Local Board of Health Guide to On-Site Wastewater Treatment Systems

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FOREWORD

The National Association of Local Boards of Health (NALBOH) is pleased to provide this *Local Board of Health Guide to On-Site Wastewater Treatment Systems*. NALBOH contracted with Judith L. Sims, Associate Research Professor for Utah State University to write this guide for local board of health members. The *Guide's* purpose is to help board members understand on-site wastewater treatment systems. The Environmental Health Services Branch of the Centers for Disease Control and Prevention (CDC), National Center for Environmental Health (NCEH) encouraged the development of this project and provided technical oversight and financial support.

Boards of health are responsible for fulfilling the three public health core functions: assessment, policy development, and assurance. The board of health must continually work to assure that there is adequate and appropriate legal authority for any public health activity, including on-site wastewater. In addition, the board must ensure the availability of sufficient resources, develop solid policies and procedures to support the program, facilitate collaboration between the partners and the public, and evaluate the effectiveness of the current program.

This print guide and companion video/DVD are designed to assist local boards of health understand their role in an effective on-site wastewater treatment program. The resources begin by introducing board members to wastewater and how it is treated. They continue by discussing the local public health agency's role in regulating on-site sewage systems and conclude by providing specific information on the local board of health's responsibilities regarding its community's on-site wastewater programs.

Local boards of health are responsible for assuring the provision of adequate public health services in their communities, including protecting the community from the risks associated with inadequately treated effluent from on-site wastewater treatment systems.

Members of a local board of health should actively seek to understand how on-site wastewater systems function, proactively work to assess their community's needs, develop policies and programs to meet those needs, and assure that support is available to implement policies and programs.

Introduction

The health of a community and its water resources must be protected from the harmful effects of inadequately treated wastewater. These harmful effects include waterborne diseases or other illnesses and the pollution of rivers, streams, lakes, groundwater supplies, or other water bodies.

All persons generate wastewater, also known as sewage, as they go about their daily activities of washing dishes and clothes, showering and bathing, and using the toilet. To protect public health and environmental quality, wastewater must be cleaned (treated) before it is returned to the environment for further use.

Before the establishment of fixed dwellings, humans left their wastes (feces and urine) in the environment where they lived. As people formed settled communities, wastes accumulated in homes, creating foul smells and unclean conditions. In the nineteenth century, increases in disease resulting from overcrowding led researchers to discover the link between disease and unclean water.

In response to this discovery, nineteenth century researchers developed methods to treat wastewater collected from residential homes and businesses. The first treatment method was the separation of solids from wastewater streams, and the disposal of solids on land.

In the twentieth century, new challenges prompted advances in wastewater technologies. First, residential and commercial land development reduced the amount of available property for solid waste disposal. Second, runoff from existing disposal sites contaminated ground water and caused additional environmental problems. While developing new treatment practices, researchers and scientists also created guidelines for the design and siting of wastewater systems.

Today, public health officials play an important role in regulating wastewater systems. This document is designed to assist local board of health members (or other public health governing bodies) in understanding wastewater systems and what is their role in governing the health agency’s programs and activities.

What is Wastewater?

Contaminated water used for washing, bathing, construction, and personal hygiene, must be treated before it is returned to the environment. Water is the primary component of a wastewater stream and is the component that is reused after contaminants have been removed through treatment processes. A typical resident uses about 45-60 gallons per day – a family of four may generate up to 240 gallons of wastewater per day.

There are many sources of contaminants in wastewater, including food particles, paper wastes, human wastes, cleaners, and personal-care products. Traditionally, local health agencies have been most concerned with disease-causing (pathogenic) contaminants that negatively affect public health. As populations experienced cycles of disease, public health officials began to base their strategy of treatment on worst-case scenarios. This means that they assume pathogens are always present in wastewater streams.

The World Health Organization (WHO) estimates show that three million people - two-thirds of them children - die from waterborne diseases each year. In the United States, the U.S. Environmental Protection Agency (USEPA) estimates that 168,000 viral and 34,000 bacterial illnesses occur each year as a result of the consumption of drinking water from systems that rely on improperly treated ground water.

Common pathogenic organisms are classified into three categories:

- Bacteria

  These pathogens typically cause diseases of the gastrointestinal tract, such as typhoid and paratyphoid fever, dysentery, diarrhea, and cholera. Bacterial pathogens are often highly infectious, causing many thousands of deaths every year in areas with poor sanitation.

- Viruses

  Human feces contain more than 100 different types of enteric viruses capable of causing infection or disease. Viral pathogens found in wastewaters cause diarrhea and other gastrointestinal diseases, and infectious hepatitis.

- Parasites - Protozoa

  The protozoans *Cryptosporidium parvum*, *Cyclospora*, and *Giardia lamblia* are of greatest concern because of their devastating effects on individuals with weak or compromised immune systems, including very young children, the elderly, persons with cancer, and individuals with acquired immunodeficiency syndrome (AIDS). In 1993, an outbreak of cryptosporidiosis in Milwaukee's drinking water supply resulted in over 400,000 people becoming ill and contributed to the deaths of many persons.

  Parasites - Helminths

  Helminthic parasites that may be found in wastewater include intestinal worms, such as stomach worms, tapeworms, whipworms, hookworms, and threadworms.

Other contaminants of special concern in wastewater are the two nutrients nitrogen and phosphorus. Both are macronutrients essential for the growth of plants and microorganisms. When nitrogen or phosphorus are added in excessive amounts to surface water bodies such as lakes or reservoirs, they may disturb natural aquatic ecosystems. Too much of these nutrients may cause algae and aquatic plants to overgrow, leading to oxygen loss in these waters. This process of "enhanced fertilization" of surface waters is called eutrophication.

In addition to negatively affecting surface water quality, nitrogen in the form of nitrate harms human health. Nitrate levels in drinking water above the recommended levels (i.e. higher than 10 milligrams per liter (mg/l) or 10 parts per million (ppm) may be toxic when consumed by infants under six months of age. The result is blue baby syndrome (methemoglobinemia) caused by a reduced ability of the blood to carry oxygen.

Wastewaters also contain household chemicals used for cleaning and personal hygiene. These include soaps, detergents, shampoo, toilet bowl cleaners, bleach, and drain cleaners. While moderate quantities are acceptable in wastewater, excessive amounts may have adverse effects on a wastewater treatment system.

Other contaminants can enter the wastewater stream and harm surface or ground waters. Hazardous chemicals, such as paints, paint thinners and antifreeze, should only be disposed of in facilities approved for such substances. Despite these regulations, hazardous chemicals are sometimes found in wastewaters. Unused medications that are flushed down toilets may pass through treatment systems largely unchanged and be discharged to surface or ground waters.

How Do We Treat Wastewater?

To protect the health of a community from waterborne diseases and to ensure that water is of high quality, public health agencies make sure that all wastewater is delivered to an effective and properly managed treatment facility. The wastewater is then properly treated before being returned to surface waters.

Two types of treatment facilities are used in the United States: centralized (municipal) and decentralized (on-site). Both systems treat wastewater by separating solids from the water then biologically degrading the remaining organic materials. Some systems discharging to environmentally sensitive areas may incorporate further treatment processes to remove nutrients from the wastewater. Disinfection is commonly used in centralized treatment facilities to eliminate pathogenic microorganisms before releasing treated wastewater to surface water bodies.

Overall, about 75% of the U.S. population is connected to municipal wastewater collection and treatment systems. The remaining 25% use on-site wastewater treatment systems to treat their wastewater (Figure 1). Up to 40% of wastewater associated with new home construction is discharged to on-site systems. On-site systems treat and release about 4 billion gallons of wastewater per day into the environment.

Centralized (Municipal) Wastewater Collection and Treatment Facilities

In urban areas, wastewater is usually managed through a centralized system. A network of sewer pipes carries the wastewater from many homes and commercial facilities to a central municipal treatment plant where the combined community flows are treated (Figure 2). The collection system typically requires large-diameter deep pipes, large excavations, and frequent manhole accesses.

At the treatment facility, the wastewater is treated to the standards required for discharge

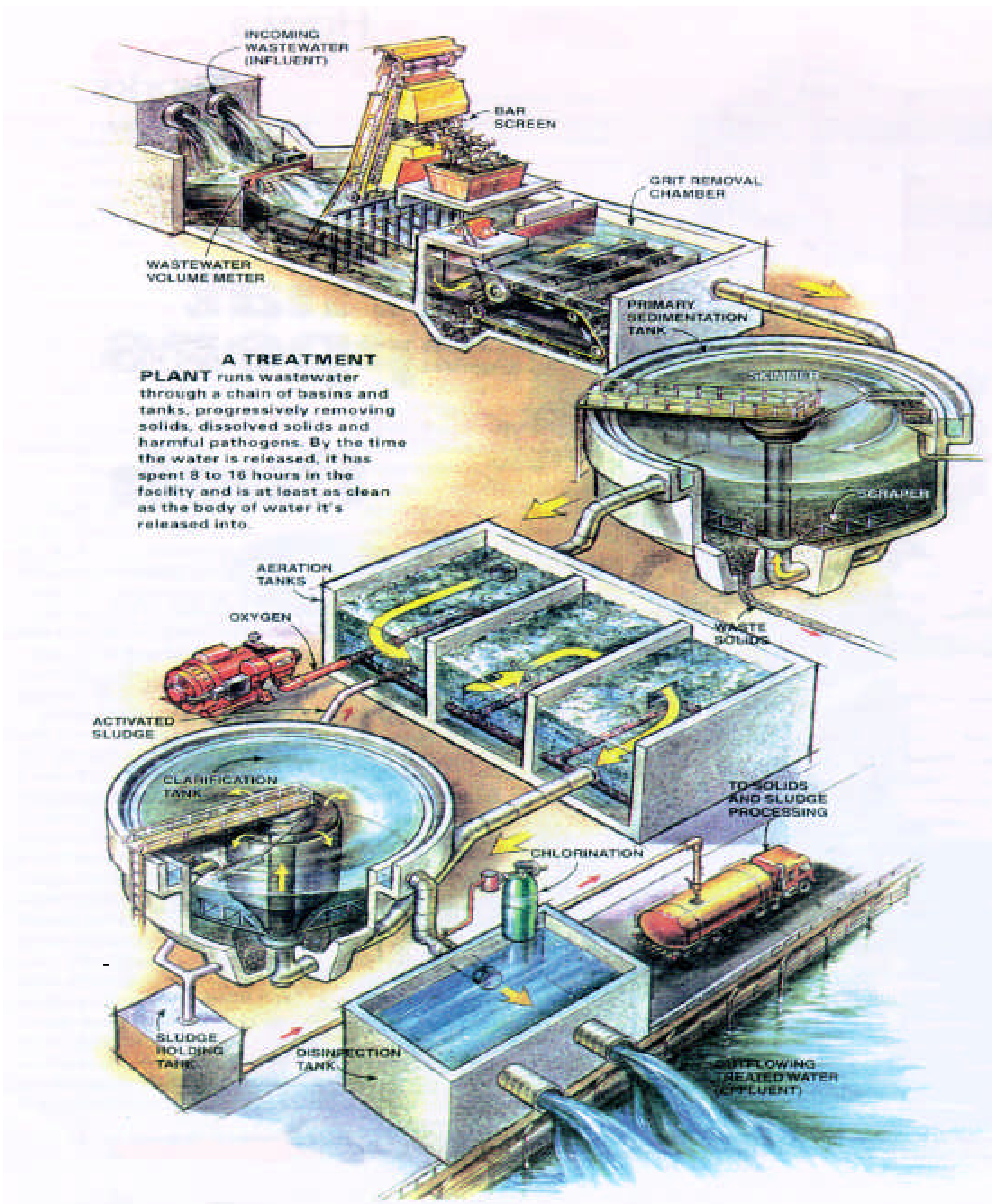

Figure 2. Centralized wastewater treatment system

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to a surface water body, which is usually far from the point of origin for the water supply. Discharge standards are regulated under the Clean Water Act through the National Pollutant Discharge Elimination System (NPDES) administered by the states under the guidance of the USEPA.

The large amounts of biosolids generated during treatment are typically used as fertilizer, buried in landfills, or incinerated (Figure 3).

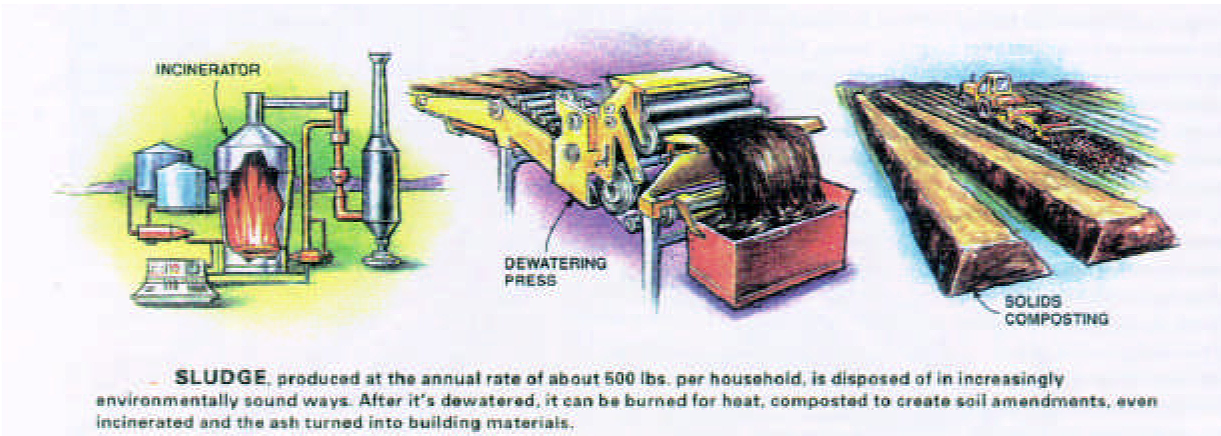

Figure 3. Disposal options for biosolids from centralized wastewater treatment systems
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Centralized systems can help prevent urban sprawl if development is limited to the lengths of the sewer pipes. Although many urban developers use or re-use vacant lots with existing sewers, a process known as "in-filling," large regional sewer systems in rural areas may encourage growth, urban sprawl, and the loss of open space.

There are substantial costs for community-wide centralized wastewater systems. In areas with lower populations, the cost per household can be extremely high. The Clean Water Act of 1972 promoted the installation of centralized systems through a federal construction-grants program. However, the 1987 Amendments to the Clean Water Act created a revolving-fund program that changed the funding mechanism from the federal construction-grants program to state-operated loan programs. Under the new program, states and localities are primarily responsible for financing, constructing, and managing municipal wastewater facilities through a State Revolving Fund (SRF). SRF officials make loans to local governments for specific water-pollution-control purposes. Loan repayments, including interest, are used to make new loans for the same purposes.

Decentralized (On-site) Wastewater Treatment Systems

In areas where there is no access to centralized collection and treatment systems, developers often use an on-site wastewater treatment system that serves an individual residence, a group of residences, or a commercial facility. An on-site system allows wastewater to be treated near its source. The systems are "decentralized," because there are no collection sewers or a single treatment plant to treat wastewater for an entire service area. On-site wastewater treatment systems are also commonly referred to as septic systems, septic tank/soil absorption systems, septic tank/drain field or leach field systems, septic tank and subsurface wastewater infiltration system (SWIS), or private sewage disposal systems.

A conventional on-site system consists of a septic tank and a soil absorption system (Figure 4). The septic tank (Figure 5) is used to provide separation of the solids from the liquids and to provide limited anaerobic decomposition of the organic materials.

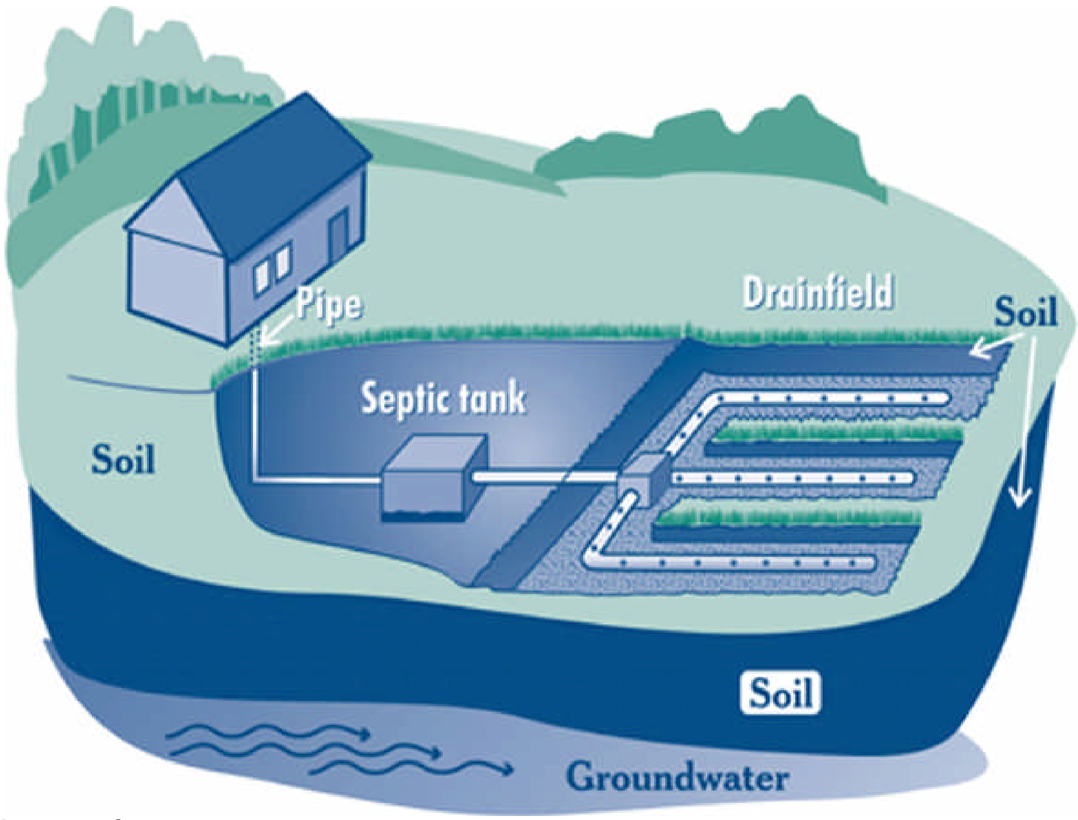

Figure 4. Conventional on-site wastewater treatment
Reference: Olson, K, B. Chard, D. Malchow, and D. Hickman. *Small Community Wastewater Solutions: A Guide to Making Treatment, Management, and Financing Decisions*. BU-07734-S, College of Natural Resources and Extension Service, University of Minnesota, St. Paul, MN.

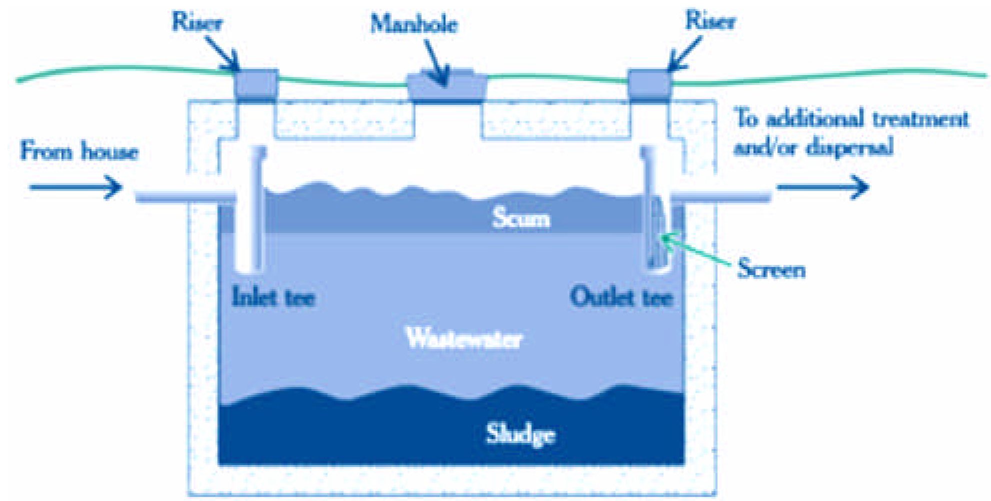

Figure 5. Septic tank
Reference: Olson, K, B. Chard, D. Malchow, and D. Hickman. *Small Community Wastewater Solutions: A Guide to Making Treatment, Management, and Financing Decisions*. BU-07734-S, College of Natural Resources and Extension Service, University of Minnesota, St. Paul, MN.

A septic tank must be periodically pumped and cleaned to remove accumulated solids. The mixture of solids and liquids removed from a tank is called septage. Septage is usually treated in an off-site facility. It may also be applied to the soil in a land treatment facility or delivered to a centralized municipal wastewater treatment plant.

The wastewater from a septic tank is discharged into a subsurface soil absorption area where soils and soil microorganisms trap and destroy pathogens, remove nutrients, and degrade suspended and dissolved solids that are not removed in the septic tank (Figure 6). The treated wastewater then moves down through the soil, where it serves to recharge ground water and adds to base flows for surface waters, aiding in long-term sustainability of water supplies for the future.

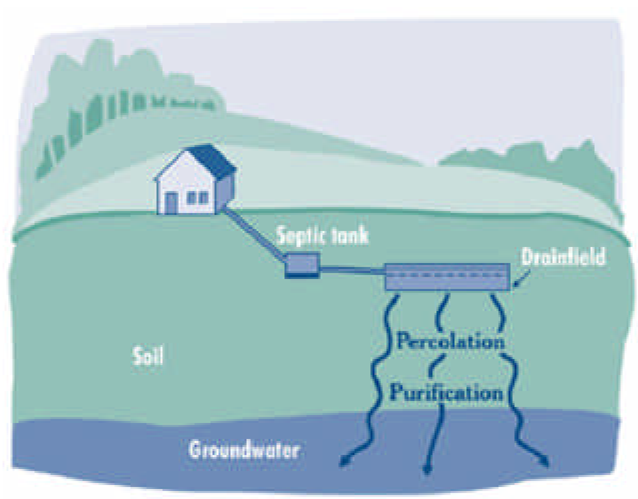

Figure 6. Treatment in a conventional on-site wastewater treatment system
Reference: Olson, K, B. Chard, D. Malchow, and D. Hickman. *Small Community Wastewater Solutions: A Guide to Making Treatment, Management, and Financing Decisions*. BU-07734-S, College of Natural Resources and Extension Service, University of Minnesota, St. Paul, MN.

Conventional on-site soil-based systems require adequate space to accommodate the required soil absorption areas. These systems use more land for development due to the initial siting and replacement area considerations.

In places where difficult site conditions prevent the use of conventional systems, some jurisdictions are able to use advanced on-site systems (commonly referred to as alternative systems) to accommodate the demand for building with the environmental challenges of siting a wastewater system. These conditions include: small lot sizes; high ground water; shallow depth of soil to bedrock; high permeability soils with excessive amounts of gravel, rocks or sand; or low-permeability soils with large amounts of restrictive clays. Alternative systems may also be used to provide a higher level of treatment that cannot be obtained with the use of conventional on-site systems. Alternative systems components are different from those typically used in conventional systems. Examples include sand filters, aerobic treatment units, mounds, and pressure and drip distribution systems.

An on-site system often serves only one generator of wastewater, e.g. a single home or business. However, cluster systems are a type of on-site system that serve multiple generators of wastewater. Cluster systems operate by collecting wastewater from a group of homes (two to several dozen), a commercial center, a subdivision, or the central core of a community and delivering it to a nearby site that has the appropriate soil conditions for treatment and disposal (Figure 7). Cluster systems may use traditional septic tanks located on individual properties, a single large septic tank, or multiple tanks may be placed at a central location.

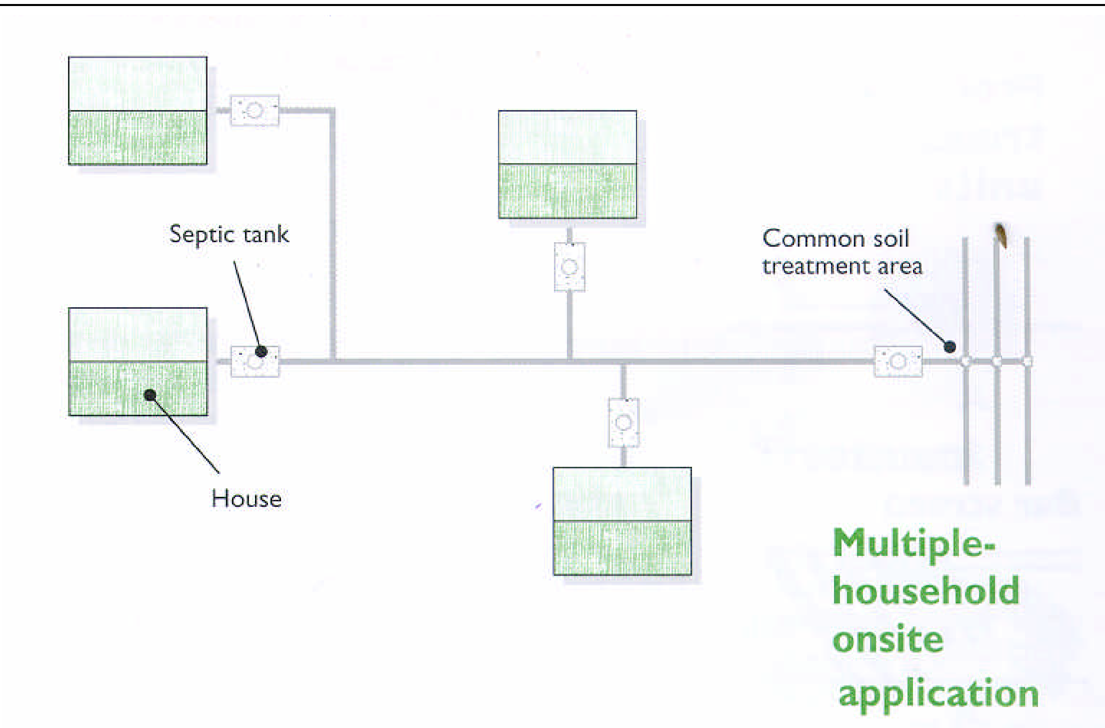

Figure 7. Cluster system
Reference: Olson, K, B. Chard, D. Malchow, and D. Hickman. *Small Community Wastewater Solutions: A Guide to Making Treatment, Management, and Financing Decisions.* BU-07734-S, College of Natural Resources and Extension Service, University of Minnesota, St. Paul, MN.

On-site systems provide numerous benefits for many types of communities and conditions. In smaller communities with low population densities, on-site systems are often the most cost effective option. If properly planned, sited, designed, installed, operated and maintained, on-site systems can provide the level of treatment necessary to protect public health and meet water quality standards.

On-site systems may also aid in watershed management by avoiding potentially large transfers of water from one watershed to another. Local aquifers may be recharged by discharging wastewater into subsurface waters, thus maintaining a sustainable groundwater supply and a consistent base flow for surface waters. Other water reuse opportunities, such as irrigation using on-site wastewaters, may be available close to the point of wastewater generation. However, such uses may require additional treatment (such as disinfection), and may also involve additional permitting requirements

Despite the many benefits, on-site systems may also pose challenges for local public health officials. For example, many on-site systems in use today do not provide the treatment level necessary to adequately protect public health and water quality. Many inadequate systems were initially installed as temporary solutions with the assumption that centralized collection and treatment facilities would soon replace them. More than half of existing on-site systems are over 30 years old. At least 10% of these older systems cause wastewater to back up onto the ground surface or into a home each year. In many areas of the country, the local public health agencies do not have records of many of these older systems within their jurisdictions.

In addition, some situations and locations are not appropriate for any type of on-site wastewater treatment system. Allowing on-site systems to be installed on such unsuitable locations and in unsuitable soil conditions could result in adverse effects on public health and the environment through contact with inadequately treated wastewater. Property values may also be negatively affected when wastewaters are not treated properly. All on-site sewage systems have a limited life expectancy and will ultimately fail.

The Local Health Agency's Role and Responsibilities Regarding Wastewater Treatment Programs

A local health agency's responsibilities vary based on the types of wastewater treatment facilities in an area or community and the specific government regulations that apply in a given jurisdiction.

Role in Centralized System Programs

Local health agencies usually do not have a formal role in centralized municipal wastewater management. A municipality or other publicly owned agency assumes the responsibility for the treatment of wastewater, which is regulated by state and federal rules.

However, when problems occur with centralized systems, a local health agency is often the first called to investigate complaints. Such problems may include fish kills, algae blooms, aesthetic concerns such as bad odors or appearance, or hazardous chemicals in wastewater.

Local health agencies are also responsible for identifying potential sources of illness that occur in their communities, which can include exposure to wastewater and associated pathogens. Local health agencies may consider appointing a liaison between municipal wastewater operators and the health agency to clearly identify ways to communicate during outbreaks and to proactively work together to prevent waterborne diseases and nuisance complaints.

Role in On-Site System Programs

In rural areas, where many on-site wastewater treatment systems are used, a local health agency is often the only direct regulatory authority that provides oversight and enforcement of wastewater management.

The first on-site wastewater regulations were concerned only with "disposal" of wastewater and were based on soil percolation tests (tests of a soil to estimate its permeability and its suitability for septic systems), local practices, and past experience. These early codes did not consider the complex interrelationships among soil conditions, wastewater characteristics, biological treatment mechanisms, and climate. The regulations often depended on minimally trained personnel to oversee design, permitting, and installation, and mostly untrained and uninformed homeowners to operate and maintain the systems.

During the 1950s, many states adopted improved regulations that upgraded system design and installation practices to ensure that onsite systems function properly and eliminate risks associated with waterborne pathogens. Recent regulations have included treatment as a goal in addition to disposal and dispersal of wastewater into the environment. Today, however, most regulations do not address cumulative ground and surface water impacts of on-site systems, especially in areas with a large number of systems in close proximity to each other.

Most regulations in use today do not address the issue of system performance. Rather, regulations are prescription-based, which means that jurisdictions using prescriptive codes specify the types of systems that must be installed and the types and depth of soils that must be present. If site conditions are unacceptable, the prescribed systems cannot be used, which has resulted in restrictions in development options for many areas. For example, in Florida, the USDA Natural Resources Conservation Service criteria determined that 74% of the soils have severe or very severe limitations for conventional on-site systems.

Prescription-based regulations also require mandatory setbacks of on-site systems from seasonally high water tables, property lines, wells, surface waters, and other landscape features. The lengths of these setbacks vary widely among different jurisdictions.

If prescribed systems are sited, designed, and constructed according to regulatory requirements, the systems are then presumed to meet public health and water quality standards. Ongoing monitoring of performance is usually not conducted to see if standards are being met. In many cases, prescriptive standards are protective of public health and the environment.

A new model that focuses on system performance to regulate on-site systems has been proposed. Performance requirements establish specific and measurable standards that are necessary to achieve the required level of environmental and public health protection for a specific area and water resource. These standards may be expressed as numeric limits (e.g., contaminant concentrations) or as narrative descriptions of desired conditions or requirements (e.g., no leaks, odors, cracks, or surfacing wastewater). Many states and local health agencies are adopting or considering the use of performance requirements to achieve protection of public health and environmental quality.

In performance-based regulatory programs, a wide range of technologies, including the conventional system, are available for use at a specific site. These systems are matched to site and soil conditions and wastewater flows and content concentration. Performance-based approaches depend heavily on results of research investigations, wastewater characterization processes, site evaluations, installation practices, operation and maintenance activities, and careful monitoring of system performance. The National On-Site Wastewater Recycling

Association (NOWRA) is developing a model guidance framework for the use of performance regulations in on-site programs.

In the future, a practical approach to on-site program management may utilize a hybrid of methodologies, i.e., retain prescriptive requirements for systems that have proven to be effective over a known range of site and soil conditions, while allowing the regulatory agency to review and evaluate the use of alternative systems for sites with limiting conditions. Programs that allow or encourage a performance-based approach must have a strong management program to provide oversight to ensure that the systems installed are properly operated and maintained. These programs may also require additional funding in order to be properly implemented.

Goals for On-Site Programs

Traditionally, a local public health agency directs on-site wastewater activities towards the following goals:

- Reduce the risks to public health by:
  - Reducing health risk from wastewater backup into homes
  - Preventing wastewater discharges to the ground surface to avoid direct public contact
  - Preventing ground water and well water contamination due to pathogens, nitrates, and toxic substances
  - Protecting shellfish habitat and harvest areas from contamination with pathogens
  - Minimizing risk from the reuse of inadequately treated effluent for drinking water, irrigation, or other uses
  - Minimizing risks from inadequate management of septage
  - Minimizing risk of public contact with on-site system components

- Abate public nuisances by:
  - Eliminating odors caused by inadequate plumbing or treatment processes
  - Eliminating odors or other nuisances related to transportation or disposal of septage

More recently there has been increased focus on developing goals to prevent on-site system-related surface and groundwater quality degradation and adverse impacts on water quality, including goals related to the protection of environmental resources. These goals include:

- Prevention and reduction of adverse impacts on water resources due to contaminants and pathogens discharged from on-site systems

- Prevention and reduction of nutrient over-enrichment of surface waters, which may result in algae blooms or low dissolved oxygen in surface waters

- Protection of sensitive aquatic habitat and life

Approaches to Achieve On-Site Program Goals

Local health agencies may assist other public agencies, such as local public works departments, water reclamation districts, or state and federal environmental protection agencies, in proactively addressing wastewater generation, treatment, and disposal. With increased emphasis on protection of water quality and aquatic habitats, water quality agencies have become more involved with on-site wastewater issues. In many cases, these agencies lack the authority to regulate on-site systems directly, so they must work closely with local health agencies to ensure that both public health and water quality goals are addressed.

One means of protecting and restoring water resources is to use a watershed approach to assessment, planning, and management. In this method, all land uses and other activities, and the characteristics of each drainage basin or groundwater recharge zone are considered in land use planning activities. Because on-site systems may have significant impacts on water resources, local health agencies are important components of watershed partnerships.

Coordination and involvement of local health agencies with other land-use planning processes are also recommended. Increasing construction in non-sewered suburban or rural areas results in an increased volume of on-site wastewater generation and an increased potential for public health risks. On-site wastewater treatment issues should be integrated into decisions regarding future growth and development of a community. Land use should reflect a comprehensive planning effort that incorporates community health and environmental protection goals and considers local geological, soil, and watershed characteristics, growth patterns, and water quality/quantity issues into planning and zoning decisions.

Growing populations and changing values have increased demands on water supplies and river systems. These pressures result in water use and management conflicts throughout the country, particularly in the West where the population is expected to increase 30% in the next 20-25 years. As part of its responsibilities, a local health agency might require assurance that an adequate water supply is available before considering a building site or development proposal. This assurance may be especially important in states where the doctrine of prior appropriation, often referred to as “first in time, first in right,” determines who may use water resources and in what amounts.

Local health agencies should check to ensure that proposed developments have an approved wastewater treatment plan (whether it is for treatment by on-site or centralized systems or a combination of both) so that wastewater treatment strategies that protect public health and environmental quality are incorporated into a community’s development plans. Local health agencies may also play an especially important role in evaluating the cumulative impacts that wastewater management may have on a region or community.

A proactive approach to land use planning and the assurance of adequate wastewater treatment is a complex issue. Some areas are not considered to be suitable for development because the soil and site conditions are not suitable for the installation and use of conventional on-site systems. In these areas, the limitations caused by environmental conditions act as an informal way of considering zoning issues. If a conventional system is unable to be sited, the land must remain undeveloped.

Local health agencies have a choice when considering land that is unsuitable for conventional on-site systems. Use of an alternative system (where site and soil conditions are appropriate) permits some land development. It is important, however, that local health agencies consider using alternative systems only when they are deemed necessary for development and when the site and soil conditions allow for such systems. A proactive and deliberate approach to protecting water quality and the environment should be followed by leaving predetermined areas undeveloped. Land use management and zoning decisions should not be based solely on whether the land supports wastewater treatment.

Well recharge areas and drinking water sources must be protected under the 1996 amendments to the Safe Drinking Water Act. To accomplish this protection, state drinking water agencies must conduct source water assessments, which include conducting an inventory of potential sources of contamination in a source water assessment area (i.e., a well recharge or drinking water source area) and determining the susceptibility of the water supply to those contamination sources. The information collected during the assessment is used to develop plans to protect the well recharge areas and drinking water sources. These plans may recommend limiting on-site systems or improving the performance and management of on-site systems within delineated areas.

To achieve on-site program goals, local health agencies may: (1) administer a permitting program for on-site systems; (2) manage or oversee ongoing monitoring and maintenance of systems; (3) implement corrective action programs for failing systems; (4) provide or require certification and licensure for on-site wastewater system professionals; (5) facilitate appeals and variances; (6) offer or require inspections of on-site systems during real estate transactions; and (7) develop public education and outreach programs. Each of these topics is addressed individually in the following sections.

Permitting Processes

Local health agencies use site evaluations and construction permit applications as a primary means of managing on-site wastewater treatment. Evaluations and permits may be issued for individual or cluster on-site systems.

A comprehensive, ideal permitting program should include the following elements: site evaluation procedures, technology selection guidance, design review, permit issuance, construction inspections, and record keeping.

Site Evaluation Procedures

To achieve both wastewater treatment and dispersal in on-site systems, conventional and alternative systems must be installed in suitable soils for the type of system and in appropriate locations. A conventional system usually requires hundreds of square feet of drain field to effectively accomplish treatment, so an adequate area of suitable soil on a particular building lot must be available for installation of the system. Usually, an additional repair area of suitable soil is also required to accommodate installation of a new system if the original system fails.

What is suitable soil? To accomplish dispersal of wastewater into the soil environment, wastewater must move through a soil quickly enough so it does not back-up into the home or pond on the soil surface. However, to accomplish treatment, the wastewater must move through the soil slowly enough so that chemical contaminants and pathogens are removed or reduced in concentration. A suitable soil has a texture (which is defined by the relative proportions of sand, silt, and clay in a soil) and structure (which is the combination or arrangement of individual soil particles into aggregates) that allows wastewater to move through it at a moderate rate.

Elements of an On-site Permitting Program

1. Site Evaluation Procedures
2. Technology Selection Guidance
3. Design Review
4. Permit Issuance
5. Construction Inspections
6. Record-keeping

The specific processes that result in treatment in a soil, acting individually or in combination, include:

- Physical filtration and entrapment of contaminants in soil pores.
- Chemical adsorption of contaminants to soil particles (especially to clay minerals).

  As nitrogen moves through an on-site treatment system, it is changed from organic nitrogen to ammonia nitrogen in the septic tank, and from ammonia nitrogen to nitrate nitrogen in a properly operating soil absorption field. The ammonia nitrogen is adsorbed to soil particles and then biologically converted to a soluble and mobile form of nitrogen: nitrate. Nitrate, one cause of "blue baby" syndrome, may move with percolating water through the soil to ground water, which may serve as a source of drinking water.

  In a properly functioning on-site septic system, phosphorus is tightly held by soil particles and does not reach surface waters. Many other contaminants are also adsorbed onto soil particles. Some organic materials are held on soil particles until they can be biodegraded.
- Biological decomposition (biodegradation) of organic contaminants

  Organic materials in wastewater serve as food sources for native soil microorganisms. Most of the solids in wastewater are organic and easily biodegradable, that is, broken down to harmless products by microorganisms. Organic solids in wastewater include food particles, fats, oils, greases, human feces, hair, toilet paper, and pathogenic and non-pathogenic microorganisms. Some of these materials are also retained in the septic tank. Pathogens die if retained in the soil long enough.

All soils are composed of sand (0.05 - 2.0 mm in size), silt, which includes intermediate sized particles that can not be seen with the naked eye, but feels like flour when pressed between the fingers (0.002 - 0.05 mm in size) and clay which is extremely small (less than 0.02 mm in size). Clay is the mineral particle that gives cohesion to a soil. To achieve the treatment and dispersal goals by moving wastewater through the soil, the most suitable soils are coarse, loamy textured soils containing more than 30 % sand-sized particles in the soil mass. Other soil textures may be usable for on-site systems if adequate design provisions are incorporated including the use of alternate systems. However, clay texture soils containing Montmorillonite (or 2:1) clays should not be used for on-site systems due to extremely slow permeability.

Not only must suitable soils be present on the proposed site, but an adequate vertical depth of the suitable soils must be available so that wastewater is treated before it reaches ground water, fractured or solid bedrock, or impervious layers. Most studies have shown that 2 to 4 feet of suitable soil are adequate to accomplish wastewater treatment. The specific depth of suitable soil required is usually dictated by regulatory code and varies among jurisdictions. This vertical separation distance between the infiltrative surface (i.e., the bottom of the absorption system, where the wastewater enters the natural soil) and ground water, bedrock, or other limiting layers, is the most important characteristic of the soil to prevent disease transmission by pathogenic organisms.

A local health agency should develop policies and procedures for evaluating site and soil conditions to determine if suitable soils are present at a proposed building location. Results of the evaluation will determine whether a specific site is suitable for the types of on-site systems available for use within the jurisdiction of the health agency, as defined by regulatory code. These evaluations must be conducted before a permit is issued for the construction of an on-site system. To ensure that the evaluations are performed correctly, soil scientists, environmental health scientists, or other trained professionals should conduct these evaluations.

If site and soil conditions are not appropriate for installation of a conventional on-site system, that is, if the wastewater will not be adequately treated and dispersed, the local health agency should not approve the building lot for construction. However, if the site and soil conditions are not too limiting, an alternative system designed to overcome the specific site or soil limitations may be used in many jurisdictions.

Elements of a soil and site evaluation include:

1. *Examination of various soil properties through depth*
   Texture, structure, drainage, and consistence of a soil must be evaluated to determine the potential rate of wastewater percolation through the soils. Commonly, these properties are evaluated in a soil pit that is dug so that several feet of soil below the depth of the drain field can be examined. The depth of suitable soil available for treatment and disposal of wastewater must meet regulatory requirements.

2. *Percolation testing*
   In addition to evaluating soil properties, some regulatory jurisdictions also require the use of percolation (perc) testing to evaluate the permeability of the soil. A perc test is conducted by digging a hole in the soil at the depth proposed for the discharge of the wastewater into the subsurface environment and measuring the rate of water flow from the hole into the surrounding soil. Perc test results have been shown to be a poor indicator of the absorptive capacity of a soil and should only be used as part of a comprehensive soil analysis. Many jurisdictions no longer use the perc test, but rely solely on examination of soil properties.

3. *Evaluation of other site conditions*
   General features that should be evaluated include:

   - Landscape position and topography

     A system should not be located in areas that retain water flows, such as depressions or floodplains. Preferred locations include positions that promote wastewater infiltration and dispersal into unsaturated soils, such as convex (water-shedding) slopes and flat areas with deep permeable soils.

   - Vegetation

     Existing vegetation at the site can provide information on soil depth, drainage, and moisture conditions.

   - Natural and cultural features

     Suitability of a site will be affected by rock outcrops, areas of potential flooding, surface waters, wetlands, wells, roads, buildings, buried utilities, underground storage tanks, and property lines.

4. *Determination of area available for installation of an on-site system*
   A sufficient area of suitable soils must be available to install the projected size of the system. System size is usually determined by the size of the home or business that will be served by the system. In many jurisdictions, the system size is determined by the number of bedrooms in the home, or for commercial establishments, the amount of wastewater expected to be generated in the specific business type and size. Most regulatory codes also require that an additional area of suitable soil is available on the building lot for replacement of the system if it should fail.

5. *Determination of setback distances*
   Setback distances (also called isolation or separation distances) are usually dictated by the regulatory code of the specific jurisdiction. The location of an on-site system on a specific building lot may be dictated or even prohibited by required setback distances.

   The soil absorption field must be located away from water bodies, wells, steep slopes, property lines, buildings, and other landscape and property features. Horizontal setbacks from property lines are established to ensure that there is adequate space to install, construct, and maintain on-site systems within the property boundaries where the system is located. Setbacks from foundations and buildings are established to provide structural stability and to prevent wastewater leakage into the building. Setbacks from critical water resources, such as wetlands, public and private water supplies (including water wells), water supply pipelines, lakes, and rivers, are based on public health and water quality concerns.

Technology Selection Guidance

There is no single treatment technology that meets the specific conditions and treatment needs of every community. An overall goal for public health officials is to use the simplest system that is appropriate for site conditions and required treatment level. In some areas, site and soil conditions may be so limiting that no on-site technology will be appropriate.

As part of the permitting process, the local health agency may define a set of feasible on-site treatment systems that will perform in the types of soils and sites and within the climatic conditions found within its jurisdiction. For example, a system relying on evaporation will not work in a temperate climate where precipitation exceeds evaporation (Figure 8). Not only should the selected system address this issue, it should also be able to provide a level of treatment that will produce a discharge without degrading the quality of the receiving body of water.

Elements of an On-site Permitting Program

1. Site Evaluation Procedures
2. Technology Selection Guidance
3. Design Review
4. Permit Issuance
5. Construction Inspections
6. Record-keeping

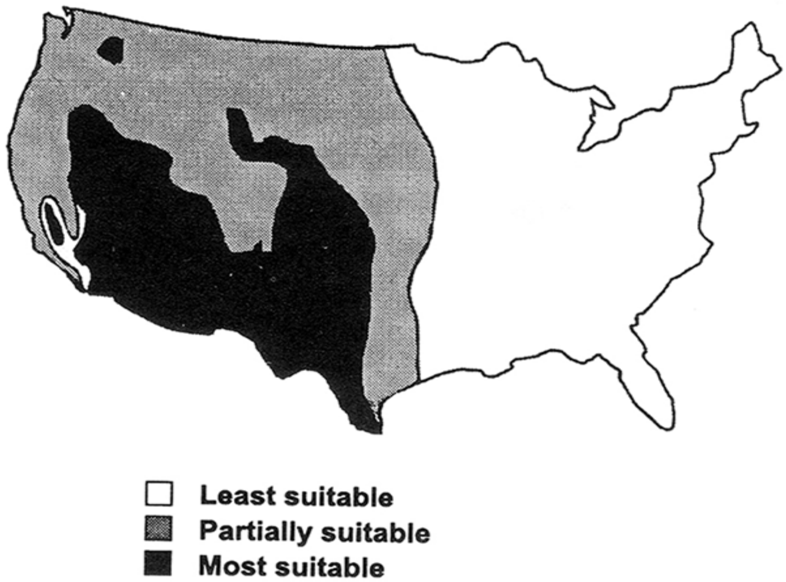

Figure 8. Areas where evaporation treatment systems may be used
Reference: USEPA. 2002. Onsite Wastewater Systems Manual. EPA/625/R-00/008, U.S. Environmental Protection Agency, Washington, DC.

If the local health agency uses performance-based regulations, engineers or other qualified persons may design systems to address specific site and soil characteristics and limitations and to meet regulatory standards. Regardless of who designs the system, the local health agency must review it to ensure that it protects public and environmental health.

Characteristics of specific treatment systems that should be considered and compared during the technology selection process includes effectiveness of the treatment technology, all costs over time, reliability, longevity, ease or difficulty of management, space required, and ability of the technology to handle changes in amount of flow and wastewater quality.

Technology selection also depends upon:

1. County or local land use plans, ordinances, and long-term land use goals
2. Community characteristics, including population trends, location and distribution of population, character and culture of the community (whether it is rural or urban), and desire for open spaces
3. Physical site characteristics, including topography, soil properties, surface and groundwater conditions, type and quantity of wastewater to be treated, climate, and condition of existing systems
4. Financial conditions, including community income levels and financial reserves and capacity

Conventional System

The most commonly used and least expensive on-site system is the conventional system, also referred to as a septic tank/drain field or septic tank/leach field system. If properly sited, designed, installed, operated, and maintained, conventional systems have been shown to provide reliable treatment of wastewater for up to 20 years or more. Their use is based on years of research, application, and experience. The use of conventional systems is usually prescribed by regulatory codes, which include detailed guidance on design and installation. Conventional systems generally require less maintenance than non-standard, alternative systems and are the preferred system for use when soil and site conditions are not limiting.

In the conventional system, when wastewater is generated in the home or commercial facility, an equivalent amount of wastewater flows under the force of gravity from the septic tank through solid wall pipe to perforated pipes that are laid in underground gravel trenches or beds. The wastewater flows through the gravel into the underlying and surrounding soil for treatment and dispersal (Figure 9).

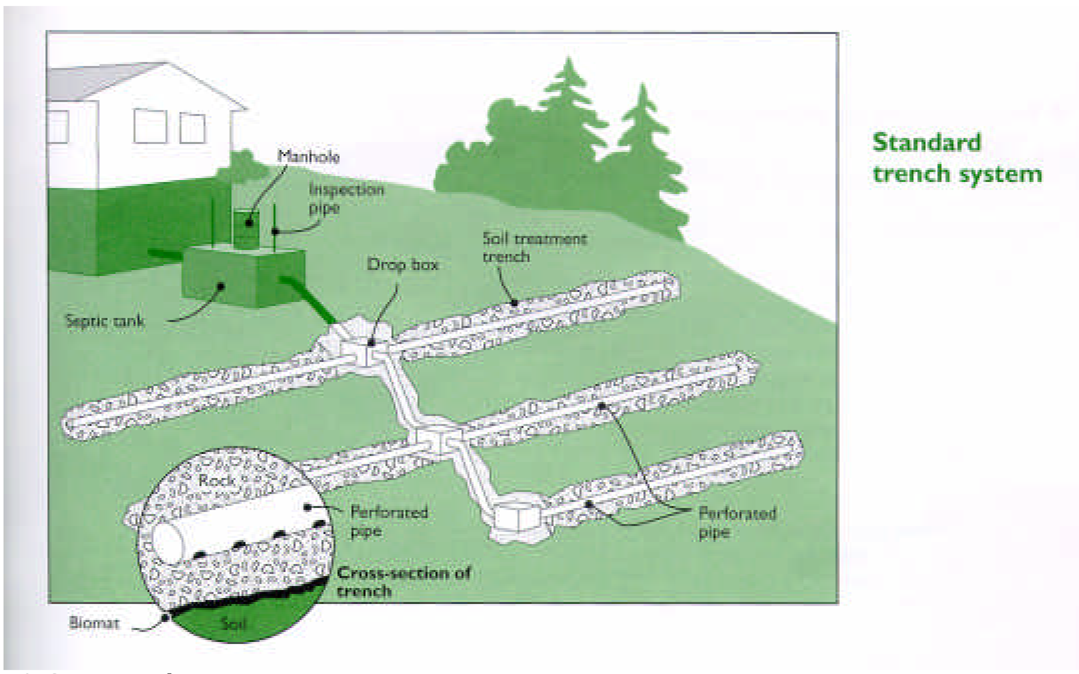

Figure 9. Conventional on-site wastewater treatment system
Reference: Olson, K, B. Chard, D. Malchow, and D. Hickman. *Small Community Wastewater Solutions: A Guide to Making Treatment, Management, and Financing Decisions*. BU-07734-S, College of Natural Resources and Extension Service, University of Minnesota, St. Paul, MN.

Alternative Systems

Alternative systems, also known as non-standard systems, provide wastewater treatment and dispersal, just as conventional systems do. Despite the same outcome, alternative systems are used to compensate for site and soil conditions that a conventional system cannot overcome. These adverse conditions include unsuitable soils, high ground water, inadequate separation from fractured or solid bedrock or impervious layers, and small lot size. Alternative systems may also be used to provide improved treatment (such as increasing nitrogen removal) to protect environmentally sensitive resources such as estuaries, lakes, or drinking water supplies.

Alternative systems are either added on to conventional systems as an extra component or used to replace a conventional system that is inappropriate for the conditions. The long-term performance of alternative systems has not been as well documented as conventional systems because they have been in use for a short time.

Types of alternative systems include:

1. Alternative systems used to compensate for inadequate depths of suitable soils

   These types of systems usually are installed either at shallow depths within the soil or above the ground surface. Such systems include:

   a. Low-pressure pipe systems (Figure 10), which include a pressurized network of small diameter pipes installed in very narrow trenches installed at very shallow soil depths

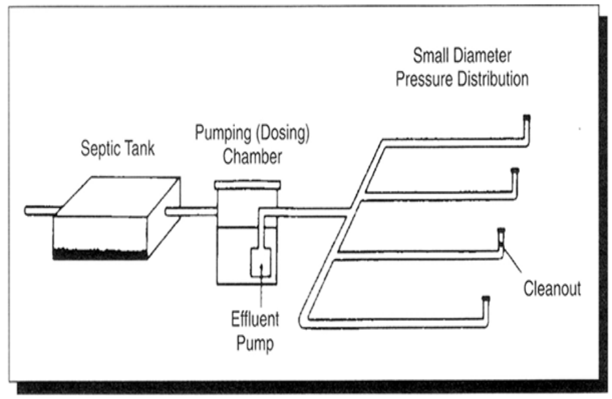

Figure 10. Low pressure pipe system
Reference: USEPA, 1992. Decentralized Systems Technology Fact Sheet. EPA 832-F-99-076. U.S. Environmental Protection Agency, Washington D.C.

   b. At-grade system, which is a drain field constructed on the surface of the original soil and covered with fill

   c. Mound system, which is a drain field built above the ground, constructed of sandy materials below the pipes, covered with fill, and usually dosed with a pressurized distribution system (Figure 11)

2. Pretreatment alternative systems that add an additional treatment step between the septic tank and the soil absorption system

   This additional treatment step results in a higher quality effluent (for example, containing fewer pathogens or less organic materials) that requires less treatment in the soil absorption field. As a result of better treatment, some regulatory authorities allow the size of the absorption field or the required depth of adequate soil to be decreased. Even if requirements are not reduced, the use of pretreatment systems may mean that the system will last longer.

   Types of pretreatment alternative systems include single-pass sand filters (Figure 12), recirculating sand filters (Figure 13), peat filters (Figure 14), and constructed wetlands.

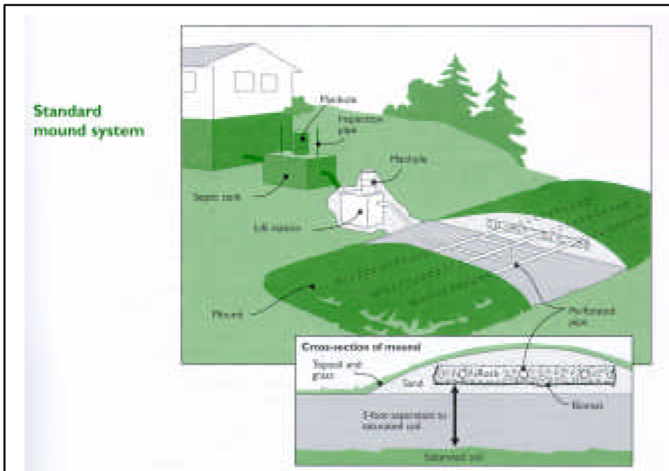

Figure 11. Mound system
Reference: Olson, K, B. Chard, D. Malchow, and D. Hickman. *Small Community Wastewater Solutions: A Guide to Making Treatment, Management, and Financing Decisions.* BU-07734-S, College of Natural Resources and Extension Service, University of Minnesota, St. Paul, MN.

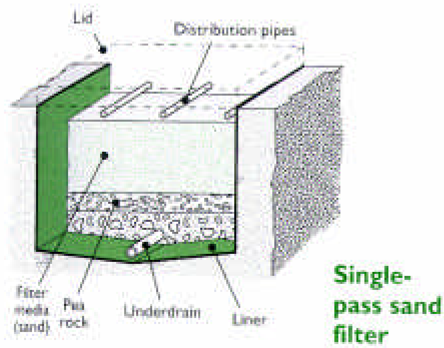

Figure 12. Single-pass sand filter
Reference: Olson, K, B. Chard, D. Malchow, and D. Hickman. *Small Community Wastewater Solutions: A Guide to Making Treatment, Management, and Financing Decisions*. BU-07734-S, College of Natural Resources and Extension Service, University of Minnesota, St. Paul, MN.

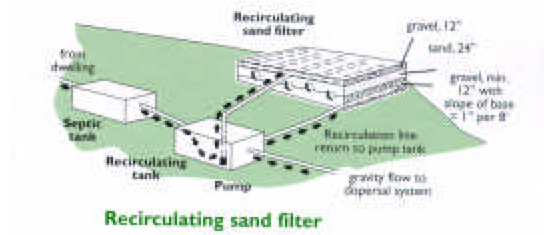

Figure 13. Recirculating sand filter
Reference: Olson, K, B. Chard, D. Malchow, and D. Hickman. *Small Community Wastewater Solutions: A Guide to Making Treatment, Management, and Financing Decisions*. BU-07734-S, College of Natural Resources and Extension Service, University of Minnesota, St. Paul, MN.

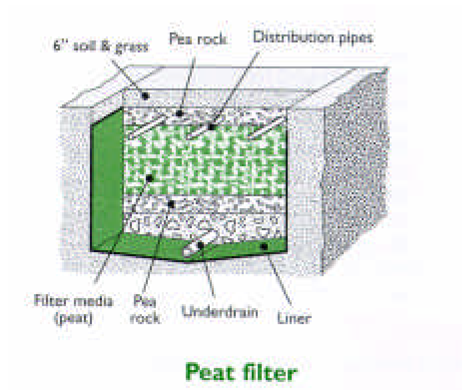

Figure 14. Peat filter
Reference: Olson, K, B. Chard, D. Malchow, and D. Hickman. *Small Community Wastewater Solutions: A Guide to Making Treatment, Management, and Financing Decisions*. BU-07734-S, College of Natural Resources and Extension Service, University of Minnesota, St. Paul, MN.

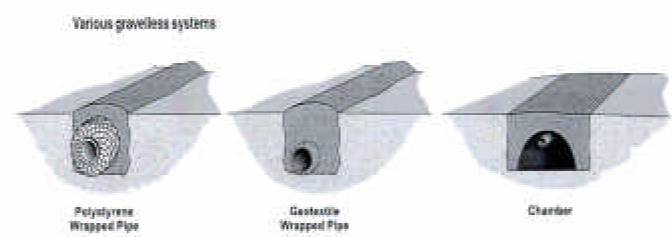

Figure 15. Gravel-less systems
Reference: USEPA. 2002. Onsite Wastewater Systems Manual. EPA/625/R-00/008, U.S. Environmental Protection Agency, Washington, DC.

3. Alternative systems that utilize different types of distribution systems for final disposal of the wastewater

   Wastewater from the septic tank or a pretreatment system may be applied to the soil through pressurized distribution systems that assure infiltrative surfaces are evenly loaded. (Mounds and low-pressure pipe systems are also examples of such systems.) These examples include gravel-less systems (Figure 15), evapotranspiration systems (Figure 16), drip distribution (Figure 17), and wetlands (Figure 18). Not all of these systems are typically pressurized (wetlands, gravel-less systems).

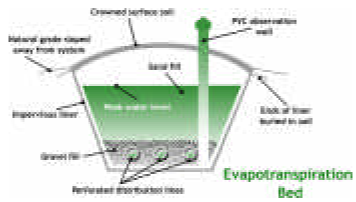

Figure 16. Evapotranspiration system
Reference: Olson, K, B. Chard, D. Malchow, and D. Hickman. *Small Community Wastewater Solutions: A Guide to Making Treatment, Management, and Financing Decisions*. BU-07734-S, College of Natural Resources and Extension Service, University of Minnesota, St. Paul, MN.

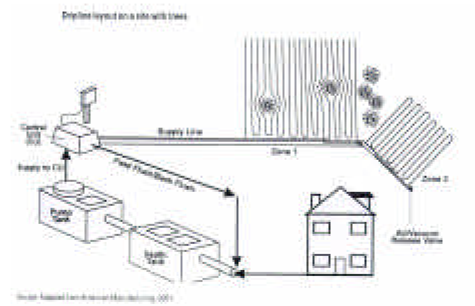
Figure 17. Drip distribution system
Reference: USEPA. 2002. Onsite Wastewater Systems Manual. EPA/625/R-00/008, U.S. Environmental Protection Agency, Washington, DC.

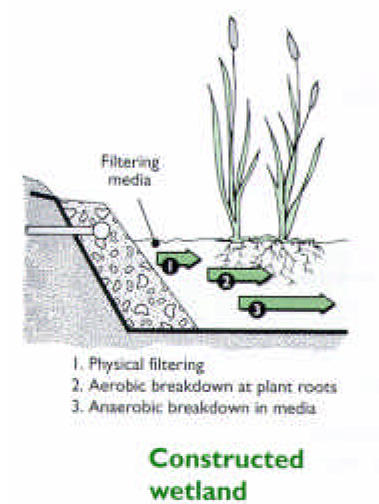

Figure 18. Wetland treatment system
Reference: Olson, K, B. Chard, D. Malchow, and D. Hickman. *Small Community Wastewater Solutions: A Guide to Making Treatment, Management, and Financing Decisions*. BU-07734-S, College of Natural Resources and Extension Service, University of Minnesota, St. Paul, MN.

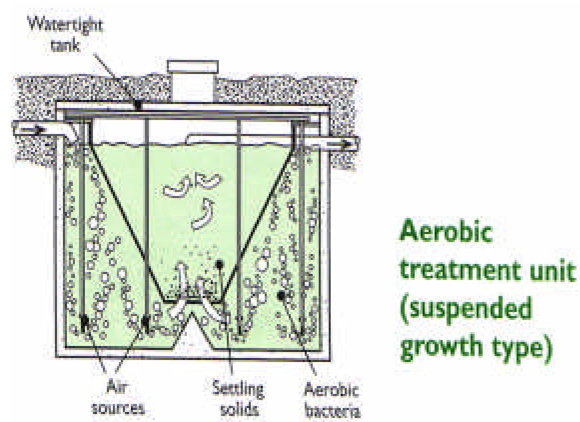

Figure 19. Aerobic treatment unit
Reference: Olson, K, B. Chard, D. Malchow, and D. Hickman. *Small Community Wastewater Solutions: A Guide to Making Treatment, Management, and Financing Decisions*. BU-07734-S, College of Natural Resources and Extension Service, University of Minnesota, St. Paul, MN.

4. Aerobic systems

   Aerobic systems are similar to conventional septic systems, because they both use biological processes to treat wastewater. However, unlike septic anaerobic treatment, the aerobic treatment process requires oxygen. Aerobic treatment units use a mechanism to inject and circulate air inside the treatment tank and require electricity to operate (Figure 19).

   Aerobic systems cost more to operate and need more routine maintenance than do conventional systems. Some aerobic systems include a pretreatment step to reduce the amount of solids entering the aerobic unit that may clog the systems and reduce the effectiveness of treatment. Pretreatment methods include a septic tank, a primary settling compartment in the aerobic unit, or a trash or grease trap.

5. Dual black water/gray water systems

   In dual black water/gray water systems, wastewater flow from toilets (referred to as black water) is treated separately from wastewater generated from the rest of the water fixtures in the home or commercial facility (referred to as gray water) (Figure 20). Water-less toilets, such as composting or incinerating toilets, are often used in such dual systems to take care of toilet wastes. These types of toilets require disposal of residual solids.

   Gray water is commonly used for irrigation. However, because gray water can potentially contain pathogenic organisms, it should be disposed of in a subsurface system or disinfected before use in surface irrigation systems. Gray water may also require additional permitting for surface discharge.

   The use of dual systems may require extensive plumbing changes in an existing home. To ensure that these systems are operated properly and that black water solids are safely handled and disposed of, management guidelines and programs are recommended.

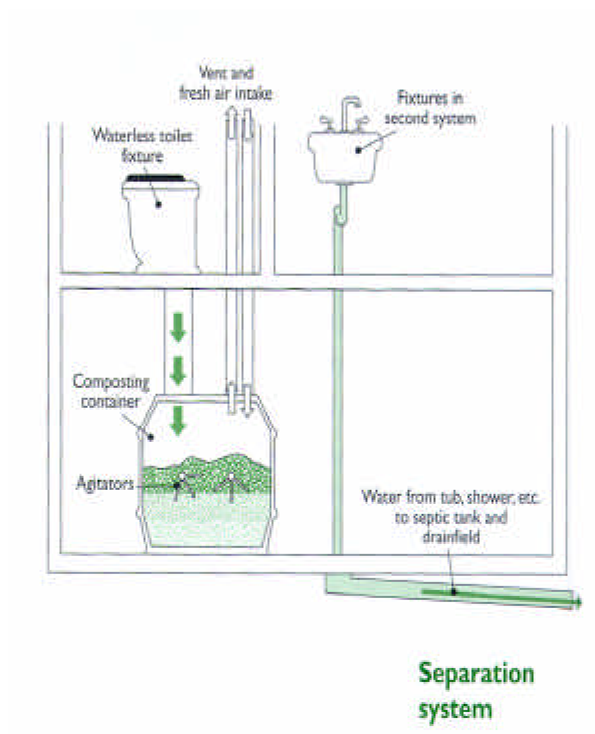

Figure 20. Dual black water/gray water system
Reference: Olson, K, B. Chard, D. Malchow, and D. Hickman. *Small Community Wastewater Solutions: A Guide to Making Treatment, Management, and Financing Decisions*. BU-07734-S, College of Natural Resources and Extension Service, University of Minnesota, St. Paul, MN.

Design Review

As part of the permitting process, a local health agency reviews the design plans for on-site wastewater treatment systems. Because an adequately trained staff is essential to accomplish design review, the health agency may require additional training to that received during formal education.

Elements of design review include an assessment of whether the correct technology for the specific site and soil conditions and environmental requirements have been selected, and whether the designs are appropriate, adequate, and accurate. A health agency should not accept a design until it meets all requirements.

Permit Issuance

Once the requirements have been met, a local health agency issues a permit allowing the on-site system to be installed according to the properly reviewed and approved design. Permits are legal authorizations to install and operate a particular system at a specific site, based on the information collected. Many jurisdictions require an on-site wastewater permit from the local health agency prior to the issuance of a building permit.

More comprehensive on-site management programs include the use of renewable/revocable operating permits to ensure that systems are maintained after installation. Renewable permits usually 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. Failure to maintain satisfactory inspection and maintenance of the system may result in terminating or revoking the permit.

Elements of an On-site Permitting Program

1. Site Evaluation Procedures
2. Technology Selection Guidance
3. Design Review
4. Permit Issuance
5. Construction Inspections
6. Record-keeping

Construction Inspections

A poorly constructed or improperly installed on-site system is not likely to operate in an effective manner. To ensure that a system meets approved specifications, the local health agency staff should schedule inspections during the installation process.

Construction oversight should be conducted at several key stages during the system installation process to ensure compliance with regulatory requirements. Inspections before and after backfilling are used to verify that approved construction procedures are employed. The construction schedule for soil-based systems must be flexible to accommodate various issues. For example, wet weather conditions may cause soils to become compacted during the installation process, which may prevent the soil from accepting and treating wastewater.

Record Keeping

Accurate and thorough record keeping is essential for effective functioning of an on-site program. Two types of information are needed to maintain comprehensive records. These types include:

1. Inventory of existing systems
    - Records of site evaluations
    - Inventory of all existing on-site systems, cluster systems, and package plants
        - System owner and contact information
        - System components

  - Design and site specifications and drawings
  - Performance expectations or effluent requirements (if any)
  - As-built information and installation date
  - Installation inspection results
  - Maintenance records (especially important if more advanced or complex on-site systems are used)
  - Septage disposal records
  - Problems and actions taken
2. Administrative information
   - Personnel files (staff and/or installation inspectors)
   - Financial data (relevant for cost analysis of program)
   - Lists of certified or licensed service providers
   - Management program information (if any)
   - Septage management plans

Efficient record keeping involves the use of a data management information system that includes database development, data collection, data entry, data retrieval and integration, data analysis, and reporting. The use of electronic databases, spreadsheets, and geographic information systems (GIS) increases the ease of collecting, storing, retrieving, using, and integrating data. Successful installation, maintenance and use of such systems requires trained personnel.

GIS are especially useful tools for making data interpretation and assessment easier. GIS may be used to graphically display baseline conditions and what-if scenarios. GIS users may construct models to predict impacts from proposed housing developments and aid in understanding the potential for contamination of water resources from on-site systems.

Most local health agencies have inventories of newer systems from their permitting programs, but older systems (for example, those installed before 1970) may not be included in their records. Inventories of older systems are important if an area decides to develop an on-site management plan.

<u>On-going Monitoring and Maintenance Management Programs</u>

On-site system users usually prefer to follow a “flush and forget” philosophy. Forgetting about wastewater, especially when on-site wastewater treatment systems are used, may cause system failures and result in adverse effects on human health and the environment. Bacteria and nitrates from wastewater may show up in drinking water, a lake may become green with algal blooms in the summer, or the area may smell like sewage on warm summer days.

Many people do not realize that on-site systems require management through on-going monitoring, inspection, and maintenance. The user of an on-site system has the primary responsibility to ensure the system is properly operated and maintained. Some new on-site users do not realize that they must maintain their systems because they did not have to be concerned with wastewater disposal when they lived in an area served by a centralized wastewater system. Others who have used on-site systems all of their lives still may not understand their operation so they may have not taken care of them properly.

Regardless of their experience with an on-site system, users must learn that, just as with their cars, a little care reaps huge benefits in system performance. Every time they use water, e.g. by flushing the toilet, washing a load of laundry, or taking a bath, they are operating their treatment system. Through their individual habits, they control the amount and the quality of the wastewater that must be treated.

Traditionally, local health agencies have not required, conducted, or emphasized routine periodic inspection and maintenance of on-site systems. Rather than having trained professionals conduct on-going inspection and maintenance activities, many health agencies rely upon untrained and uninformed system owners and users to monitor build-up of solids in the tank, to schedule septic tank pumping, and to check for proper flow distribution in the drain field. When more complex systems are used, system users often have had the additional responsibility for checking pumps, float switches, filtration media, and other system components for proper operation.

User education must be the first step in managing individual or multi-household wastewater treatment systems. Users must learn about control of water usage, proper disposal methods for different types of household wastes, use of appropriate cleaning products, timely scheduling of regular maintenance activities, and types of repairs needed for different kinds of problems.

The type of system used also imposes additional management issues. The development and installation of more complex systems results in a corresponding level of advanced management to ensure proper performance. In addition, managers of multiple-household on-site systems must address the needs of individual users while maintaining overall system performance.

Regular professional care and servicing needed by complex systems is best provided through formalized management programs. The best way to accomplish this is by using a legal and responsible management entity that works on behalf of the community to ensure that on-site systems are properly planned, built, operated and maintained. The benefits of an on-site management company include reduced costs for repairs, maintenance, and replacement, longer system life, improved system performance, and increased reliability.

USEPA developed model voluntary national guidelines for management of on-site/decentralized wastewater systems to raise the level of system performance. Local health agencies may use these guidelines as a resource to develop management programs for their communities. The management guidance materials, *Voluntary National Guidelines for Management of On-Site and Clustered (Decentralized) Wastewater Treatment Systems* and *Handbook for Management of On-Site and Clustered (Decentralized) Wastewater Treatment Systems* are available at <www.epa.gov>.

The *Guidelines* contain a set of management approaches that rely on coordinating the responsibilities and actions of the regulatory authority, management entity, service providers, and system owners. These approaches, presented as five model management programs (Table 1), are structured to address an increasing need for more comprehensive management as the sensitivity of the environment, the number and density of system installations, and the degree of system complexity increases. The five-model management program suggested in the *Guidelines* describes essential program elements ranging from planning and record keeping to operation and maintenance needs. The management program's responsibilities increase progressively from Model Program 1 through Model Program 5, reflecting not only the increased level of management activities needed to achieve more stringent water quality and public health goals, but also the increased capability required to properly manage larger numbers of more complex technologies in more vulnerable watersheds.

Table 1. The Five Management Models

- Management Model 1 - "Homeowner Awareness" specifies appropriate program elements and activities where treatment systems are owned and operated by individual property owners in areas of low environmental sensitivity. This program is adequate where treatment technologies are limited to conventional systems that require little owner attention. To help ensure that timely maintenance is performed, the regulatory authority mails maintenance reminders to owners at appropriate intervals.
- Management Model 2 - "Maintenance Contracts" specifies program elements and activities where more complex designs are employed to enhance the capacity of conventional systems to accept and treat wastewater. Because of treatment complexity, contracts with qualified technicians are needed to ensure proper and timely maintenance.
- Management Model 3 - "Operating Permits" specifies program elements and activities where sustained performance of treatment systems is critical to protect public health and water quality. Limited-term operating permits are issued to the owner and are renewable for another term only if the owner demonstrates that the system is in compliance with the terms and conditions of the permit. Performance-based designs may be incorporated into programs with management controls at this level.
- Management Model 4 - "Responsible Management Entity (RME) Operation and Maintenance" specifies program elements and activities where frequent and highly reliable operation and maintenance of decentralized systems is required to ensure water resource protection in sensitive environments. Under this model, the operating permit is issued to an RME instead of the property owner to provide the needed assurance that the appropriate maintenance activities are performed.
- Management Model 5 - "RME Ownership" specifies that program elements and activities for treatment systems are owned, operated, and maintained by the RME, which removes the property owner from responsibility for the system. This program is analogous to central sewerage and provides the greatest assurance of system performance in the most sensitive of environments.

Although adoption of the *Guidelines* or any management approach is voluntary, USEPA encourages states and local communities to consider the *Guidelines* as a basis for their decentralized/on-site wastewater management programs. A small investment in improved management of onsite and cluster systems may prevent the need for subsequent and larger investments in centralized wastewater facilities or in continued repair and replacement of on-site systems that fail due to lack of management attention. The *Guidelines* may be applied to both existing and new systems serving residential and commercial facilities.

The management model selected depends on the specific circumstances, capabilities, resources, and commitment of each community. Many communities may develop management programs through the involvement of several organizations, such as local health agencies, planning departments, approved design and service providers, and environmental agencies. Others may select a more comprehensive program that places most management responsibilities in a sanitation board, service district, or other responsible management entity.

The success of a wastewater management program is highly dependent on community involvement. The extent to which residents "take ownership" of the management program will determine its long-term success. If residents feel a system has been imposed on them, they may not meet their ongoing responsibilities for using the systems properly and facilitating their maintenance. A substantial investment will then be endangered, and public health problems may occur. Public involvement should be encouraged early on, continually, and in many forms.

Corrective Action Programs for Failing Systems

Many serious problems are associated with failed systems. Outbreaks of disease, such as hepatitis, dysentery, and gastroenteritis, may result from contact with or ingestion of wastewater pathogens. Nutrients from failing systems can accelerate the eutrophication process of nearby water bodies, lowering oxygen levels and suffocating aquatic life. From an economic point of view, septic system repair bills can be large and failing systems can negatively impact property values.

The local health agency should have a corrective action program in place to address system failures and protect public and environmental health resources. Elements of a corrective action program include:

- Establishing a process for reporting and responding to problems
- Defining conditions that constitute violations of program requirements
- Establishing inspection procedures for reported problems and developing corrective action schedules
- Developing a system for issuing violation notices, compliance schedules, contingencies, fines, or other actions to address uncorrected violations

Certification and Licensing Programs

The success or failure of an on-site program depends, in part, on capable and trained technical and field health agency staff and service providers. These include system designers, site evaluators, operation and maintenance personnel, local health agency inspectors, and septage pumpers and haulers. A certification and licensing program is recommended as an effective means of ensuring that on-site system regulators and service providers are adequately trained. Training of private sector service providers may also reduce the burden upon the staff of a local health agency.

Certification and licensing programs should include training and examinations that address basic knowledge, skills, demonstrated competency, and experience necessary to perform services. Other components of a licensing or certification program include requirements for continuing education, defined protocols and procedures that service providers should follow, and disciplinary guidelines or other mechanisms to ensure compliance and consistency.

Appeals and Variances Processes

On-site wastewater treatment programs regulations may require health agency staff to make decisions that deny a petitioner's request to install or permit an on-site system. The petitioner, however, may appeal the decision and request that a variance or exception be allowed. Variances from on-site regulatory requirements, however, are not recommended, because they bypass the regulations that were developed to protect public health, safety, and environmental quality. Local health agencies should set a goal that all minimum standards defined in regulations are met. Local health agencies must resist pressures from politicians, developers, and others to develop unsuitable areas that are not appropriate for use of on-site systems. To do so may lead to system failures, loss of property values, and lawsuits. In jurisdictions that allow variances, local health officials should minimize the deviation from the regulations. For example, a variance may be an action, design modification, use of an alternative system, or extenuating site detail that provides the same level of health and environmental protection that a system meeting all regulatory requirements does.

On-Site Systems and Real Estate Transfer Inspections

In some jurisdictions, local health agencies may be involved in inspections of on-site systems during real estate transactions. Sellers of property must disclose or verify on-site system performance prior to property transfer as a means to protect the consumer and to identify systems in need of upgrade or repair. An inspector may determine whether a system conforms to regulations and evaluate how well the system is performing.

In many cases and even without regulatory requirements, lending institutions have influenced the adoption of system inspections before home or property loans are approved. Inspections are incorporated into the loan and asset protection protocols of local banks and lending firms.

One example of a set of guidelines for an inspection program during property transfers has been developed by the State of Rhode Island. Although the guideline requirements are specific to Rhode Island regulations, other jurisdictions may adapt the procedures to reflect their statutes. The Rhode Island guidelines are available online at <www.state.ri.us/dem/pubs/regs/regs/water/isdsbook.pdf>.

Public Education, Outreach, and Involvement

Public education and outreach are critical aspects of an on-site program administered by a local health agency to ensure that public support is sufficient for program development, implementation, and funding. An owner's understanding of system operation and maintenance is necessary for satisfactory system performance. An effective public outreach program makes information accessible by presenting the information in a non-technical format.

A public education and outreach program should include the following three components:

1. Identification of program audience, including homeowners, installers, system operators and maintenance contractors, commercial or industrial property owners, public agency planners, inspectors, site evaluators, the public, students, citizen groups and homeowner associations, civic groups, and environmental groups

2. Information about the program, including benefits of the program, water conservation activities of on-site programs, and household hazardous waste disposal practices

3. Determination of potentially effective public outreach media, including local newspapers, radio and TV, speeches and presentations, exhibits and demonstrations, conferences and workshops, and public meetings

Early identification, contact and consultation with interested parties encourages public involvement in the process of making major decisions or proposing significant program changes. The formation of a citizens' advisory group may play an important role in representing community interests and promoting support for any on-site program.

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In most jurisdictions, a local board of health or other governing body (e.g. county commissioners, city council) oversees the activities of the health agency. Local boards of health are charged with the assessment, policy development and assurance of public health in their communities. While local board of health members do not perform or engage in the services provided by the health agency, they are responsible for ensuring that the necessary resources (time, money, personnel) are available to provide the appropriate health programs or services to the community.

To provide safe wastewater management in the community, the local board of health must remedy existing problems and identify potential problems before they exist. An assessment of the effectiveness of the on-site program through a structured and regular evaluation process provides valuable information for maintaining and improving the program. The procedure to accomplish this includes:

1. Assessment of the community's wastewater management needs
2. Development or recommendation of policies and programs to meet the community's wastewater management needs
3. Assurance that the personnel, training, and resources are available to support necessary wastewater management programs

These topics are discussed individually in the following sections.

Assess the Community's Wastewater Management Needs

If they do not already have the information, the local board of health should evaluate existing wastewater policies and programs to determine if they meet the community's wastewater management needs. Such an assessment identifies problems, evaluates the means for improvement through new technologies or program enhancements, and ensures that funding is available to sustain programs and achieve intended outcomes.

Depending on local circumstances, a comprehensive program evaluation may require significant resources and time. The board may appoint one or more local health agency staff members to conduct the evaluations. For a more wide-ranging review, however, a program evaluation team may be formed that consists of service providers, elected officials, interested citizens, and representatives from public health agencies and environmental protection organizations.

The first step in conducting a successful assessment program involves gathering data. Local boards of health that succeed in finding viable solutions to their wastewater needs use data to clearly understand their current situation before proposing changes. Without a good base of information, it is difficult, time-consuming, and frustrating to make informed decisions regarding solutions. Many kinds of information are readily available, but sources and completeness of data may vary from community to community.

Based on the data collected, the extent of any existing and potential future problems in the community may be defined. The local board of health should evaluate the cumulative impacts that different types of wastewater treatment systems may have on a region or a community in terms of water quality and in future growth and development.

Policies and programs to be evaluated may include:

(a) Sanitary ordinances and regulatory codes

Sanitary ordinances and regulatory codes are the rules that authorize local health agencies to regulate the siting, design, and permitting of individual and multiple-

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household wastewater treatment facilities. Local boards should determine whether the state and local regulatory framework and legal authority is adequate. Specifically, the health agency should provide the board with information about the site evaluation and permitting processes, applicable regulations, and appeal procedures.

With assistance from the health agency staff, which has the technical knowledge, the board ensures that guidelines and regulations are available for site evaluation, design, construction, and operation and maintenance of specific acceptable technologies allowed by regulatory code. In addition, the board ensures that there are clear policies and procedures that the health agency staff follows regarding on-site wastewater systems. This includes appeal and variance procedures, the use of advanced systems, program evaluation, user/owner education programs, and data collection.

If adequate regulations are not in place, the board should assess if the legal authority is in place to adopt necessary regulations. If there are barriers to adopting the regulations, the board should determine what barriers exist and the difficulties that must be overcome to develop or change regulations.

It is especially critical that the board knows if the local health agency strongly enforces compliance with existing regulations. Without enforcement, even if comprehensive regulations are in place, an on-site regulatory program will not be effective. If enforcement is lacking, the board must evaluate factors or barriers that create such a situation.

The board should rely upon baseline data as well as advice from trained health agency staff to provide appropriate information before making an informed decision on these matters.

(b) Appeal and variance procedures

If a local board of health allows variances from on-site regulatory requirements, an evaluation of the adequacy of the variance and appeals processes should be made. An action proposed to correct a system deficiency must be assured to result in a level of health and environmental protection equivalent to that provided with the use of a system that meets all regulatory requirements.

For a board of health to make informed decisions concerning variances, the members must understand the technical principles of on-site wastewater treatment. They must also recognize which requirements for conventional on-site systems are most critical to the protection of public health and the environment, namely adequate vertical separation to ground water, adequate horizontal distances to water resources, and adequate sizing of on-site systems so as to maintain appropriate loading rates. Within these restraints, the local board of health should develop appeal and variance procedures that will balance environmental and public health concerns with prevention of undue hardship on individuals who want to make reasonable use of their property.

The Massachusetts Department of Environmental Protection and the Barnstable County Department of Health and the Environment have developed a self-paced tutorial for local board of health members to aid in evaluating variance requests (<www.learntitle5.org> or <barnstablecountyhealth.org>). The course consists of informational modules followed by self tests. The information correlates with Massachusetts on-site regulations, but the principles discussed are applicable to on-site systems in general.

(c) Local health agency workforce capabilities

The local board of health ensures that the staff is knowledgeable in on-site wastewater treatment. A trained staff is essential to the success of any on-site wastewater program. Adequate staffing levels, educational background of existing staff, and training opportunities needed to achieve and maintain necessary expertise should be investigated. Licensed or registered environmental health specialists should be employed whenever possible.

If alternative systems are used, staff will require training in siting, design, construction inspection, monitoring and maintenance of the specific systems used in the community. Additional staff may also be required due to an increased workload as more building sites become available through the use of alternative systems.

The local board of health assures a trained workforce by working with the health officer to allocate funding for additional training, hire additional qualified staff, and ensure that investigations are completed according to an approved schedule.

(d) Comprehensive land use plans, economic development plans, and zoning ordinances

The board of health should ensure that the local health agency's on-site wastewater program supports any existing community land use and development plans and evaluate whether these plans will protect public and environmental health. Local health agency staff and board of health members are encouraged to participate in community planning activities to provide input on public health issues that may impact land use decisions.

An ideal comprehensive land use plan should illustrate the vision that the community plans to use in responding to and managing land use, environmental quality, and resource preservation and utilization. Information from land use plans is useful for wastewater planning because it provides information on future population density and growth potential.

Economic development planning should include planning for wastewater management strategies. An assessment should be made to determine if existing wastewater options are appropriate for current and future land use plans and if the wastewater program adequately addresses types and quantities of wastewaters generated in the community. If not, plans should be made to add adequate treatment capacity. Community economic characteristics may also determine the types of wastewater treatment systems that may be utilized within a specific community.

Zoning ordinances are used to establish guidelines for types of allowed land uses and the density at which development can proceed. Both factors influence the size and type of wastewater treatment technologies that a community may consider. The local health agency on-site wastewater program should be compatible with community zoning requirements.

(e) Evaluation of partnerships and coordination with other agencies

A local board of health should evaluate the adequacy of partnerships and data-sharing policies that their local health agency has developed with other agencies involved in health and environmental issues. Such cooperative agreements will help improve efficiency and overall program performance.

A good working relationship with building departments is especially important so building permits are not issued before a building's on-site plans have been developed and accepted. Many jurisdictions require issuance of an on-site wastewater permit prior to issuance of a building permit.

(f) Community water resource protection goals

A local health agency that has identified environmental resources (e.g., aquifers, watersheds) that need to be protected within the community will be better able to develop and select wastewater treatment strategies that will protect them. As part of the evaluation, current or future risks that may impair that resource should be identified. Information from watershed protection programs may be used to develop water resource protection goals.

The local board of health supports these protection goals through the development of policies and regulations that incorporate wastewater treatment strategies into the overall health agency's strategic plan. Policies should include the resources to conduct periodic evaluations to determine if regulations are meeting their intended objectives.

(g) Assessing the adequacy of public education, outreach, and community involvement programs

Effective public education and outreach activities are critical to ensure that public support is provided for program development, implementation, and funding. A local board of health evaluates its health agency's programs and activities and their outcomes. When necessary, the board allocates funding to improve or continue existing programs and to implement new ones.

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Develop or Recommend Policies and Programs to Meet the Community's Wastewater Management Needs

There are many ways to effectively develop a wastewater program that protects both public health and environmental quality. Based on the information gathered during the assessment phase, the local board of health should define goals for managing community wastewater. These goals include the development of wastewater regulatory and management programs to:

- Protect public health and environmental resources
- Meet land use planning needs
- Address types and quantities of wastewater generated in the community

- Meet the limitations imposed on selection of technologies by local site and soil characteristics
- Assure adequate community water resources (especially important for water rights in western states)
- Provide for ongoing operation, maintenance, and monitoring of on-site systems

Making an informed decision involves having adequate knowledge of potential solutions that are applicable to the data collected. To accommodate wastewater generated within the jurisdiction, the local board of health, in cooperation with environmental protection agencies, must make decisions on whether to utilize centralized or decentralized systems, or a combination of both. The specific types of the selected system must provide adequate protection for public health and for the water resources found within the community.

Appropriate plans and tools must be developed to achieve a community's wastewater goals. These tools include regulatory codes, permitting processes, certification programs, and public education programs. Proactive participation by local health agency staff and local board of health members in community land use planning decisions should be considered to provide input on public health issues.

When using on-site systems, the board should ensure that on-going management requirements for the specific technologies selected are developed as well as defining the type of legal and responsible management entity that will be employed and providing financial options for funding a management program.

The use of an advisory committee by the local board of health is often the key to effective community decision-making concerning wastewater treatment strategies. Members of the committee must be willing to contribute their expertise over what may be a long period of time. The committee should reflect the demographic make-up of the community regarding the economic, educational, and geographic distribution of the population. An ideal committee also includes persons of diverse talents, such as environmental health scientists, accountants, community educators, community organizers, planners, lawyers, and technical experts. Even critics of various wastewater solutions may be valuable members of an advisory committee to ensure that all points of view are considered.

Assure that the Personnel, Training, and Resources are Available to Support Necessary Wastewater Management Programs

After developing a comprehensive wastewater management program, the local board of health should investigate ways to assure that local health agency staff, training opportunities, and resources are available to support necessary wastewater management programs.

If more complex alternative on-site systems are utilized in a community or area, more local health agency staff may be necessary to review designs and conduct inspections during and after construction. Adequate staff must also be available to oversee public education and system management programs to ensure that

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appropriate materials and guidelines are used and that the programs are achieving their desired goals.

In the past, training in on-site wastewater treatment has not been readily available. On-site systems were traditionally not covered in depth in most university curricula, and opportunities for continuing education were few. However, in recent years, many states have developed training centers and programs dedicated to on-site wastewater education. These programs typically target system regulators, health agency staff, pumpers and haulers, and system designers and installers. Some programs have expanded their focus to target other small community audiences, such as public officials, homeowners, and students. An *Onsite Wastewater Training Directory* that describes training center programs and centers is available from the National Small Flows Clearinghouse <www.nsfc.wvu.edu>.

Management programs may be provided by a local health agency itself or by a private service entity with local health agency oversight. The USEPA guidance materials, *Voluntary National Guidelines for Management of On-Site and Clustered (Decentralized) Wastewater Treatment Systems* and *Handbook for Management of On-Site and Clustered (Decentralized) Wastewater Treatment Systems*, provide valuable information on how a management program may be set up and implemented. The information can be obtained online at <www.epa.gov/owm> or by e-mailing <decentralized@epa.gov>.

A comprehensive and effective on-site wastewater management program may require more funding resources than have traditionally been required in the past. Base funding to a local health agency provided through local and state government agencies and permitting fees should be set at levels high enough to cover the cost of programs and services provided to the community. On-going management programs may be funded through different types of fee-for-service mechanisms.

Various grants and loans are available at local, state, and federal levels to finance wastewater projects, including the USEPA, U.S. Department of Agriculture Rural Utilities Service, and the U.S. Department of Housing and Urban Development community development block grant (CDBG) programs.

Success in obtaining funding from the USEPA and other agencies is enhanced if the project can demonstrate fiscal, managerial, and technical capacity. Fiscally, the project must have sufficient revenue, creditworthiness, and good fiscal management and controls. Managerially, the project must demonstrate ownership accountability and adequate staffing, while technically, the project must show that continuing technical knowledge is available to support it, the adequate infrastructure to maintain it, and the ability to make changes over the long-term. By developing these types of capacity, the wastewater project should be self-sustaining in the future.

Conclusion

To protect the health of the citizens in a community and the community's environmental resources, members of a local board of health should actively seek to understand how on-site systems function, proactively work to assess their community's needs, develop policies and programs to meet those needs, and assure that support is available to implement policies and programs. For questions or additional local board of health resources, please contact the National Association of Local Boards of Health.