or gas service might be terminated (as applicable).	Effective procedure, especially if management entity is responsible for water supply.	Termination of public servi poses potential health ris Cannot terminate water se if property owner has wel
Fines	Monetary penalties for each day of violation, or as a surcharge on unpaid bills.	Fines can be levied through local judicial system as a result of enforcement of violations.	Effectiveness will depend the authority vested in th entity issuing the fine.

Source: Ciotoli and Wiswall, 1982.

through an established inspection and compliance program. The service providers should be involved in such programs to ensure that they develop the knowledge and skills to successfully design, site, build, and/or operate the treatment system within established performance standards. Finally, the management entity should develop a replicable process to ensure that more new treatment technologies can be properly evaluated and appropriately managed.

2.4.19 Data collection, record keeping, and reporting

Onsite wastewater management entities require a variety of data and other information to function effectively. This information can be grouped in the following categories:

- *Environmental assessment information*: geology, topography, soils, slopes, grou and surface water characterization data ing direction of flow), land use/land co information, physical infrastructure (ro water lines, sewer lines, commercial de ment, etc.).
- *Planning information*: existing and pro development, proposed water or sewe extensions, zoning classifications, po trends data, economic information, regarding other agencies or entities onsite wastewater issues.
- *Existing systems information*: record evaluations conducted and inventory existing onsite systems, cluster sys plants, and wastewater treatment p ing location, number of homes/fac and size (e.g., 50-seat restaurant,

Record keeping and reporting program elements

Establish a database structure and reporting systems, at a minimum, for

- Environmental assessments
- Planning and stakeholder involvement functions
- Existing systems
- Staff, service providers, financial, and other administrative functions
- Inspection and monitoring program, including corrective actions required
- Septage and residuals management, including approved haulers, disposal sites, and manifest system records

homes), system owner and contact information, location and system type, design and site drawings (including locations of property lines, wells, water resources), system components (e.g., concrete or plastic tank, infiltration lines or leaching chambers), design hydraulic capacity, performance expectations or effluent requirements (if any), installation date, maintenance records (e.g., last pumpout, repair, complaints, problems and actions taken, names of all service providers), and septage disposal records. Many states and localities lack accurate system inventories. USEPA (2000) recommends the establishment and continued maintenance of accurate inventories of all OWTSs within a management entity's jurisdiction as a basic requirement of all management programs.

- *Administrative information*: personnel files (name, education/training, work history, skills/expertise, salary rate, job review summaries), financial data (revenue, expenses, debts and debt service, income sources, cost per unit of service estimates), service provider/vendor data (name, contact information, certifications, licenses, job performance summaries, disciplinary actions, work sites, cost record), management program initiatives and participating entities, program development plans and milestones, septage management information, and available resources.

Data collection and management are essential to program planning, development, and implementation. The components of a management information system include database development, data collection, data entry, data retrieval and integration, data analysis, and reporting. A variety of software is commercially available for managing system inventory data and other information. Electronic databases can increase the ease of collecting, storing, retrieving, using, and integrating data after the initial implementation and learning curve have been overcome. For example, if system locations

Use of onsite system tracking software in the Buzzards Bay watershed

The Buzzards Bay Project is a planning and technical assistance initiative sponsored by the state environmental agency's Coastal Zone Management Program. The Buzzards Bay Project was the first National Estuary Program in the country to develop a watershed Comprehensive Conservation and Management Plan, which the Governor and USEPA approved in 1991. The primary focus of the Buzzards Bay management plan is to provide financial and technical assistance to Buzzards Bay municipalities to address nonpoint source pollution and facilitate implementation of Buzzards Bay Management Plan recommendations. The Buzzards Bay Project National Estuary Program provided computers and a software package to municipal boards of health in the watershed to enable better tracking of septic system permits, inspection results, and maintenance information. The software, along with the user's manual and other information, can be downloaded from the Buzzards Bay to provide easy access for jurisdictions interested in its application and use (see **http://buzzardsbay.org/septrfct.htm**). This approach is designed to help towns and cities reduce the time they [illegible] retrieving, and maintaining information through a system that can provide—at the click of a [illegible] relevant data on any lot in the municipality. The software program can also help towns respond to [illegible] requests more effectively, process permit applications more quickly, and manage new inspection [illegible] reporting requirements more efficiently.

[illegible] Bay Project National Estuary Program, 1999.

are described in terms of specific latitude and longitude coordinates, a data layer for existing onsite systems can be created and overlaid on geographic information system (GIS) topographic maps. Adding information on onsite wastewater hydraulic output, estimated mass pollutant loads, and transport times expected for specified hydrogeomorphic conditions can help managers understand how water resources become contaminated and help target remediation and prioritization actions. Models can also be constructed to predict impacts from proposed development and assist in setting performance requirements for onsite systems in development areas.

System inventories are essential elements for management programs, and most jurisdictions maintain databases of new systems through their permitting programs. Older systems (those installed before 1970), however, are often not included in the system inventories. Some onsite management programs or other entities conduct inventories of older systems when such systems are included in a special study area. For example, Cass County and Crow Wing County in Minnesota have developed projects to inventory and inspect systems at more than 2,000 properties near lakes in the north-central part of the state (Sumption, personal communication, 2000). The project inventoried systems that were less than 5 years old but did not inspect them unless complaint or other reports indicated possible problems. Costs for inventorying and inspecting 234 systems in one lake watershed totaled $9,000, or nearly $40 per site (Sumption, personal communication, 2000). Mancl and Patterson (2001) cite a cost of $30 per site inspection at Lake Panorama, Iowa.

Some data necessary for onsite system management might be held and administered by other agencies. For example, environmental or planning agencies often collect, store, and analyze land and water resource characterization data. Developing data sharing policies with other entities through cooperative agreements can help all organizations involved with health and environmental issues improve efficiency and overall program performance. The management agency should ensure that data on existing systems are available to health and water resource authorities so their activities and analyses reflect this important aspect of public health and environmental protection.

2.4.20 Program evaluation criteria an[illegible] procedures

Evaluating the effectiveness of onsite managem[illegible] program elements such as planning, funding, enforcement, and service provider certification, provide valuable information for improving programs. A regular and structured evaluation of any program can provide critical information to program managers, the public, regulators, and decision makers. Regular program evaluations should be performed to analyze program method and procedures, identify problems, evaluate the potential for improvement through new techno[illegible] gies or program enhancements, and ensure fun[illegible] is available to sustain programs and adjust pro[illegible] goals. The program evaluation process should include

- A tracking system for measuring success and for evaluating and adapting program components
- Processes for comparing program achieve[illegible] to goals and objectives
- Approaches for adapting goals and objec[illegible] internal or external conditions change
- Processes for initiating administrative or actions to improve program functioning
- An annual report on the status, trends, a[illegible] achievements of the management progr[illegible]
- Venues for ongoing information exchan[illegible] among program stakeholders

A variety of techniques and processes can [illegible] to perform program evaluations to assess [illegible] trative and management elements. The meth[illegible] chosen for each program depends on local c[illegible] stances, the type and number of stakehold[illegible] volved, and the level of support general[illegible] management agencies to conduct a careful, detailed review of the program's success [illegible] health and water resources. Regardless of [illegible] method selected, the program evaluation [illegible] performed at regular intervals by exp[illegible] and program stakeholders should be in[illegible]

A number of state, local, and private [illegible] have implemented performance-based [illegible] programs for a wide range of activiti[illegible] budgeting processes to industrial pro[illegible] operations. The purpose of these pro[illegible]

Performance-based budgeting in Texas

Since 1993 state agencies in Texas have been required to develop a long-term strategic plan that includes a mission statement, goals for the agency, performance measures, an identification of persons served by the agency, an analysis of the resources needed for the agency to meet its goals, and an analysis of expected changes in services due to changes in the law. Agency budget line items are tied to performance measures and are available for review through the Internet. Information on the budgeting process in Texas is available from the Texas Legislative Budget Board at **http://www.lbb.state.tx.us**.

Source: Texas Senate Research Center, 2000.

[illegible] linking required resources with manage[illegible] objectives and ensuring continuous improve[illegible] Onsite management programs could also ask [illegible] entities to use their experience to help [illegible] and implement in-house evaluation processes.

[illegible] Financial assistance for [illegible] management programs and [illegible] system installation

[illegible] management programs do not construct or [illegible] systems they regulate. Homeowners or [illegible] individuals usually pay a permit fee to [illegible] to cover site evaluation and permitting [illegible] then finance the installation, operation, [illegible] and repair of their systems them[illegible] recent years, however, onsite [illegible] officials and system owners have [illegible] supportive of centralized operation, [illegible] repair services. In addition, some [illegible] programs are starting to provide [illegible] installation, repair, or replacement in the [illegible] funding, grants, and low-interest [illegible] have elected to make a [illegible] individual systems to a clustered [illegible] on the financial and other [illegible] with the joint use of lagoons, [illegible] system components linked by [illegible] pressure piping. Developers of [illegible] Individual septic tanks [illegible] treatment units, have been [illegible] aggressive in obtaining [illegible] installation.

Funding for site evaluation, permitting, and enforcement programs is generally obtained from permit fees, property assessments (e.g., health district taxes), and allocations from state legislatures for environmental health programs. However, many jurisdictions have discovered that these funding sources do not adequately support the full range of planning, design review, construction oversight, inspection and monitoring, and remediation functions that constitute well-developed onsite management programs. Urbanized areas have supplemented funding for their management programs with fees paid by developers, monthly wastewater treatment service fees (sometimes based on metered water use), property assessment increases, professional licensing fees, fines and penalties, and local general fund appropriations. This section includes an overview of funding options for onsite system management programs.

2.5.1 Financing options

Two types of funding are usually necessary for installation and management of onsite wastewater systems. First, initial funding is required to pay for any planning and construction costs, which include legal, administrative, land acquisition, and engineering costs. Once the construction is complete, additional funding is needed to finance the ongoing operation and maintenance, as well as to pay for the debt service incurred from borrowing the initial funds. Table 2-6 lists potential funding sources and the purposes for which the funds are typically used. As indicated in the table, each funding source has advantages and disadvantages. Decision makers must choose the funding sources that best suit their community.

Primary sources of funds include

- Savings (capital reserve)
- Grants (state, federal)
- Loans (state, federal, local)
- Bond issues (state, local)
- Property assessments

Publicly financed support for centralized wastewater treatment services has been available for decades from federal, state, and local sources. Since 1990 support for public funding of onsite treatment systems has been growing. The following section summarizes the most prominent sources of

Suggested approach for conducting a formal program evaluation

Form a program evaluation team composed of management program staff, service providers, public health agency representatives, environmental protection organizations, elected officials, and interested citizens.

Define the goals, objectives, and operational elements of the various onsite management program components. This can be done simply by using a checklist to identify which program components currently exist. Table 2-5 provides an excellent matrix for evaluating the management program.

Review the program components checklist and feedback collected from staff and stakeholders to determine progress toward goals and objectives, current status, trends, cost per unit of service, administrative processes used, and cooperative arrangements with other entities.

Identify program components or elements in need of improvement, define actions or amount and type of resources required to address deficient program areas, identify sources of support or assistance, discuss proposed program changes with the affected stakeholders, and implement recommended improvement actions.

Communicate suggested improvements to program managers to ensure that the findings of the evaluation are considered in program structure and function.

Table 2-5. Example of Functional Responsibilities Matrix

	State health departments	County health departments	Towns	Homeowners	Private firms	Comments
Planning/Administration						
Plan preparation			X			
Plan review coordination	X	X	X			
Research and development	X					
Office and staff management		X				
Site Evaluation						
Guidelines and criteria	X					
Evaluation certification		X				
Site sustainability analysis					X	
System Design						
Standards and criteria						Not done
Designer certification	X					
System design					X	
* Design review		X				
Permit issuance		X				
Installation						
* Construction supervision		X				Not done
Installer certification		X				
* Record-keeping		X				
Permit issuance		X				
Operation and Maintenance						Not done
* Procedures and regulations						Not done
Operator/inspector certification						Not done
* Routine inspections						
* Emergency inspections		X		X		
* System repair/replacement						Not done
* Repair supervision		X				
Performance certification				X		
System ownership						
Residuals Disposal						
Disposal regulations	X					
* Hauler certification	X					
Record-keeping		X				
Equipment inspections		X				
Facility inspections		X				
Facility operations		X				
Financing						
* Secure funding					X	
* Set changes						Not applicable
* Collect charges						Not applicable
Monitoring						Not applicable
* Reporting system						Not applicable
Sampling	X					
Public Education						
Develop methods	X					
* Disseminate information	X					
* Respond to complaints		X				

*Management functions that require local agency input.

Table 2-6. Funding options

Fund type	Source of funds	How funds are used						
		Construction and repair	Inspections	Permitting	Planning	Capital reserve	Principal and interest	Operation and maintenance
Initial funds	Municipality receives state grants, state revolving funds, state bonds	X	X	X	X			
	Municipality uses savings (capital reserve)	X	X	X	X			
	Municipality obtains federal grants or loans	X	X	X	X			
	Municipality obtains loans from local bank	X	X	X	X			
	Cost sharing with major users	X	X	X	X			
	Property assessments (might require property owner to obtain low-interest loans)	X	X	X	X			
Management program costs (continual)	User fees (property owner)		X	X		X	X	X
	Taxes (property owner)		X	X		X	X	X
	Fees for specific services, punitive fees (property owner)		X	X				X
	Capital reserve fund	X			X			
	Developer-paid fees (connection fees, impact fees)	X	X	X	X	X	X	X

[illegible] interest payment (debt service) on various loans used for initial financing.
[illegible] Wiswall, 1982, 1986; Shephard, 1996.

[illegible] and loan guarantee funding and outline [illegible] funding sources.

[illegible]ary funding sources

[illegible]cies and programs are among the [illegible] and popular sources of funds for [illegible]gement and installation programs.

State Revolving Fund

[illegible] State Revolving Fund, or CWSRF [illegible] gov/owm/finan.htm), is a low- or no-interest loan program that has traditionally financed centralized sewage treatment plants across the nation. Program guidance issued in 1997 emphasized that the fund could be used as a source of support for the installation, repair, or upgrading of onsite systems in small towns, rural areas, and suburban areas. The states and the territory of Puerto Rico administer CWSRF programs, which operate like banks. Federal and state contributions are used to capitalize the fund programs, which make low- or no-interest loans for water quality projects. Funds are then repaid to the CWSRF over terms as long as 20 years. Repaid funds are recycled to fund other water quality projects. Projects

Financial assistance program elements

- Determine program components or system aspects that require additional financial assistance.
- Identify financial resources available for system design, installation, operation, maintenance, and repair.
- Research funding options (e.g., permit or user fees, property taxes, impact fees, fines, grants/loans).
- Work with stakeholder group to execute or establish selected funding option(s).

that might be eligible for CWSRF funding include new system installations and replacement or modification of existing systems. Costs associated with establishing a management entity to oversee onsite systems in a region, including capital outlays (e.g., for trucks on storage buildings), may also be eligible. Approved management entities include city and county governments, special districts, public or private utilities, and private for-profit or nonprofit corporations.

U.S. Department of Agriculture Rural Development programs

U.S. Department of Agriculture Rural Development programs provide loans and grants to low and moderate-income persons. State Rural Development offices administer the programs; for state office locations, see **http://www.rurdev.usda.gov/recd_map.html**. A brief summary of USDA Rural Development programs is provided below.

Rural Housing Service

The Rural Housing Service Single-Family Housing Program (http://www.rurdev.usda.gov/rhs/Individual/ind_splash.htm) provides homeownership opportunities to low- and moderate-income rural Americans through several loan, grant, and loan guarantee programs. The program also makes funding available to individuals to finance vital improvements necessary to make their homes safe and sanitary. The Direct Loan Program (section 502) provides individuals or families direct financial assistance in the form of a home loan at an affordable interest rate. Most loans are to families with incomes below 80 percent of the median income level in the communities where they live. Applicants might obtain 100 percent financing to build, repair, renovate, or relocate a home, or to purchase and prepare sites, including providing water and sewage facilities. Families must be without adequate housing but be able to afford mortgage payments, including taxes and insura These payments are typically within 22 to 26 percent of an applicant's income. In addition, applicants must be unable to obtain credit elsew where yet have reasonable credit histories. Elder and disabled persons applying for the program have incomes up to 80 percent of the area medi income.

Home Repair Loan and Grant Program

For very low-income families that own homes need of repair, the Home Repair Loan and Gra Program offers loans and grants for renovatio Money might be provided, for example, to rep leaking roof; to replace a wood stove with cent heating; or to replace a pump and an outhous running water, a bathroom, and a waste disposa system. Homeowners 62 years and older are eligible for home improvement grants. Othe income families and individuals receive loans 1 percent interest rate directly from the Rura Housing Service. Loans of up to $20,000 an grants of up to $7,500 are available. Loans a up to 20 years at 1 percent interest.

Rural Utilities Service

The Rural Utilities Service (**http://www.wat rus/water/programs.htm**) provides assista public or not-for-profit utilities, including water management districts. Water and was disposal loans provide assistance to develop and waste disposal systems in rural areas an with a population of 10,000 or less. The fu available to public entities such as munici counties, special-purpose districts, Indian t and corporations not operated for profit. T program also guarantees water and waste loans made by banks and other eligible l Water and Waste Disposal Grants can p reduce water and waste disposal costs to a able level for rural users. Grants might p up to 75 percent of eligible project cost cases.

Rural Business-Cooperative Service

The Rural Business-Cooperative Service (**http://www.rurdev.usda.gov/rbs/busp/b&i_gar.htm**) provides assistance for businesses that provide services for system operation and management. Business and Industry Guaranteed Loans can be made to help create jobs and stimulate rural economies by providing financial backing for rural businesses. This program provides guarantees up to 90 percent of a loan made by a commercial lender. Loan proceeds might be used for working capital, machinery and equipment, buildings and real state, and certain types of debt refinancing. Assistance under the Guaranteed Loan Program is available to virtually any legally organized entity, including a cooperative, corporation, partnership, trust or other profit or nonprofit entity, Indian tribe or federally recognized tribal group, municipality, county or other political subdivision of a state.

Community Development Block Grants

The U.S. Department of Housing and Urban Development (HUD) operates the Community Development Block Grant (CDBG) program, which provides annual grants to 48 states and Puerto Rico. The states and Puerto Rico use the funds to award grants for community development to smaller cities and counties. CDBG grants may be used for various activities, including rehabilitating residential and nonresidential structures, constructing public facilities, and improving water and sewer facilities, including onsite systems. USEPA works with HUD to improve access to CDBG for wastewater treatment system owners by raising awareness, reducing paperwork burdens, and including promotional activities in eligible grants. Information is available at **http://www.hud.gov/cpd/cdbg.html**.

Nonpoint Source Pollution Program

Clean Water Act section 319 (nonpoint source pollution control) funds can support a wide range of polluted runoff abatement, including onsite wastewater projects. Authorized under section 319 of the federal Clean Water Act and financed by federal, state, and local contributions, these projects provide cost-share funding for individual and community systems and support broader watershed assessment, planning, and management activities. Projects funded in the past have included direct cost-share for onsite system repairs and upgrades, assessment of watershed-scale onsite system contributions to polluted runoff, regional remediation strategy development, and a wide range of other programs dealing with onsite wastewater issues. For example, a project conducted by the Gateway District Health Department in east-central Kentucky enlisted environmental science students from Morehead State University to collect and analyze stream samples for fecal coliform "hot spots." Information collected by the students was used to target areas with failing systems for cost-share assistance or other remediation approaches (USEPA, 1997b). The Rhode Island Department of Environmental Management developed a user-friendly system inspection handbook with section 319 funds to improve system monitoring practices and then developed cost-share and loan programs to help system owners pay for needed repairs (USEPA, 1997). For more information, see **http://www.epa.gov/OWOW/NPS/**.

2.5.3 Other funding sources

Other sources of funding include state finance programs, capital reserve or savings funds, bonds,

PENNVEST: Financing onsite wastewater systems in the Keystone State

Pennsylvania Infrastructure Investment Authority (PENNVEST) provides low-cost financing for systems on lots or within entire communities. Teaming with the Pennsylvania Housing Finance Agency and the Department of Environmental Protection, PENNVEST created a low-interest onsite system loan program for moderate-income (150 percent of the statewide median household income) homeowners. The $65 fee is refundable if the project is approved. The program can save system owners $3,000 to $6,000 in payments on a 15-year loan of $10,000. As of 1999 PENNVEST had approved 230 loans totaling $3.5 million. Funds for the program come from state revenue bonds, special statewide referenda, the state general fund, and the State Revolving Fund.

certificates of participation, notes, and property assessments. Nearly 20 states offer some form of financial assistance for installation of OWTSs, through direct grants, loans, or special project cost-share funding. Capital reserve or savings funds are often used to pay for expenses that might not be eligible for grants or loans, such as excess capacity for future growth. Capital reserve funds can also be used to assist low- and moderate-income households with property assessment or connection fees.

Bonds usually finance long-term capital projects such as the construction of OWTSs. States, municipalities, towns, townships, counties, and special districts issue bonds. The two most common types of bonds are general obligation bonds, which are backed by the faith and credit of the issuing government, and revenue bonds, which are supported by the revenues raised from the beneficiaries of a service or facility. General obligation bonds are rarely issued for wastewater treatment facilities because communities are often limited in the amount of debt they might incur. These bonds are generally issued only for construction of schools, libraries, municipal buildings, and police or fire stations.

Revenue bonds are usually not subject to debt limits and are secured by repayment through user fees. Issuing revenue bonds for onsite projects allows a community to preserve the general obligation borrowing capacity for projects that do not generate significant revenues. A third and less commonly used bond is the special assessment bond, which is payable only from the collection of special property assessments. Some states administer state bond banks, which act as intermediaries between municipalities and the national bond market to help small towns that otherwise would have to pay high interest rates to attract investors would be unable to issue bonds. State bond banks, backed by the fiscal security of the state, can issue one large, low-interest bond that funds projects in a number of small communities

Communities issue Certificates of Participation (COPs) to lenders to spread out costs and risks of loans to specific projects. If authorized under state law, COPs can be issued when bonds would exceed debt limitations. Notes, which are written promises to repay a debt at an established interest rate, are similar to COPs and other loan programs. Notes are used mostly as a short-term mechanism to finance construction costs while grant or loan applications are processed. Grant anticipation notes are secured by a community's expectation that it will receive a grant. Bond anticipation notes are secured by a community's ability to sell bonds.

Finally, property assessments might be used to recover capital costs for wastewater facilities. In a benefit property owners within a defined area. For example, property owners in a specific neighborhood

Funding systems and management — Massachusetts

The Commonwealth of Massachusetts has developed three programs that help finance onsite systems' management programs. The loan program provides loans at below-market rates. A tax credit program provides a tax credit of up to $4,500 over 3 years to defray the cost of system repairs for a primary residence. Finally, the Comprehensive Community Septic Management Program provides fund-based, term community, regional, or watershed-based solutions to system failures in sensitive environmental areas. Low-interest management program loans to $100,000 are available.

Source: Massachusetts DEP, 2000.

		Loans must be repaid with interest. Lending agency might require certain provisions (e.g., power to levy taxes) to assure managing agency of ability to repay the debt. Commercial loans generally are available at higher interest rates and might be difficult to obtain without adequate collateral.	Applying for grants and managing grant money require time and money. Sometimes grant-imposed wage standards apply to an entire project even if the grant is only partially funding the project; this increases project expense. Some grants require use of material and design requirements that exceed local standards. (Grants might result in higher costs.)
Grants	Funds awarded to pay for some or all of a community project.	State and federal agencies can often issue low-interest loans with a long repayment period. Loans can be used for short-term financing while waiting for grants or bonds.	Funds need not be repaid. Small communities might be eligible for many different grants to build or upgrade their environmental facilities.
General obligation bonds	Bonds backed by the full faith and credit of the issuing entity. Secured by the taxing powers of the issuing entity. Commonly used by local governments.	Interest rates are usually lower than those of other bonds. Offers considerable flexibility to local governments.	Community debt limitations might restrict use. Voters often must approve of using these bonds. Usually used for facilities that do not generate revenues.
Revenue bonds	Bonds repaid by the revenue of the facility.	Can be used to circumvent local debt limitation.	Do not have full faith and credit of the local government. Interest rates are typically higher than those of general obligation bonds.
Special assessment bonds	Bonds payable only from collection of special assessments. Property taxes cannot be used to pay for these.	Removes financial burden from local government. Useful when direct benefits can be readily identified.	Can be costly to individual landowners. Might be inappropriate in areas with nonuniform lot sizes. Interest rate might be relatively high.
Bond bank monies	States use taxing power to secure a large bond issue that can be divided among communities.	States can get the large issue bond at a lower interest rate. The state can issue the bond in anticipation of community need.	Many communities compete for limited amount of bond bank funds.
Certificates of participation	COPs can be issued by a community instead of bonds. COPs are issued to several lenders that participate in the same loan.	Costs and risks of loan spread out over several lenders. When allowed by state law, COPs can be issued when bonds would exceed debt limitations.	Requires complicated agreements among participating lenders.
Note	A written promise to pay a debt. Can include grant and bond anticipation notes.	Method of short-term financing while a community is waiting for a grant or bond.	Community must be certain of receipt of the grant money. Bond notes are risky because voters must approve general obligation bonds before they are issued. Voter support must be overwhelming if bond notes are used.
Property assessment	Direct fees or taxes on property. Sometimes referred to as an improvement fee.	Useful where benefits from capital improvements are identifiable. Can be used to reduce local share debt requirements for financing. Can be used to establish a fund for future capital investments.	Initial lump sum payment of assessment might be a significant burden on individual property owners.
User fee	Fee charged for using the wastewater system.	Generates steady flow of revenue. Graduated fees encourage water conservation.	Flat fees discourage water conservation. Graduated fee could discourage industries or businesses that use high volumes of water from locating in an area.
Service fee	Fee charged for a specific service, such as pumping the septic tank.	Generates funds to pay for O&M. Fees not imposed on people not connected to the system.	Revenue flow not always continuous.
Punitive fees	Charges assessed for releasing pollutants into the system.	Generates revenue while discouraging pollution.	Generation of funds not always reliable. Could encourage business to change location or participate in illegal activities to avoid fees. Could generate opposition to O&M scheme.
Connection fees	Charges assessed for connection to existing system.	Connection funded by beneficiary. All connection costs might be paid.	Might discourage development.

Source: USEPA, 1994.

hood could be assessed for the cost of installing sewers or a cluster treatment system. Depending on the amount of the assessment, property owners might pay it all at once or pay in installments at a set interest rate. Similar assessments are often charged to developers of new residential or commercial facilities if the developers are not required to install wastewater treatment systems approved by the local regulatory agency. Funding for ongoing management of onsite systems in newly developed areas should be considered when these assessments are calculated.

Although funds from grants, special projects, and other one-time sources can help initiate special projects or develop new functions, support for onsite management over the long term should come from sources that can provide continuous funding (table 2-7). Monthly service fees, property assessments, regular general fund allocations, and permit/licensing fees can be difficult to initiate but provide the most assurance that management program activities can be supported over the long term. Securing public acceptance of these financing mechanisms requires stakeholder involvement in their development, outreach programs that provide a clear picture of current problems and expected benefits, and an appropriate matching of community resources with management program need.

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