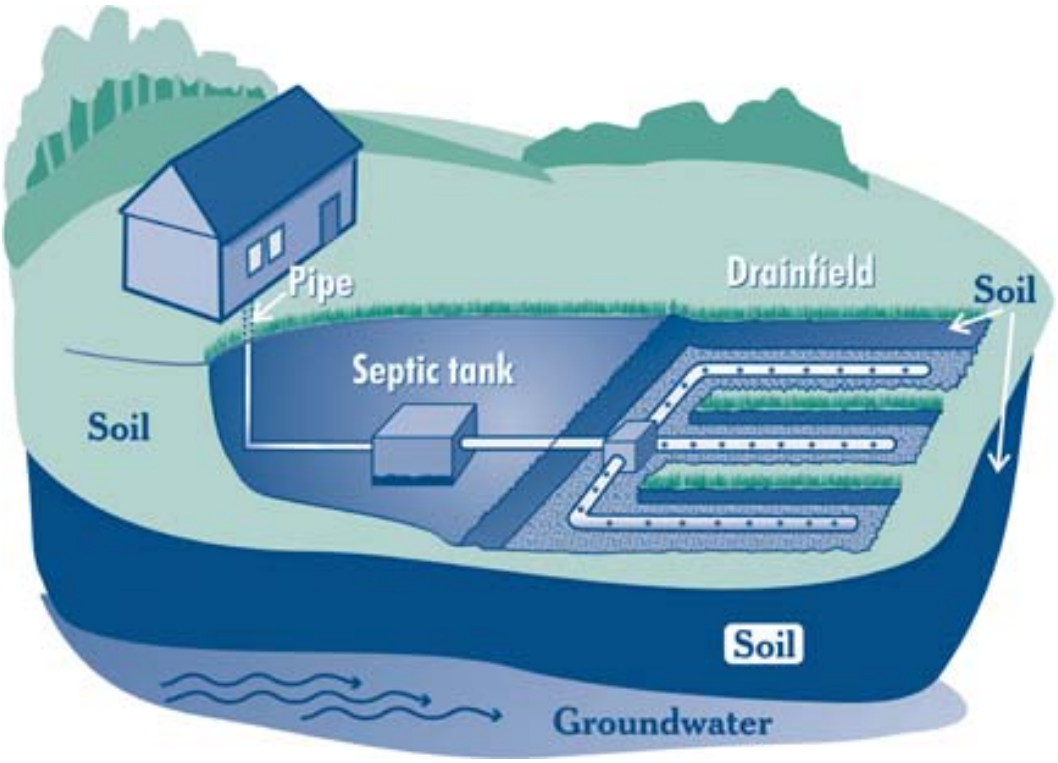
Ohio Department of Health

Report to the Household Sewage and Small Flow On-Site Sewage Treatment System Study Commission



January 1, 2008

(This page intentionally left blank)

Executive Summary

Safe communities require safe sewage treatment systems. Sewage systems should provide for the treatment of sewage and not merely disposal. These systems constitute the wastewater treatment infrastructure for homes, small businesses, churches or community buildings in areas that are not served by public sewers, and their proper design and management is a significant public health and safety issue. Approximately 25% of Ohio's households are served by some type of sewage system located on the property, with an estimated one million systems in use today.

Ohio's legacy of household sewage management began with state minimum rules adopted in 1977 by the Public Health Council that authorized the use of three basic system types. The most common sewage system of a septic tank to leach lines, was designed to use the soils as the primary treatment media. Ohio's soils, however, are clay-rich, and seasonally saturated. Systems installed in these soils provided for disposal through dilution, versus treatment of sewage. In some areas, discharging systems were installed due to the challenging soils. These discharging systems, numbering over 250,000, produce waste streams that do not meet water quality standards of the Clean Water Act, causing water quality impacts in many areas. Poor system designs have also led to ground water contamination and disease outbreaks. As a result, the state, communities and homeowners have spent hundreds of millions of dollars to extend sewer lines and build wastewater treatment plants, or replace failing systems.

With the statewide rules remaining unchanged since 1977, many local health districts adopted more stringent rules that provided for the use of newer technology systems and the evaluation of site and soil conditions. The passage of Sub. H.B. 231 by the 125th General Assembly and enacted on May 5, 2006 as Chapter 3718 of the Revised Code provided comprehensive legislation that authorized statewide rules that established standards for the proper siting, design, installation, monitoring, operation and maintenance, and abandonment of sewage treatment systems. The Public Health Council adopted rules that became effective on January 1, 2007 and greatly expanded the use of different system technologies in Ohio. The law also created the Sewage Treatment System Technical Advisory Committee and a process to quickly approve the use of new technologies in the state. Continuing concerns over the costs of systems that ensured treatment led to the suspension of the authorizing statute and rescission of the 2007 rules. Through Am. Sub. H.B. 119 adopted by the 127th General Assembly, the Ohio Department of Health (ODH) was directed by the legislature to prepare a comprehensive analysis and report on the types of alternative systems, and their costs and economic factors.

ODH researched and evaluated the performance of the sewage treatment systems being used in Ohio and the surrounding Midwestern states. Most sewage treatment systems in Ohio use septic tanks to shallow or moderate depth leach lines installed into the soil. Unsaturated, aerobic soil is used as the primary media for treatment of the wastewater. Where the soils are seasonally saturated at shallow depths, the sewage

can be treated with various components to reduce the amount of treatment the soil must accomplish. Systems can also be elevated above saturated soils using sand and gravel. Other methods of soil dispersal such as low-pressure pipe and drip irrigation can be used to evenly distribute the sewage effluent across the soil and improve treatment. Spray irrigation systems are an above ground method of distributing highly treated wastewater.

Seasonal saturation in the soils, and the presence of bedrock represent conditions that do not allow for the treatment of wastewater necessary to keep communities safe. Receptors of wastewater that can be contaminated include the shallow water table in soils, drinking water and ground water aquifers and surface water bodies. ODH obtained data from other state agencies to evaluate soils, bedrock, surface and ground water data to help guide recommendations for system standards using an approach that considered risks to public health, drinking wate, and recreational resources in the state. ODH evaluated regional percentages of land areas affected by setting the vertical separation distance needed (i.e., the thickness of useable soil needed) for use of soil absorption trenches or leach lines for wastewater treatment. National research suggests that a minimum of 2 feet of useable soil is needed to remove odor, organics, solids, bacteria and viruses in sewage. ODH recommends that at least 18 inches of useable soil or vertical separation distance is needed for treatment. Setting the vertical separation distance at 18 inches to the seasonal perched water table will impact under 38% of the state, and setting 36 inches of useable soil above bedrock and sand and gravel aquifers will impact less than 5% of the state and still provide treatment of sewage.

ODH worked with local health districts to collect information from January 1 to November 30, 2007, on nearly 6,000 sewage treatment systems installed and their costs. Between January 1 and June 30, 2007, 87% of systems installed were septic tank to soil absorption systems; 10% were elevated mound systems; 3% used a pretreatment component to help reduce the vertical separation distance needed, less than 1% used drip distribution systems; 1% were authorized discharging replacement systems, and 4% were reported as unknown. Between July 1 and November 30, 2007, 60% of the systems were septic tank to soil absorption; 12% used pretreatment prior to soil absorption; 10% used elevated sand mounds; 3% used drip distribution; 6% were authorized discharging replacement systems; and 10% were reported as other. No low-pressure pipe or spray irrigation systems were installed. For the entire reporting period, over 95% of the systems installed were for households; the remainder was for small flow systems such as businesses, churches, and community buildings. New installations totaled 85% of all systems installed, 12-13% were replacement systems, and the remainder not reported.

Average state costs for new system installations ranged from $6,500 to 7,500 for septic tanks to leach lines (soil absorption trenches); $8,000 to 8,700 for pretreatment to leach lines; $14,000 to 19,000 for sand mounds; $19,000 for drip distribution systems; and $11,600 for discharging systems in compliance with water quality standards set under

the General National Pollutant Discharge Elimination System (NPDES) permit. Based on reported data, the average state cost for new system installation was $8,100.

Using the reported and averaged statewide system costs, the total estimated annual dollars spent on system installations and replacements in Ohio was calculated. Total dollars spent on system replacements was estimated at $14.6 million, representing nearly 30% of the total estimated $49 million spent on system installations. This compares to the nearly 1 billion spent on sewer line installations to areas of failing systems since 1989, at an average annual cost of 55 million per year.

Costs and numbers of disease outbreaks from sewage are difficult to detect and determine unless larger numbers of persons are affected such as the outbreak on South Bass Island in 2004. U.S. EPA does provide information on projected illness costs associated with viral outbreaks that range from over $100 up to $23,000 per person. Exposure to sewage diseases has the most significant impact on sensitive populations such as small children, the elderly, and immune-compromised persons.

True annual system costs (system installation plus operation and maintenance) amortized over 30 years were calculated and ranged from $336 (conventional system) to $1,172 (drip distribution) which is very similar to the state average sewer rate costs of $442 annually, and 30 year annual costs of $504 to 1,272 with the addition of connection fees and costs.

U.S. EPA establishes a benchmark of affordability for public sewer rates for communities as 2% of the median annual household income. Socioeconomic data was calculated for each county and region of the state. For all regions, 2% of the annual median household income ranged from $660 to $996. True annual sewage treatment system costs reported ranged from $336 to 1,056 annually, within the range of the 2% benchmark set for wastewater treatment with public utilities. Using the 2000 census data, and the average annual rate of system replacements, ODH has calculated that approximately 500 households below 200% of federal poverty levels will need financial assistance at an estimated cost of $2.1 to 4.2 million annually.

According to U.S. EPA (2002) many states have chosen to take a practical hybrid approach to sewage management that combines performance based objectives with some prescriptive technologies that have proven effective under known range of site conditions. Hybrid approaches can integrate risk assessment into the setting of performance standards and prescriptive requirements, with the consideration of economic factors as required by the legislature in Ohio. ODH used this approach to consider low to high-risk receptors (seasonal perched water to drinking water sources) and then recommend appropriate treatment levels for those resources based on national standards. System costs and affordability were also considered. ODH also researched other types of information in providing sewage treatment system recommendations, including an evaluation of the standards set by surrounding states, and the more stringent rules that local health districts have adopted and been using for the last five months.

Using this approach, ODH is recommending new design standards for sewage treatment systems that vary from the standards set in the 2007 rules. ODH is recommending that the vertical separation distance to seasonal perched water table be reduced from 2 feet to 18 inches. Different methodologies can be used to reduce the thickness of suitable soil needed in those areas of the state (38%) where shallow seasonal water is within 18 inches or bedrock or ground water aquifers are within 36 inches (5%). Pretreatment units can be used to reduce the amount of treatment the soils need to do resulting in less thickness of soil needed. In conjunction with a risk-based approach, artificial drainage may also be used in some soils to help modify sites with shallow seasonal saturation. ODH is working with the Ohio State University to determine which soils in the state can use artificial drainage to help effectively lower the seasonal perched water table to help improve sewage system treatment while reducing system costs by allowing more conventional systems to be used. Different methods of soil dispersal ranging from low pressure pipe, pressure distribution to sand mounds, drip distribution and spray irrigation can also be used to help ensure effective treatment in the soil and address challenging soil or site conditions. The thickness of suitable soil can be reduced from 12 inches to 6 inches with appropriate levels of treatment. By providing different tools and options for systems and sites, most lots can be developed, and more conventional systems can be installed, resulting in lower system costs.

Other recommendations refer to practices and activities that are critical to ensure proper system design, installation, permitting, operation and management, some of which were in place prior to 2007, during early 2007, and have been continued by local health districts through local, more stringent rules. Site and soil evaluations are a key prerequisite to system design followed by the use of best standards of practice for system installation. ODH recommends that system contractor registration and competency requirements continue with recognition of national certification programs. Local operation and management programs must have flexibility and be tailored to local community needs and system types. Continued proper management of septage to ensure compliance with federal regulations is also recommended. ODH has evaluated existing financial resources available for individuals to supplement or finance system replacements and installations, and has researched and presented information on other financial management solutions. Finally, ODH believes that the key elements of a successful sewage treatment systems program, as identified nationally, can be implemented by retaining the provisions of Chapter 3718 of the Revised Code that are now tolled. ODH recommends that this Chapter be reinstated effective July 1, 2009.

ODH is pleased to provide this report and stands ready to work with the Household Sewage and Small Flow On-Site Sewage Treatment System Study Commission, our local health partners, and the regulated community to achieve a cost-effective, long term solution for sewage treatment systems that protects the health and safety of Ohioans.

Table of Contents

Page

Executive Summary…….. 1
List of Tables……7
List of Figures……..7

Household Sewage Systems - *History and Introduction*……... 9

Safe Communities -*Sewage Systems and Public Health*……13

What is the Risk?..... 13
The Human Impacts - Diseases and sewage……14
The Environmental Impacts - Surface and Ground Water, Aquatic Life
and Recreational Waters…… 17
Types of Sewage System Failure ……21
Documented System Failure Rates In Ohio……21

Sewage Systems - *The Basics*…… 24

Functions of an On-site Sewage Treatment System…… 25
Sewage Treatment System Types Used in Ohio and the Midwest…… 28
Evaluation of State Soils and Bedrock Data…… 32
Consideration of Sensitive Ground Water, Surface Water and Drinking
Water Protection Areas…… 38
Use of Engineered Drainage to Lower the Seasonal Perched Ground Water…… 41

Sewage Treatment Systems - *Type, Costs and Economics*…… 44

Historical System Type Information…… 44
Historical cost information…… 44
2007 System Type Information……44
2007 System Cost Data…… 50
State, Community and Individual Costs of Sewage Treatment System Failure…... 52
Documented State Costs…….. 54
Documented Community/County Costs……..54
Surface Water Contamination from Failing Systems…… 55
Ground Water Contamination from Failing Systems……56
Individual Costs of Failing Systems – Connection to Public Sewers……..60
Individual Costs of Failing Systems - System Replacement Costs……... 60
Illness Costs to Individuals from Exposure to Sewage…… 63
State Socioeconomic Data…… 64

Page

Safe Systems - *Recommendations for Standards*..... 70

Performance and Prescriptive Approaches to Sewage Treatment Standards and Management 70
Comparison of Local Health District soil absorption standards and requirements.. 74
Comparison of sewage treatment system standards from other Midwestern states with similar soils and geology..... 75
Recommendations for Sewage Treatment System Siting 75
Recommendations for Sewage Treatment System Design 76
Recommendations for Sewage Treatment System Installation..... 80
Recommendations for Sewage Treatment System Abandonment..... 81
Recommendations for system operation, monitoring and maintenance..... 81
Recommendations for Progressive System Repairs 82
Additional Recommendations..... 82

System Costs - *Recommendations for Financial and Management Solutions*..... 84

Existing Financial Resources to Assist System Owners..... 85
Alternative Funding Sources..... 86

References..... 88

Appendix 1 Sewage Treatment System Fact Sheets

Appendix 2 Permit Reports for Jan – June, 2007 and July - November, 2007

Appendix 3 Ohio Counties: Number of Households/Value, Income, Poverty – Not within Municipal Boundaries

Appendix 4 Survey Results of Interim Regulations Adopted by Local Health Districts

Appendix 5 Survey of Midwestern State Sewage Rules

List of Tables

Page

1. Survival of Certain Pathogens in Soil and Ground Water (after Salvato, 1992) ……..15
2. Areas in Ohio where ground water has been impacted by sewage systems…….20
3. Typical constituents of sewage (U.S. EPA, 2002). …….. 24
4. Comparison of sewage treatment systems in Ohio……29
5. Depth to Seasonal Saturation and Bedrock in Ohio Soils by region of the state……..33
6. Total cumulative percentage of land area impacted at different vertical separation distances……. 37
7. Number and percentage of system type codes installed by region from January 1 to June 30, 2007…… 45
8. Number and percentage of system description codes installed by region from January 1 to June 30, 2007……. 46
9. Combined system type/description totals and regional percentages from January 1, 2007 to June 30, 2007…… 47
10. Totals and percentages by regions for household and small flow onsite sewage treatment systems installed from January to June, 2007…… 47
11. Totals and percentages by regions of replacement and new systems for January to June, 2007…….. 48
12. Type, number, and percentage by region of sewage treatment system installations reported between July 1, 2007 to November 30, 2007…… 49
13. Number and percentage by region of household sewage treatment systems versus small flow onsite sewage treatment systems, and the new, alteration or replacement systems installed from July 1, 2007 through November 30, 2007….. 49
14. Estimated sewage treatment system costs by type and region as reported from July 1, 2007 to November 20, 2007…… 50
15. Sewage system installer survey reported average system cost, October, 2007……. 52
16. Costs of failing systems……. 53
17. Initial and amortized costs, and resulting true monthly costs of various sewage treatment systems and public sewers. …….. 61
18. Statewide sewage treatment system installation, replacement and alteration costs….. 62
19. Demographic and clinical information for cases reporting illness, South Bass Island, Ohio, May 30-September 10, 2004 (N=1,450)…….. 63
20. Select regional socioeconomic data…… 68
21. System type and total annual system cost…… 68
22. Summary of local health district interim rule requirements…….. 74
23. Total number of households outside of municipal boundaries for each region earning below 200% of the poverty level…….. 84

List of Figures

1. The fate of wastewater discharged into septic sytems (U.S. EPA, 2002)…… 17
2. Aquatic life use impairments with failing onsite systems identified as a contributing source (1995-2004 data)……. 19
3. Examples of sewage system failures…… 21
4. Conventional subsurface wastewater infiltration system (U.S. EPA, 2002)…… 25
5. Sewage system design and performance boundaries (U.S. EPA, 2002)…… 26
6. Consideration of slope and contour with system design (U.S. EPA, 2002)…… 27
7. Depth to seasonal saturation in Ohio soils…….. 34
8. Depth to bedrock in Ohio soils…… 35
9. Public water supplies with elevate nitrate-nitrogen concentrations and sensitive aquifers in Ohio…….. 40

Page

10. Drinking Water Source Water Protection Areas and Sensitive Aquifers…….. 41
11. Characteristics of the water table in a soil absorption area with drains…… 42
12. Average Median House Value – Non Municipalities…… 65
13. Average Median Incomes – Non Municipalities…….. 66
14. Percentage of Population that is 200 Percent of Poverty Level – Non Municipalities…….. 67
15. Schematic showing a site boundary for possible regulation…….. 71
16. Integrated risk assessment framework for sewage treatment systems…… 73

Household Sewage Systems - *History and Introduction*

The statewide regulation of sewage systems in Ohio began with the adoption of minimum sewage disposal rules by the Public Health Council in 1974. Minor modifications were made to these rules in 1977. The Household Sewage Disposal Rules, Ohio Administrative Code (OAC) Chapter 3701-29 remained unchanged until January 1, 2007. Prior to 2007, Ohio had the oldest sewage rules in the United States.

The 1977 rules set specifications for the "disposal" of sewage for one, two, and three family dwellings, and only listed three approved technologies. From 1977 through 2007, most properties used conventional septic tanks to leach line systems which rely on the soils to do most of the waste treatment. Many of Ohio's soils are seasonally wet or they poorly drain causing approximately 27% of septic systems to fail (Mancl, 1990; NOACA, 2001, Ohio EPA, 1995). Where soils were challenging and routinely caused system failures, aerobic treatment units and sand filters were used to allow for systems that discharged to ditches, streams and rivers. These discharging systems were not legally permitted under the Clean Water Act, and were often not maintained creating public health nuisance conditions. System failures caused sewage to back up in yards and homes, and discharge to streams and ground water resulting in contamination that has been documented by Ohio EPA and many local health districts.

Many communities have extended public sewers to areas of failing systems at substantial additional costs to the system owners and the communities. Since 1989, Ohio has spent nearly 1 billion dollars in low interest loans and grants to communities to run sewers to areas of failing septic systems (OWDA, 2006). The Clean Watersheds Needs Survey conducted by Ohio EPA in 2004 as required by the Clean Water Act identified $875 million is needed to extend sewers to areas of currently failing systems (Ohio EPA, 2004).

A few statistics define the extent of the legacy of sewage management in Ohio:

- Estimated number of existing household sewage systems in Ohio based on 1990 census data (adjusted): 1 million - representing 21% of the 4,709,000 housing units in Ohio.
- Failure rate of existing systems: 25-30% (documented from statewide/regional studies and permit data)
- Number of estimated failing systems: 250,000 systems
- Sewage systems generate approximately 120 gallons per day (gpd) of waste effluent per person– at 4 persons per household this <u>equals 480 gallons per day per household waste released into the environment. Over a year this equals approximately 175,000 gallons.</u>
- One million systems generating 480 gallons per day of waste equals 480 million gallons of waste per day going into the environment in Ohio.
- At a 25% failure rate, <u>this is approximately 120 million gallons of poorly to untreated waste discharging daily to surface and ground water.</u>

In response to these statistics, many local health districts, as permitted by Ohio Administrative Code (OAC) Chapter 3701-29, adopted more stringent local rules, and sought the use of experimental concurrence from ODH for the use of newer technologies that could be used on lots with poorly drained soils or seasonal water tables near the surface. This included technologies such as sand mounds, drip distribution, peat biofilters, various pretreatment units, and constructed wetlands. These technologies were used by over 30% of Ohio counties since the mid 1980's.

The 125th General Assembly enacted H.B. 231 that was signed by Governor Bob Taft in May 2005, which provided for the comprehensive regulation of sewage systems in Ohio. The law created Chapter 3718 of the Ohio Revised Code (ORC) which established authority for the Ohio Department of Health (ODH) to implement administrative rules establishing standards for the siting, design, permitting, installation, alteration, operation, monitoring, maintenance, and abandonment of sewage treatment systems serving homes and small non-residential facilities. The new law required that rules be adopted within one year. Recognizing the need for widespread advice and input from industry, academia, state agencies, and interest groups, ODH established the Sewage Advisory Committee (SAC). The SAC membership included:

- Association of Ohio Health Commissioners
- Association of Ohio Pedologists
- County Commissioners' Association of Ohio
- County Engineers Association of Ohio
- Ohio Association of Realtors
- Ohio Department of Natural Resources
- Ohio Environmental Council
- Ohio Environmental Health Association
- Ohio Environmental Protection Agency
- Ohio Home Builders Association
- Ohio Onsite Wastewater Association
- Ohio Manufactured Home Association
- Ohio Precast Concrete Association
- Ohio Public Health Association
- Ohio State University Extension
- Ohio Township Association
- Ohio Waste Haulers Association

From April 2005 through December, 2005, ODH worked with the SAC to identify decision points and draft rules. Public comment periods were held from December, 2005 through April, 2006, with final rule adoption by the Public Health Council in May, 2006 with a delayed effective date of January 1, 2007 to allow for a smooth transition. The new sewage treatment systems rules focused on ensuring the effective treatment of sewage while providing a wide array of system options for property owners. Concerns expressed by stakeholders over potential system costs related to the new

rules prompted ODH to reevaluate certain standards in the rules. Subsequently, the Public Health Council adopted revisions to the rules in October, 2006. The public health community and the majority of the regulated industry were supportive of the rules as finally enacted. From October to December, 2006, ODH implemented extensive rule training with local health districts. Eleven training meetings were held with over 340 local health district staff in attendance. There were 5 evening meetings for the public across the state that was attended by installers, soil scientists, designers, industry, realtors and the public with over 700 attendees total for all meetings. Presentations on the new rules were made in multiple venues including trade and professional association meetings; local township, health district and organization meetings.

The costs for new and replacement systems continued to be a concern, although little actual data documenting systems costs had been collected. The Association of Ohio Health Commissioners in May, 2007, surveyed local health districts on systems costs. Their data showed that for some areas and system types, costs were relatively similar to those costs for the same systems in 2006, and in other areas, system costs did increase, with average costs of systems installed of $13,000.

Effective July 1, 2007, the 127th General Assembly made several changes to sewage treatment system law and rules for Ohio, including the suspension of the state sewage law and the rescission of the sewage treatment system rules. As directed by Am. Sub. H.B. 119, the Ohio Department of Health readopted the 1977 Household Sewage Disposal Rules as statewide interim rules that provide minimum standards for sewage systems in Ohio. Pursuant to this legislation, local health districts may adopt more stringent rules and are directly responsible for the permitting, inspection and enforcement of on-site sewage systems while considering the cost and economic impact of those rules. Recent changes to state law limit the oversight authority this department has over local health district programs and rules.

The law also provides that through July 1, 2009, the Home Sewage and Small Flow Onsite Sewage Treatment System Study Commission will consider and recommend efficient and effective ways to treat sewage to ensure protection of public health with consideration of economic impacts. Over the ensuing 18 months, further work and research will be done to assess the available technologies, consider the current types of systems and rates of failure across Ohio, and determine the best ways to ensure that systems in the future achieve treatment of sewage to protect the public health, the homeowner's investment in their property, and the environment in a cost effective manner.

Am. Sub. H.B. 119 also directs ODH to prepare several reports regarding sewage treatment systems in Ohio. Section 737.12 of Am. Sub. H.B. 119 states:

> *A) The Director of Health shall issue a report to the Household Sewage and Small Flow On-Site Sewage Treatment System Study Commission created in Section 737.11 of this act that includes recommendations regarding standards for*

the siting, design, installation, operation, monitoring, maintenance, and abandonment of household sewage treatment systems and small flow on-site sewage treatment systems. The recommendations shall include information concerning the cost and state of technology currently utilized in household sewage treatment systems and small flow on-site sewage treatment systems and the nature and economics of available alternatives to that technology. The Director shall issue the report to the Commission not later than January 1, 2008.

(*B) The Director shall conduct a survey of boards of health in this state concerning household sewage treatment system operations and the failure rates of those systems. The Director shall issue a report concerning the survey to the Household Sewage and Small Flow On-Site Sewage Treatment System Study Commission not later than June 1, 2008. Boards of health shall provide, in a timely manner, any and all relevant information pertaining to the household sewage treatment system program that is requested by the Director under this division and that the Director determines to be necessary for completion of the survey.*

This report fulfills the requirements of Section (A) stated above.

Safe Communities
Sewage Systems and Public Health

What is the Risk?

ODH believes that sewage systems should provide for the treatment of sewage and not merely disposal. These systems constitute the wastewater treatment infrastructure for homes, small businesses, churches or community buildings in areas that are not served by public sewers. The use of individual household or small flow sewage treatment systems in a community is referred to as decentralized wastewater treatment, and can be a very effective and economic means to treat sewage when properly designed, installed and managed.

Sewage system failures have a tangible negative impact on human health and the environment. Approximately 25% of Ohio's households are served by some type of sewage system located on the property with an estimated one million systems in use today (U.S. Census, 2000). The proper design, installation and management of these systems is critical when consideration is given to the quantity of sewage generated by the average household. The typical household of 4 persons generates approximately 480 gallons per day of sewage. This equals 146,000 gallons of sewage per year – enough to fill an average swimming pool over 10 times!

Paulding County in northwest Ohio has a population of 19,432 and has an estimated 5,000 sewage systems for homes and businesses. Sewage systems in Paulding County generate 670 million gallons per year. This is enough sewage to fill the water supply reservoir (400 million gallons) that serves the county 1.5 times (Source, Paulding County Health Department.

While one sewage system failure may cause only minimal pollution, the effect of a million individual systems across Ohio does have a cumulative impact. It can be a significant pollution problem and is a public health risk. Failing systems negatively impact property values and the ability to sell homes, and impair the overall quality of life and enjoyment of a property. The impact extends to neighborhoods, communities and watersheds and often crosses political boundaries.

Public concern over the impact of sewage systems to public health and the environment was documented in the Ohio Comparative Risk study conducted in 1995. The Ohio Comparative Risk Project (Ohio EPA, 1995) used a public advisory group to evaluate relative risks to human health, ecosystems and quality of life. Most importantly, the report clearly defined that inadequate infrastructure, which included household sewage

systems was ranked as one of the top human health threats in Ohio, and ranked as a moderate threat to quality of life. Public opinion polls conducted as part of the study identified unsafe drinking water and water pollution in lakes and streams as the second and third most important environmental problems facing Ohio. An additional survey of public health professionals conducted in 1999 showed that over half of the respondents identified onsite sewage systems as the most important environmental concern in their county (Morrone and Ryan, 2000).

Ultimately, the critical issue is how to balance the cost of proper treatment of sewage versus the costs of system failure (replacements and sewer lines) and illness.

The Human Impacts - Diseases and sewage

Systems need to be maintained and operated in a manner that will prevent people, pets and insects from coming into contact with sewage or poorly treated effluent. The risk of having direct contact with household sewage is not an unlikely occurrence in many neighborhoods. With over 1 million systems in Ohio, and an estimated failure rate of 27 percent, hundreds of thousands of gallons of sewage is discharged daily throughout Ohio, creating the conditions for potential disease transmission.

The improper disposal and subsequent exposure to human waste is a significant public health concern. These factors lead to significant causes of disease in many undeveloped countries. Human waste from ill and healthy persons may contain large numbers of pathogens that cause illness including bacteria, protozoans, and viruses. There are many human illnesses associated with sewage, including typhoid fever, gastroenteritis, cholera, dysentery, infectious hepatitis, aseptic meningitis and encephalitis. To prevent these and other related diseases, it is important to eliminate contact with sewage. Even though pathogens are transmitted by this direct contact, there is an even greater risk of disease transmission to the general public through contamination of our drinking water.

A Trumbull County Story

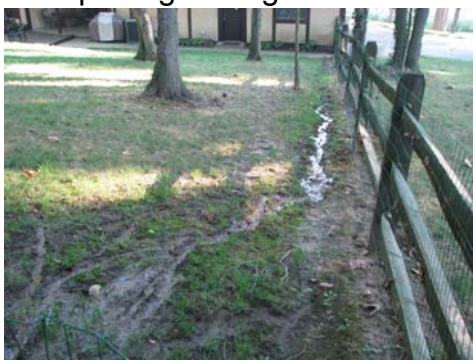
A few years ago a homeowner in Trumbull County contacted the health department due to concerns over the operation of his system. An inspection by the health department staff revealed discharging sewage in the back yard near a wooded area. Upon finding out the costs for a replacement system, the property owner expressed reluctance about correcting the sewage nuisance conditions on his land. During the health district staff visit, the owner's daughter came outside to play in the yard with the family dog. The dog ran directly through the sewage ponding in the yard and then jumped up on the daughter who playfully embraced and hugged the dog. When the property owner observed the contact his daughter just had with sewage, his reluctance to replace the failing system rapidly faded. The health department sanitarian and the property owner worked together cooperatively to determine the best solution to safely and economically treat the sewage on the property, protecting the health of the family and the neighborhood.

The survival of sewage pathogens in the environment is dependent on many factors. In general, the presence of saturated conditions in the soil and food sources (organic carbon) increases the ability of bacteria and viruses to survive and migrate to drinking or ground water sources. (Salvato,1992). Table 1.lists the survival rates of pathogens in soil and ground water.

Table 1. Survival of Certain Pathogens in Soil and Ground Water (after Salvato, 1992)

Organism	***Media***	***Survival Time (days)***
Coliforms	Soil surface Ground Water	38 (greater in soil) 7-8
E. coli	Ground Water	10-45
Cryptosporidium	Moist environment (soil and ground water)	60-180
Enteroviruses	Soil	8 days to 1 year
Salmonella	Soil Ground Water	1-120 15-70 days
Tubercle bacilli	Soil	Greater than 180

The development of illness when exposed to pathogens in sewage is dependent on the toxicity or virulence of the pathogen, the amount and duration of the pathogen ingested, and the resistance or susceptibility of each person. The infective dose of pathogens can range from 1 virus (plaque forming units (pfu)) to 10,000,000 bacteria for *E. coli* (Salvato, 1992). Persons who are particularly susceptible to illness include the very young, elderly, those with chronic respiratory or cardiovascular disease, and those who are immunocompromised. Typical symptoms of illness related to sewage exposure include vomiting, diarrhea, nausea and fever with the onset of symptoms ranging from hours to days. More severe symptoms (i.e. kidney failure and death) can occur in susceptible individuals or from ingestion of large doses of the pathogenic agent. Pooled sewage on the ground due to system failure or discharge into ditches and streams can create conditions conducive to the breeding of mosquitoes, and result in related illness such as West Nile Virus and St. Louis, Equine and Lacrosse Encephalitis.



Disease outbreaks related to improperly treated sewage have been documented throughout history and have prompted many current federal and state regulations related to the public treatment of wastewater. The relationships between disease and on-site system performance have been more difficult to quantify. Mild to moderate gastrointestinal illnesses in a family are not typically reported; ill persons routinely use over the counter medications to control symptoms, and may not visit a physician. Other factors related to rapid disease identification, state level reporting requirements, and state and laboratory capacity to

investigate and analyze outbreaks further reduces the ability to relate disease to sewage contamination (CDC, 2006).

The Centers for Disease Control and Prevention (CDC) national surveillance for waterborne disease and outbreaks associated with drinking water from 2003-2004 shows that 43% (7 total, 2 reported in Ohio) of the outbreaks were related to contamination of untreated ground water used as a drinking water source (CDC, 2006). Eighty-eight (88) percent of the waterborne disease outbreaks reported for ground water were related to illness associated with a bacterial, viral or protozoan source of pathogen. Gastroenteritis (vomiting, nausea and diarrhea) was the predominate reported illness. The CDC also reports that these pathogens can be attributed to fecal sources of contamination, and that contaminated ground water that leads to illness is a continuing problem.

The most significant disease outbreak reported during this time period for the United States, was the gastrointestinal outbreak at South Bass Island (ODH, 2005; CDC, NCEH, 2005; CDC, NDBB, 2005; Ohio EPA, 2005)**.** Over 1,450 persons reported illness after visiting the island. Studies confirmed sixteen patients had confirmed *Campylobacter jejuni* infection, nine had confirmed norovirus infection, three had confirmed *Giardia intestinalis* and one had confirmed *Salmonella typhimurium*. Environmental studies identified the presence of multiple pathogens including various bacteria, viruses and protozoans in ground water. The epidemiological and environmental studies concluded that contaminated drinking water from sewage was the source of illness. The island consists of fractured and cracked limestone rock with a very thin soil cover. Ground water resources on the island are subsequently very vulnerable to contamination. Improperly constructed sewage systems on the island, combined with other sources were identified as a source of contamination.

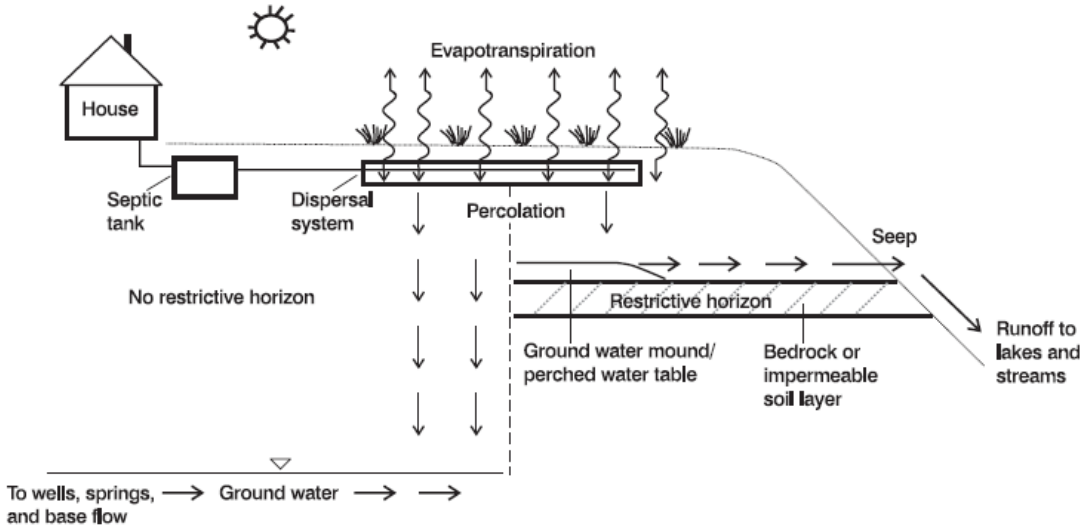
The CDC, Environmental Health Services Branch has recently evaluated the published literature regarding disease outbreaks and epidemiological studies related to failing onsite sewage systems. It's survey indicates the following trends have been related to outbreaks: 1) intermittent use of drinking water and wastewater systems (fairs and gatherings); 2) onsite sewage systems installed in unsuitable soil or vulnerable geologic conditions; and 3) extreme precipitation events such as storms and hurricanes. (Gelting, 2007). Public health effects from onsite sewage systems also appear to be related to chronic or repeated exposure to wastewater pathogens. Some research suggests that repeated exposure of residents dependent on private wells and septic systems to pathogens causes greater acquired immunity to wastewater pathogens (Parminder, et al, 1990). This acquired immunity may indicate that wastewater pathogens in the environment are more widespread, because exposures to sewage do not always result in illness (Gelting, 2007).

The Environmental Impacts - Surface and Ground Water, Aquatic Life and Recreational Waters

Environmental impacts in Ohio from failing sewage systems has been extensively documented in Ohio through investigations of water quality contamination, routine water quality assessments, response to complaints, and enforcement orders.

Contamination from sewage systems has occurred through the direct discharge into ditches, farm tiles, collector tiles, streams, rivers and lakes. Where shallow perched or seasonal water is present in the soil, sewage effluent moves downward until the limiting zone or condition is reached, it then travels horizontally and may reach ditches or streams. In areas where sewage systems are installed in shallow perched seasonal water tables, sewage can also be captured by curtain or perimeter drains and transported to nearby ditches and streams. Failing discharging sewage systems have impacted or impaired the recreational uses of water in Ohio, including wading, swimming, fishing and boating.

Figure 1. The fate of wastewater discharged into septic systems (U.S. EPA, 2002).



Certain types of geologic conditions in Ohio cause ground water to be sensitive or vulnerable to contamination from improperly designed, installed, or maintained sewage systems. Very porous sand and gravel deposits can allow the rapid transport of sewage into the ground water aquifer. Areas with thin soil cover over fractured bedrock also allow the rapid transport of sewage to ground water without proper treatment in the soil.

The most commonly identified impact from failing systems in Ohio has been contamination of surface water, particularly in areas with large numbers of discharging sewage systems. Several counties, including Hamilton, Cuyahoga and Trumbull have experienced widespread contamination, and subsequent enforcement actions resulting in millions of dollars spent on extending public sewers to many areas or direct replacements of failing systems. As required by the Clean Water Act, Ohio EPA

conducts assessments of watersheds and evaluates sources of contamination and their impacts on surface water quality. Figure 2 depicts aquatic life use impairments with failing on-site systems identified as a contributing source and lists low, medium and high threat watersheds from failing systems. These water quality impacts limit the ability to use the streams in these watersheds for recreational purposes such as wading and fishing.

Reports (bacterial total maximum daily load) released in 2007 by Ohio EPA for the Chagrin, Grand Lake St. Marys, Sugar Creek and Olentangy River watersheds identified failing sewage systems as a major contributing source of bacterial contamination (www.epa.state.oh.us/dsw/tmdl/index.html, 2007)

Figure 2. Key to Impairment Figure Color Coding (Source: Ohio EPA)

Low Threat: Watershed listed for an aquatic life use impairment with sources including failing on-site systems. Available fecal coliform data from ambient sites indicate few and only sporadic exceedences of WQS criteria. Recreation use is not listed as impaired or not enough data are available to make the determination. Bacteria sources include failing on-site systems but also other potential sources such as combined sewer overflows and those that are livestock or agriculture related.

Medium Threat: Watershed listed for an aquatic life use impairment with sources including failing on-site systems. Available fecal coliform data from ambient sites indicate more widespread bacteria contamination with few to many sites with either 30-day average or individual sample maximum exceedences of WQS criteria. Recreation use is listed as impaired. Bacteria sources include failing on-site systems but also other potential sources such as combined sewer overflows and those that are livestock or agriculture related.

High Threat: Watershed listed for an aquatic life use impairment with sources including failing on-site systems. Available fecal coliform data from ambient sites indicate widespread bacteria contamination with most sites with numerous 30-day average and individual sample maximum exceedences of WQS criteria. Recreation use is listed as impaired. Bacteria sources include failing on-site systems but also other potential sources such as combined sewer overflows and those that are livestock or agriculture related.

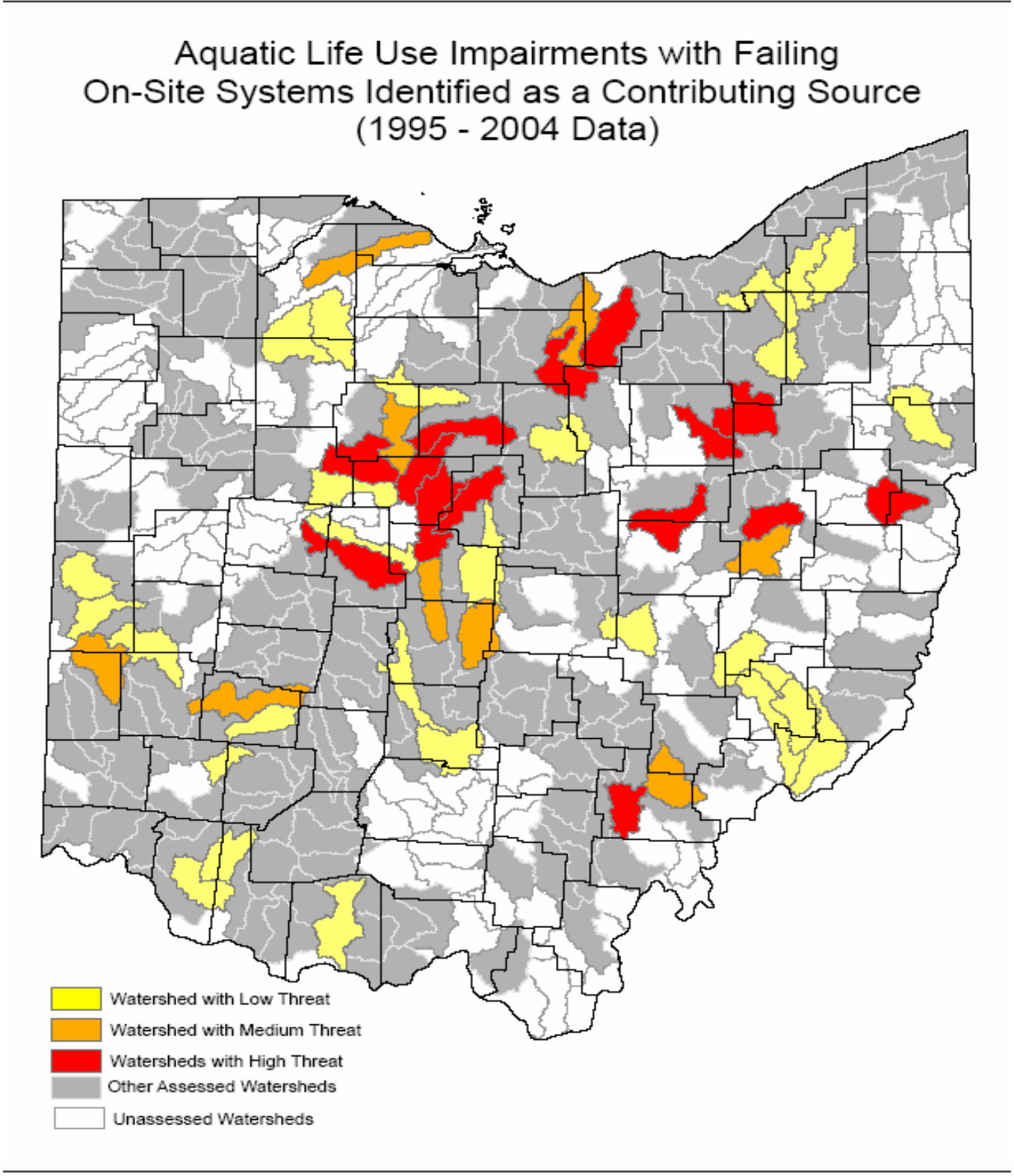


Figure 2. (Source: Ohio EPA)

In 2005, ODH contracted with the U.S. Geological Survey, to conduct a study of the migration of bacteria, nutrients and wastewater compounds from soil absorption trenches at select sites in Ohio (Dumouchelle and Stoeckel, 2005). The study also used genomic source tracking (DNA analysis) to confirm that *E. coli* detected in the water in the soil adjacent to the soil absorption trenches was the same *E. coli* that was found in the septic tank for the system. The study confirmed the migration of *E. coli* from systems several feet horizontally and up to 8 feet in depth, and confirmed migration of *E. coli* to a curtain drain 10 feet away from the soil absorption trenches. Elevated nitrates and chlorides were found in the soil water below the trenches. Compounds found in sampling piezometers at the investigation sites included fragrances, food and beverage additives, detergents, pesticides and repellents, flame retardants, and plasticizers.

Ground water quality investigations in Ohio have also identified impacts from failing sewage systems, most notably in areas where the ground water is susceptible to contamination. Table 2 identifies the areas affected, the type of ground water systems affected, and the projected number of sewage systems present.

Table 2. Areas in Ohio where ground water has been impacted by sewage systems.

Area	**Identified contaminant**	**Type of Aquifer**	**Estimated Number of sewage systems**	**Resulting Actions**
Elizabethtown, Hamilton County	Nitrates, sodium, chlorides	Sand and Gravel	Approx. 100	Replacement of sewage systems upon identified failure
Wooster Township, Wayne County	Total coliform, *E. coli*, nitrates	Fractured sandstone	Approx. 100	Extension of public sewers
South Bass Island, Ottawa County	Total coliform, *E. coli*, nitrates, viruses, *camplyobacter*, *salmonella*, *cryptosporidium* and *giardia*	Karst (fractured) limestone	400 - 500	Partial extension of public water, corrective actions for semi-private and public water supplies
Coshocton County	Total coliform, *E. coli*, nitrates	Sand and gravel	Approx. 50	Unknown
Highland County	Total coliform, *E. coli*, nitrates	Karst (fractured) limestone	Approx. 50	Recommendations for private water well disinfection and treatment for nitrates
Thompson Township, Seneca County	*E.coli* and nitrates	Karst (fractured limestone)	100+ systems	Moratorium on new construction due to water quality impacts from sewage systems
Venice Gardens, Ross County	Total coliform, *E. coli*	Sand and gravel	Unknown	Extension of public water

Types of Sewage System Failure

Routine saturated conditions in the soil commonly lead to system failure resulting in sewage surfacing in the yard, sewage runoff into nearby ditches or streams, or infiltration to ground water resources. The most common failures are ponding or surfacing in the area of the gravel trenches or the back-up of sewage into the home. Failure also occurs when the ponded effluent flows off the property and causes a public health nuisance and environmental impairment. Discharging systems that exceed public health nuisance standards and effluent quality limits also constitute system failure. Less obvious and more difficult to recognize failures occur when systems do not adequately treat sewage effluent in the soil and allow for the migration of contaminants into the ground water.

Figure 3. Examples of sewage system failures.

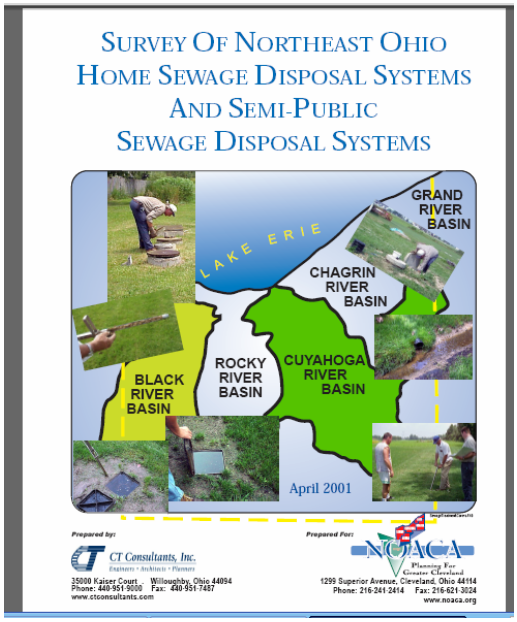
Documented System Failure Rates In Ohio

Several surveys and studies conducted in Ohio have identified approximate failure rates across the state. Mancl (1990) surveyed local health districts who estimated, based on permit and complaint data that 27% of systems were failing. This number was supported by further survey information collected from the public, and local and state agencies during the Ohio Comparative Risk Project conducted by the Ohio EPA in 1995. Many of the areas of failing systems in Ohio are older, small crossroads communities where small lots, old or non-existent systems, and a higher density of housing have caused public health nuisance conditions or environmental impacts. More recent studies have identified, however, impacts to surface and ground water in

higher density subdivisions, and lower density housing developments in sensitive ground water areas.

From 1999-2001, the Northeast Ohio Areawide Coordinating Agency (NOACA) conducted a survey of sewage systems in seven northeastern Ohio counties to provide representative data on the performance of systems constructed since 1979 and to determine factors contributing to unsatisfactory performance. Field inspections were conducted on over 700 systems. The survey found that 13 to 20% of household sewage systems in the study area were malfunctioning (surfacing effluent) as defined in the study. Systems installed in soils rated as having severe limitations for sewage disposal were significantly more likely to be malfunctioning than systems installed in soils having low or moderate limitations for sewage disposal.

The survey found that of the off-lot household systems discharging effluent at the time of the inspections (about two-thirds), 20 to 33% of discharging systems was identified as having poor effluent. The survey found operational problems with at least 34 to 47% of the off-lot systems inspected. The survey also found that the percent of systems with aerators had a statistically significant higher number of observations of poor effluent as compared to septic systems. Of the forty-four system effluents sampled for water quality, the survey found that 37 to 68% had fecal coliform concentrations above 5000 Most Probable Number (MPN)/100ml, which is a minimum water quality standard applicable to all surface waters. The survey also found that 32 to 63% of systems sampled did not meet an effluent standard of 20 mg/l BOD_5 and 40 mg/l TSS, as set by the ODH in the 1977 household sewage disposal rules.



Areas of failing systems have been identified by other areawide planning agencies and are documented in their Clean Water Act Section 208 plans. In 2001, the Toledo Metropolitan Area Council of Governments (TMACOG) identified 55 critical home sewage disposal areas in 5 counties where system failures were occurring and corrective action was needed.

From 1986 through 2007, Ohio EPA has identified 236 communities where failing systems have caused either public health nuisances or environmental degredation and administrative orders to correct have been issued. Ohio EPA has proceeded with judicial actions against 3 communities (consent agreements). From 2004 to the present, Ohio EPA has tracked the number of failing systems identified for each administrative action. Nearly 5,000 failing systems were identified in 30 communities identified as needing correction due to environmental or public health degradation from

failing systems during this time period. Most recently, Ohio EPA's environmental enforcement summary for 2006 lists those 854 failing on-lot sewage systems were corrected.

An examination of the number of alteration and replacement permits reported during the July 1 to November 30, 2007, time period may provide insight to the number of household sewage systems experiencing some type of failure. During this time period, 18% and 12% of all systems installed were replacement or alteration systems respectively, for a combined rate of 30% of all system installations during this time period. This rate is very similar to the statewide failure rate of 27% based on prior surveys and studies.

Sewage System - *The Basics*

Functions of an on-site sewage treatment system

A sewage treatment system is in effect a "mini wastewater treatment plant" on a person's property. The system is designed to serve two functions; 1) treat the sewage effluent, and 2) hydraulically load the effluent into the soil and move it away from the site.

Sewage is composed of a variety of waste products used in the home and excreted from humans. Table 3 identifies the different constituents of wastewater, the typical concentration, and total mass loads to the sewage treatment system.

Table 3. Typical constituents of sewage (U.S. EPA, 2002).

Consituent	***Mass Loading (grams/person/day)***	***Concentation* (mg/l)***
Total solids	115-200	500-880
Volatile solids	65-85	280-375
Total suspended solids (TSS)	35-75	155-330
Volatile suspended solids	25-60	110-265
5-day biochemical oxygen demand (BOD)	35-65	155-286
Chemical oxygen demand (COD)	115-150	500-660
Total nitrogen (TN)	6-17	26-75
Ammonia (NH_4)	1-3	4-13
Nitrites and nitrates (NO_2-N, NO_3-N)	<1	<1
Total phosphorous (TP)	1-2	6-12
Fats, oils and greases	12-18	70-105
Volatile organic compounds	0.02 – 0.07	0.1-0.3
Surfactants	2-4	9-18
Total coliforms (TC)		10^8 - 10^{10**}
Fecal coliforms (FC)		10^5 - 10^{8**}

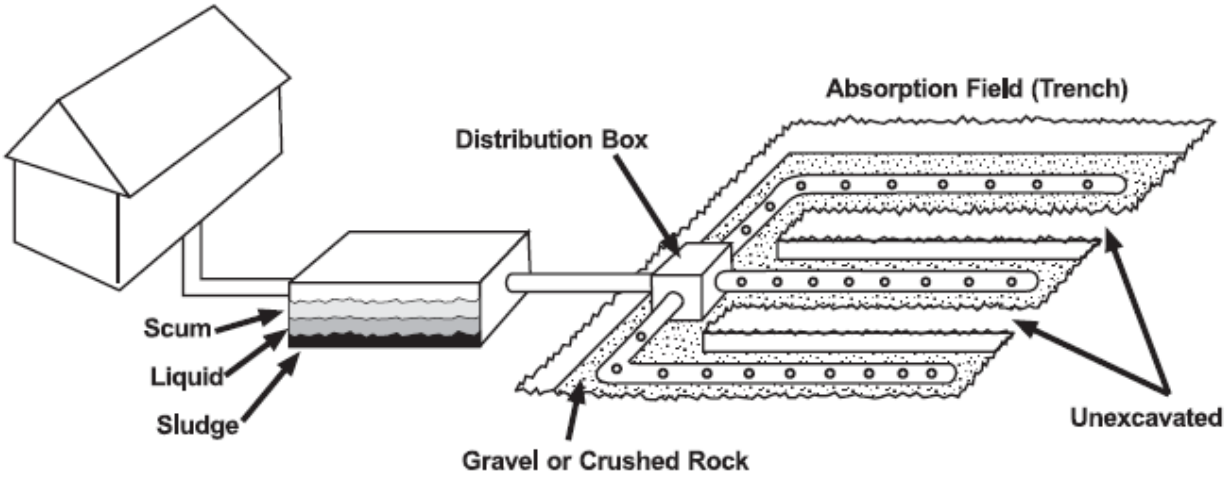
*For typical residential dwellings equipped with standard water-saving fixtures and appliances.

**Concentrations presented in Most Probably Number of organisms per 100 millilters.

The average waste volume generated by a household will vary during the course of the day. Greater flows are generated in the morning when a household is getting ready for work or school, or on weekends. Many studies have been conducted to determine the average flow rates that should be used for sewage system design. Recent studies for most households show daily per capita flow ranged from 54 to 67 gallons/person/day (U.S. EPA, 2002). This flow could be less or more depending on household practices and the use of water saving fixtures and appliances. Ohio has historically used a flow design rate of 150 gallons per bedroom in the design of sewage systems.

The most common type of sewage system used in Ohio is a conventional system that uses a septic tank that distributes effluent to gravel trenches placed into the soil. The septic tank is used to capture the liquids and solids from the home, and it's primary function is to settle out the solids materials. The liquid that comes out of the tank is called effluent, and it is distributed to perforated pipes that are placed in gravel filled trenches in the soil. Figure 4 depicts a typical conventional system configuration.

Figure 4. Conventional subsurface wastewater infiltration system (U.S. EPA, 2002).



The soil is used as a natural filter and treatment media to remove or reduce the:

- Finer suspended solids (measured as total suspended solids or TSS),
- Dissolved and particulate organic material (measured as biochemical oxygen demand or BOD),
- Pathogenic organisms including bacteria, viruses and protozoans.
- Household and personal care chemicals and pharmaceuticals.

During periods of increased water use in the household, the trenches are commonly flooded with effluent. The effluent seeps from the trenches into the surrounding soil. During periods of time when the system is not in use, the soil has a chance to rest, and re-aerate. Oxygen filtration into the soil absorption trench and the surrounding soil area is critical to ensure treatment of bacteria and viruses and removal of chemicals discharged into the system. The longer the retention time of the effluent in the soil, the better treatment that occurs as the effluent moves slowly through the soil pores. The natural processes of filtration, and the presence of beneficial bacteria in the soil both work together to ensure removal of suspended solids (TSS), organic matter (BOD) and pathogens (bacteria and viruses).

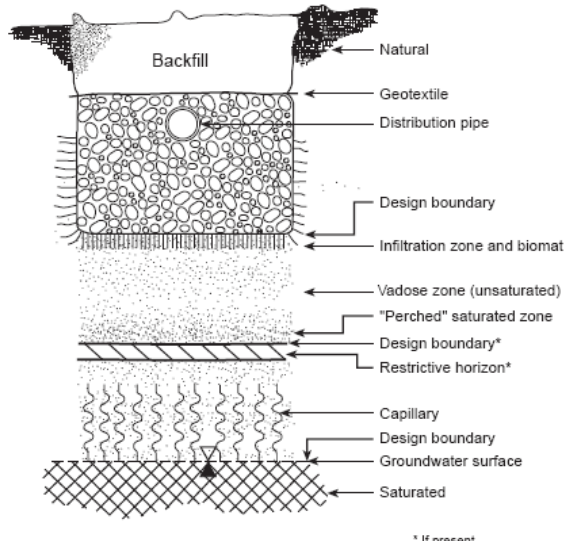


Figure 5. Sewage system design and performance boundaries (U.S. EPA, 2002).

As depicted in Figure 5, the zone or contact area where the effluent is applied to the soil is referred to as the infiltrative surface. A natural biomat forms at the infiltrative surface that contains solid particles, common soil bacteria and their growth products (bioslimes). Over time as a biomat develops, it tends to clog and reduce the ability of the trench to allow effluent to disperse into the soil. The effective removal of BOD and wastewater pathogens requires soil that contains both air and water in the pore spaces of the soil, i.e. the soil cannot be saturated below the infiltrative surface (Figure 5). Figure 1 illustrates the fate of wastewater discharged into septic systems. Substantial research indicates that BOD and TSS are removed in the first 6 inches of soil, but that 2-4 feet of unsaturated soil is needed to achieve effective removal of bacteria and viruses (U.S. EPA, 2002, Siegrist, et al, 2000). Research has shown that separation distances of 12 to 18 inches are adequate to effectively reduce fecal coliforms if the effluent receives additional treatment prior to soil application (Converse and Tyler, 1998a, 1998b)

The soil is also used to help move, infiltrate and disperse the treated effluent either to deeper zones beneath the site or horizontally to surface seeps, or shallow drainage. Therefore, the design of a sewage system must also consider factors that control the hydraulic movement of effluent into the soil such as the infiltrative loading rate of the soil and the lineal loading rate of the site. The infiltrative loading rate is a measure of the soils ability to transport effluent through the soil column as measured in gallons per day per square foot. The linear loading rate is a measure of the soil and sites ability to move effluent that is seeping into the ground across the site. These factors primarily affect the ultimate size of the soil absorption area. Consideration must be given to the slope and contour of the land when designing a

sewage system to prevent excess surface water flow over the soil absorption area, and to ensure even dispersal and movement of effluent from the site without ponding or surfacing (Figure 6).

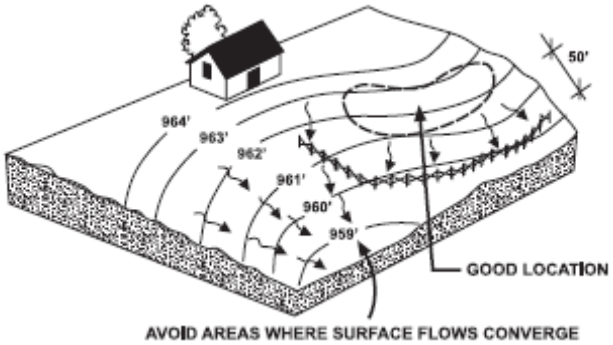


Figure 6. Consideration of slope and contour with system design (U.S. EPA, 2002).

In some areas of Ohio, the soils poorly drain, or are seasonally saturated with water. Trenches installed into seasonal water tables that are perched above a limiting layer in the subsurface result in mostly dilution of the effluent with little to no treatment of wastewater pathogens. Curtain or perimeter drains were often installed as an attempt to lower the seasonal water table or enhance subsurface drainage at the site. Due to the increased failure of conventional septic tank to trench systems in these areas, discharging systems that included the use of a secondary treatment device or media were commonly used with subsequent discharge of partially treated effluent off the lot. These discharging systems routinely used aerobic treatment units with direct discharge, septic tanks to single pass sand filters to direct discharge, or aerobic treatment units combined with single pass sand filters to direct discharge. The effluent discharged from these systems did not meet effluent discharge requirements of the Clean Water Act and have resulted in contamination of surface water in some areas of Ohio.

Challenging soil and site conditions have prompted the development of alternative wastewater treatment technologies that either provide enhanced treatment of the wastewater before it is applied to the soil for infiltration, or enhanced methods of application to the soil to improve infiltration and subsequent treatment achieved in the soil.

Enhanced treatment commonly involves lowering the TSS and BOD characteristics of the wastewater, and reducing the number of fecal coliforms (and other bacteria) before application to the infiltrative surface of the soil. Pretreatment of the effluent helps minimize the development of the biomat that leads to clogging of soil absorption trenches. Pretreatment devices include aerobic treatment units of various designs, peat biofilters, sand bioreactors, and constructed wetlands.

Enhanced application of wastewater to the soil involves providing even distribution of effluent across the surface of the soil to improve treatment, allow for soil re-aeration between doses, and enable the soil to more evenly disperse the effluent. This type of distribution can be achieved in sand mounds and low pressure pipe systems. The use of timed microdosing can achieve small, controlled regular doses of effluent spread very uniformly across the infiltrative surface. This controlled dosing allows for repeated saturation and reaeration of the soil, and slower flow through the soil particles thus enhancing treatment. These types of systems include drip distribution systems.

Artificially increasing the vertical separation distance to the limiting layer by elevating a system or installing the trench at shallow depths in the soil is also another approach to ensure adequate treatment of sewage occurs. Standard trenches are 18-30 inches deep. Shallow depth placement between 8 and 18 inches allows for use of soils with limiting conditions, and improves the exchange of oxygen, and therefore, treatment in the system. Other options for elevation include sand fill system, where sand or sandy loam soils are used as the sidewalls of the trenches, but the bottom of the trench is in the native soil. Finally, sand mounds with pressure distribution constructed as at grade or elevated systems use porous media, commonly sand, combined with the pressurized distribution of the effluent across the sand surface.

Additional information on alternative system designs, advantages, disadvantages and costs can be found in Appendix 1.

Sewage Treatment System Types Used in Ohio and the Midwest

Conventional septic tanks to soil absorption trenches are the most commonly used sewage treatment system in Ohio since the turn of the century. Where soils and lot conditions will allow their installation, these systems are by far the most cost effective, lowest maintenance system design that is capable of providing excellent treatment in the soil to remove suspended solids, organic matter, and pathogens. Experience and research have shown, however, that this system design may not be the best system to ensure safe conditions for property owners on <u>all</u> sites.

The presence of frequent, saturated conditions in the soil (seasonal water), impermeable layers that limit the downward movement (and treatment) of effluent, and shallow, fractured bedrock, all create site conditions where effective treatment and movement of the effluent is prevented. As technology for wastewater treatment developed, other treatment devices such as aerobic treatment units and sand filters were used to address these site limitations for on-site and off-lot discharge of effluent.

Today, many alternative system designs and treatment devices have been developed to deal with challenging site conditions while ensuring the protection of public health and the investment a property owner makes in their sewage system. Many of these technologies have been used reliably in Ohio and the midwest for over 20 years. Table 4 lists the different types of sewage treatment systems in use in Ohio and the Midwest,

the basic treatment process, system advantages and disadvantages, operation and maintenance requirements, and average statewide costs. Appendix 1 provides more detailed information on each system type and regional state costs.

Table 4. Comparison of sewage treatment systems in Ohio

System Type	Basic Treatment Process	Advantages	Disadvantages	Operation & Maintenance	Average Ohio Cost
Septic Tanks to Soil Absorption	Settlement of solids, anaerobic decomposition, removal of suspended solids, organic matter and pathogens in the soil	Low cost, easy to install. High contractor experience. Low maintenance. Life expectancy of 15-50 years with proper maintenance.	Must have unsaturated soil conditions and soil characteristics that ensure treatment and proper drainage. Requires adequate separation to bedrock.	Regular pumping of septic tank.	$6,500 to 7,500
Pretreatment to Soil Absorption	Use of various treatment devices to reduce TSS, BOD, and pathogens with final treatment in the soil.	Devices are readily available and have good performance records. High installer experience. Provides for 25-30% reduction in the absorption area and allowance for 1 or 2 foot soil depth credits based on level of treatment.	Moderate to high cost. Requires regular maintenance and/or service contracts by qualified service providers. Requires unsaturated soil conditions and adequate separation to bedrock.	Regular service required by qualifed service providers.	$8,100 to 8,700
Peat biofilters to soil absorption	Septic tanks for settling of solids to dosing tanks that pump to vessels filled with organic peat, then to soil absorption trenches. Effectively lowers TSS, BOD and pathogens.	Can be designed as passive system. Ease of installation. Provides for 25-30% reduction in the absorption area and allowance for 1 or 2 foot soil depth credits based on level of treatment.	Moderate to high cost. Does require replacement of the peat after 10-20 years. Requires regular maintenance. Soil absorption trenches must be installed in unsaturated conditions and with adequate separation distance to bedrock.		Estimated at $10,000 to 15,000

System Type	Basic Treatment Process	Advantages	Disadvantages	Operation & Maintenance	Average Ohio Cost
Septic tank/ pretreatment to Low pressure pipe	Septic tank or pretreated effluent to a dosing tank, to a network of PVC piping installed in gravel trenches. Effluent is applied evenly under low pressure across the soil absorption area. System is time or demand dosed.	Allows for better, even distribution of effluent providing for better treatment in the soil, and improved transport and movement away of effluent in the soil. Low maintenance systems.	Requires a more detailed design for the pressure distribution network and the addition of a dosing tank and controls. Requires installation in unsaturated soil conditions and adequate separation to bedrock.	Regular pumping of a septic tank or servicing of a pretreatment component. Expertise needed for designs. No prior use in Ohio.	Unknown, no state installations, estimated at $8,000 to 25,000
Sand mounds w/pressure distribution	Septic tank or pretreated effluent to a dosing tank, then time or demand dosed to a pressurized network of PVC pipes installed in an elevated sand mound. Mound height will vary based on site conditions or with pretreatment.	Allows for effective treatment at sites where seasonal water is shallow, and soils are of low permeability. Good contractor knowledge of installation. Uses readily available materials, although cost of sand may be high in some areas.	Moderate to high cost. Availability of sand materials in some areas. Public dislike for elevated system areas in the yard.		$14,000 to 19,000
Septic tank to single pass sand bioreactors (filters) – surface or subsurface to soil absorption	Septic tank to a watertight sand bioreactor or filter, then to soil absorption trenches. Can effectively reduce BOD, TSS and pathogens in the effluent.	With proper design, can be an effective passive, pretreatment device at a moderate cost. Upon approval, could be used to reduce the soil absorption area required by 25-30%.	Requires regular pumping of the septic tank and maintenance and cleaning of the sand filter. Moderate ease of installation and contractor knowledge. Can be elevated in the yard.		Unknown due to new law specifications, estimated at $7,000 to $15,000

System Type	Basic Treatment Process	Advantages	Disadvantages	Operation & Maintenance	Average Ohio Cost
Drip distribution	Septic tank or pretreated effluent to a dosing tank with controls for timed microdosing through drip tubing. Achieves controlled even dispersal of effluent into the soil for improved treatment, soil reaeration, and effluent dispersal.	The timed-microdosing of effluent into the soil provides for enhanced treatment in the soil. Ensures effective removal of BOD, TSS and pathogens within 12-18 inches. This system is allowed a 1 ft. soil depth credit. Can be used on wooded lots to preserve trees, and for irregular areas.	More technical design requirements are needed. Must be a system installed and maintained by a drip assurance party. Regular system flushing and maintenance is required with service contracts. Cannot be installed in saturated soils and requires adequate separation to bedrock.	Regular system flushing and maintenance is required with service contracts.	$17,000 to 19,000
Waste ponds or treatment/ disinfection to spray irrigation	Septic tank to a waste stabilization pond or treatment device with disinfection, to surface spray emitters. Achieves controlled, even dispersal of highly treated effluent. Standards can be set for restricted and unrestricted spray.	Achieves removal of BOD, TSS, Ammonia and pathogens. Spray can be utilized year round in yard areas. Good for use in areas where seasonal saturation is shallow.	Not used in Ohio. Demonstration system in use at OSU facility. Requires adequate land for stabilization pond if used instead of pretreatment and disinfection devices. Moderate to high cost.	Regular pumping of the septic tank. Infrequent repair of spray emitters.	Estimated $15,000 to 20,000 – cost of demonstration system at OSU - $17,000
Constructed Wetlands	Septic tank to a surficial lined constructed wetland layered with gravel and using specific wetland vegetation to enhance effluent treatment, with discharge to soil absorption.	Uses a passive treatment process that can lower BOD, TSS and pathogens.	Inconsistent treatment levels achieved during colder temperatures. Gravity flow systems would need sloping lots.	Issues with constructed wetland performance during the winter when plants are dormant. Consistency of treatment levels has been a concern.	Experimental systems constructed in Ohio have ranged in cost $6,500 to 7,500.

System Type	Basic Treatment Process	Advantages	Disadvantages	Operation & Maintenance	Average Ohio Cost
NPDES discharging systems	Pretreatment unit to disinfection device to re-aeration device. Achieves effluent quality standards for BOD, TSS, fecal coliform/e-coli, ammonia and dissolved oxygen specified in the General NPDES permit.	Systems demonstrate good performance at achieving the effluent quality standards in the General NPDES permit. Provides a system for replacement of existing discharging systems where soil-based treatment cannot be achieved.	Moderate to high cost. Systems require routine maintenance and service contracts. Some systems offer the option of/or require remote telemetry.	Systems require inspections and maintenance at least twice per year. Some systems require remote telemetry to ensure proper system operation. All systems require some type of failsafe mechanism.	$11,000 - 15,000

Evaluation of State Soils and Bedrock Data

ODH has proceeded to work with the Ohio EPA and the Ohio Department of Natural Resources to collect additional technical information for the state's soils, surface water and ground water. This data has been analyzed in the context of how various regulatory standards will impact system design, and subsequently cost. The data also identifies high value resources that may warrant additional protection to help guide a risk based approach to standards.

The establishment of a vertical separation distance (VSD) to a limiting condition such as perched or seasonal water table, or bedrock directly affects the thickness of useable soil on a lot that can be used for waste treatment, which subsequently affects the cost of a system. Conventional and alternative systems do not treat sewage under saturated conditions and system ponding and failure is likely to occur. Current research states that 2-4 feet of unsaturated soil is needed to achieve effective removal of bacteria and viruses.

In the first version of the rules adopted by the Public Health Council, the VSD to the perched seasonal water table and bedrock or coarse sand and gravel was set at 3 feet. Based on concerns expressed over cost, the rule was revised to set the VSD at 2 feet for seasonal, perched water and retained at 3 feet for bedrock or coarse sand and gravel, with provisions for variances as long as the soil absorption component was kept above the perched, seasonal water table. Using current research, soil depth credits were also provided for pretreating the effluent before going to the soil, by physically

elevating the system, or through careful, timed micro-dosing of effluent to the soil. Soil depth credits helped make lots that have shallow limiting conditions useable and still provide treatment and prevent failure.

Figure 7 is a map depicting depth to seasonal saturation in Ohio soils in incremental ranges of 6 inches. Table 5 provides a summary of the number of acres and the resulting percentage of area inclusive within each depth range category for each region of the state. For example, the table shows that the northwest region has 42% of the land areas (2,793,321 acres) with soils exhibiting saturation (seasonal or true ground water) from 0-6 inches of the surface. The percentage of land area in northwest Ohio that has seasonal water within 6-12 inches is 17%, for a cumulative amount of 59% of the land area with seasonal water within 12 inches of the surface. Areas with perched, seasonal water occurring from 12-18 inches add another 5% of land area. Cumulatively, 64% of the land area in northwest Ohio has seasonal water within 18 inches of the ground surface. A review of these maps shows that the presence of perched seasonal water tends to be the dominant factor affecting sewage system design for the northwest, northeast, central and southwest areas of the state.

Figure 8 depicts the depth to bedrock in Ohio in incremental ranges of 20 inches. Depth to bedrock has an impact on a much smaller area (5%) of the northwest, northeast, central and southwestern areas of the state. The southeastern region has depth to bedrock within 40 inches of the land surface for 19% of the total land area.

Table 5. Depth to Seasonal Saturation and Bedrock in Ohio Soils by Region

	North West 6,630,717 acres		**North East 4,614,589 acres**		**South West 4,633,016 acres**		**South East 7,365,334 acres**		**Central 3,168,692 acres**	
Depth to	**acres**	**%**	**acres**	**%**	**acres**	**%**	**acres**	**%**	**acres**	**%**
Bedrock (inches)										
0-20	10,293	0.2	0	0	37,272	1	113,585	2	1,667	0.1
21-40	89,116	1	54,591	1	165,850	4	1,236,739	17	7,913	0.2
40-80	5,804	0.1	139,985	3	24,049	1	1,779,792	24	0	0
>80	6,531,250	99	4,334,619	94	4,405,845	95	4,235,238	58	3,156,112	100
Depth to										
Saturation (inches)										
0-6	2,793,321	42	694,379	15	1,260,660	27	70,939	1	680,879	21
6-12	1,108,824	17	861,141	19	424,085	09	83,216	1	928,847	29
12-18	303,127	05	326,466	7	325,196	7	27,119	0	174,040	5
18-24	1,435,684	22	494,272	11	767,354	17	239,416	3	499,372	16
>24	989,761	15	2,238,331	49	1,855,721	40	6,944,644	94	885,554	28

Figure 7.

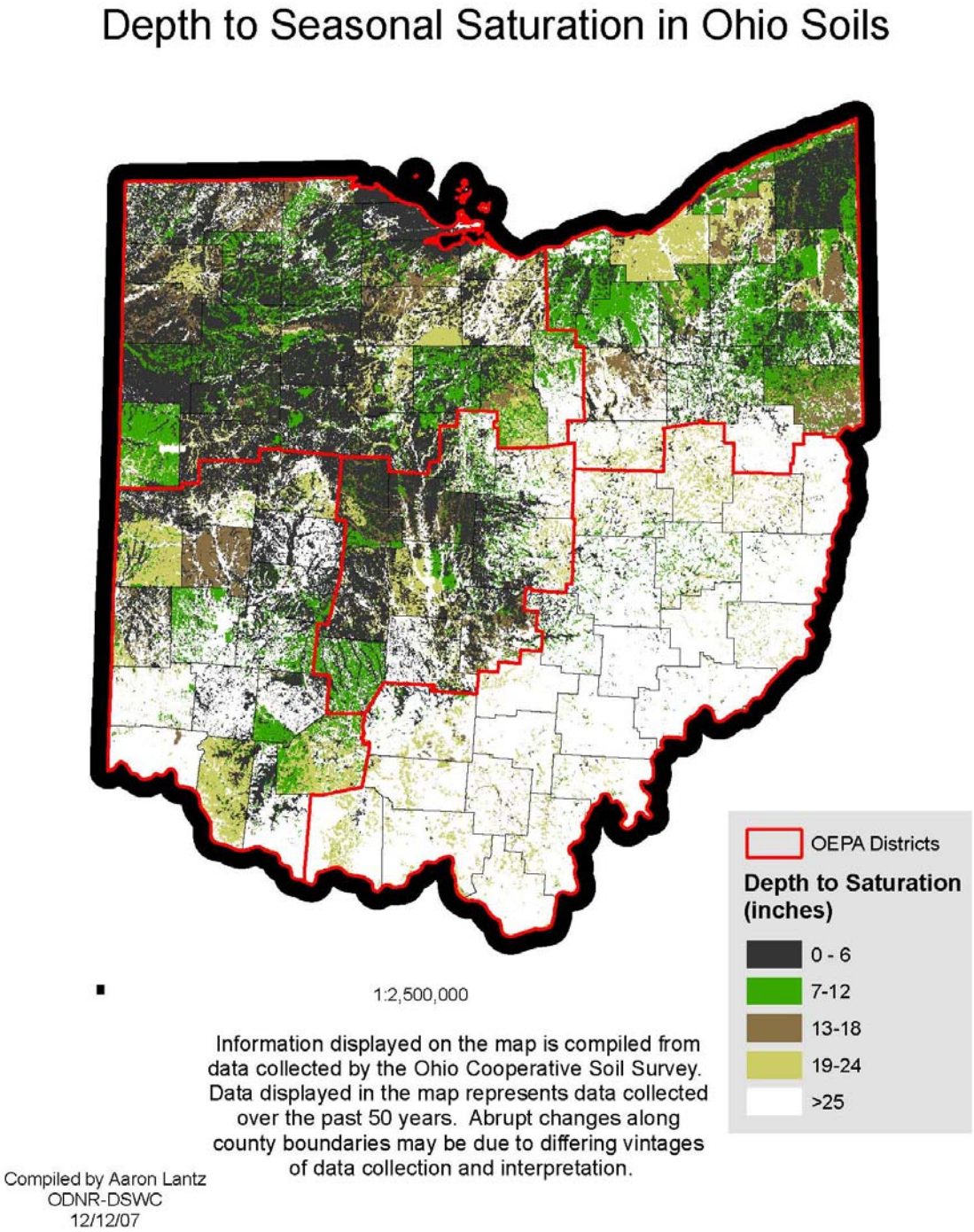
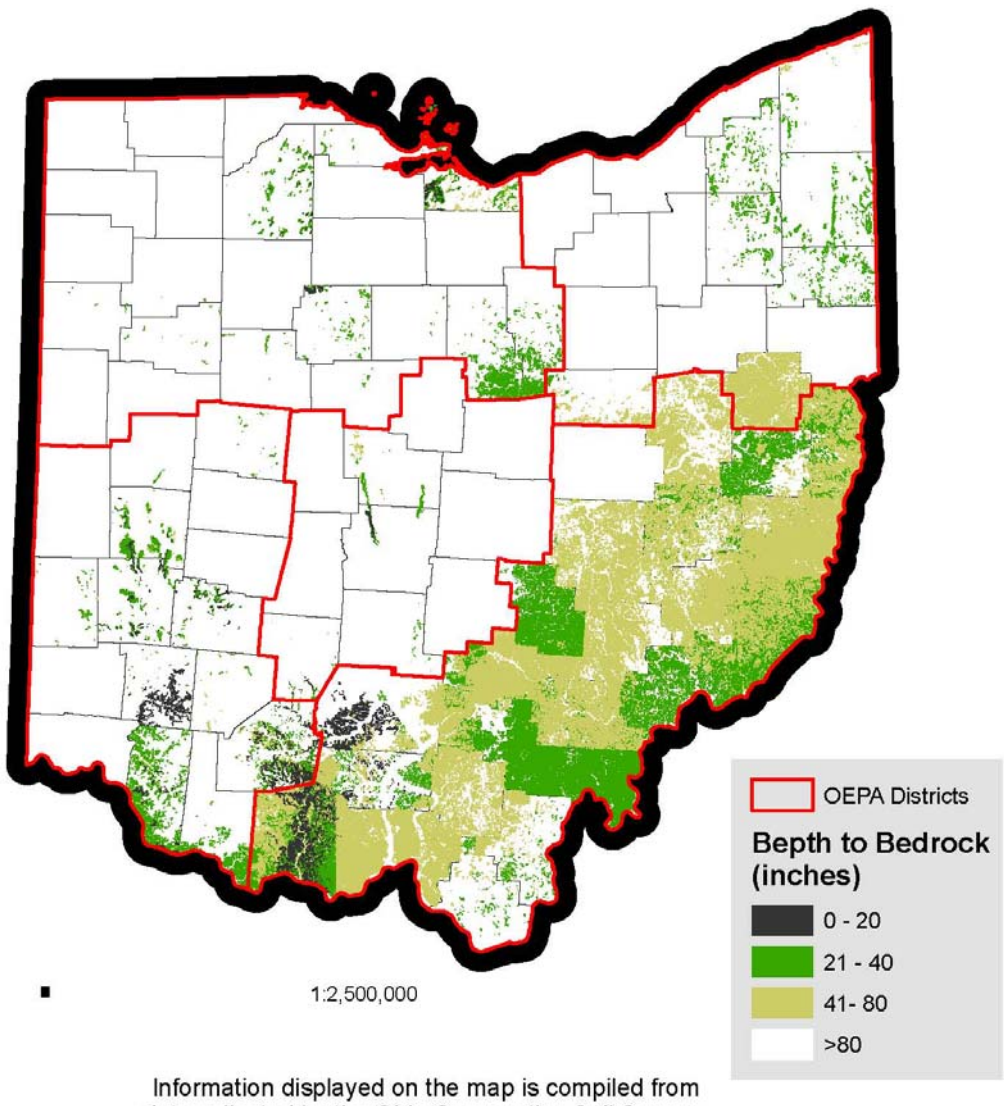

Depth to Seasonal Saturation in Ohio Soils
OEPA Districts
Depth to Saturation (inches)
0 - 6
7-12
13-18
19-24
>25
1:2,500,000
Information displayed on the map is compiled from data collected by the Ohio Cooperative Soil Survey. Data displayed in the map represents data collected over the past 50 years. Abrupt changes along county boundaries may be due to differing vintages of data collection and interpretation.
Compiled by Aaron Lantz
ODNR-DSWC
12/12/07

Figure 8.



Information displayed on the map is compiled from data collected by the Ohio Cooperative Soil Survey. Data displayed in the map represents data collected over the past 50 years. Abrupt changes along county boundaries may be due to differing vintages of data collection and interpretation.

Compiled by Aaron Lantz
ODNR-DSWC
12/12/07

How the Depth to Saturation and Depth to Bedrock Maps were derived

Depths to seasonal saturation and bedrock are derived from data in the USDA Natural Resources Conservation Service's (NRCS) Soil Survey Geographic Database ("SSURGO"). The spatial and tabular data in SSURGO were derived from detailed soil surveys completed county-by-county by NRCS and Ohio Dept. of Natural Resources soil scientists between 1954 and 2003. For areas identified on the soil maps with multiple soils (i.e., soil series), depths to seasonal saturation and bedrock for only the dominant soil is recognized on the maps and in the tables.

Depth to seasonal saturation is expressed in the database as a range in depth to the upper limit of the zone of saturation in the soil during one or more months of the year. Some soils also have a lower limit to the zone of saturation, if a saturated zone is considered to be "perched" above an unsaturated zone. For the map and table, the depth designated in the database as the "representative value," within the range in depth to the upper limit of the zone of saturation in the soil, was used. In most cases, the representative value in the database is the average of the range in depth. For example, soils with a range in depth of 0 to 1.0 feet to the upper limit of the zone of saturation typically have a representative value in the database of 0.5 feet, and these soils were categorized on the map and table as soils with saturation at between 0 and 6 inches.

The SSURGO database recognizes "ponding," or a condition of standing water on the surface, in a separate data field from saturation within the soil. In almost all cases, soils that range in the database to 0 feet to the upper limit of the zone of saturation in the soil during one or more months of the year also are recognized in another part of the database as having ponding or standing water at least 0.5 feet deep above the soil surface for two or more days during some years. This ponding condition is not reflected on the map or table.

An explanation for apparent differences at county boundaries on the depth to bedrock map can be offered. While bedrock recognized in the database is bedded in layers, it may be relatively hard or soft, or fractured to varying degrees. Bedrock layers that are soft enough to be extracted and observed by soil scientists with a hand auger were identified as soil, not bedrock, in some county soil surveys completed between 1954 and 2003. Conversely, soil layers with enough rock fragments to impede the extraction of samples for observation by soil scientists were identified as bedrock, not soil, in some county soil surveys completed during the same time interval.

Other apparent differences at county boundaries are a result of recognizing only the dominant soil on the bedrock map and table, particularly in steeper areas of the state where multiple soils, with different bedrock depths, could not be separated by soil scientists on soil maps at a scale of 1:15,840. While soil scientists in two adjacent counties may have identified the same two soils in map units on the same hillside, the deeper soil may have been considered slightly more dominant in one county and slightly less dominant in the adjacent county.

Source: ODNR, Division of Soil and Water Conservation

The following table summarizes the total cumulative percentage of land area in each region with seasonal perched water present at different depths. This data can be used to determine the amount of land that will be affected by setting the VSD to perched seasonal water at different depths.

Table 6. Total cumulative percentage of land area impacted at different vertical separation distances.

Cumulative % of land area included / ***Depth to saturation(inches)***	***Northwest % area***	***Northeast % area***	***Southwest % area***	***Southeast %area***	***Central %area***	***State Total % area***
< 6	42	15	27	1	21	21
<12	59	34	36	2	50	34
<18	64	41	43	2	55	38
<24	86	52	60	5	71	51

To discuss this in terms of affect on sewage system design, setting the VSD to seasonal perched water at 6 inches affects 21% total land area of the state, at 12 inches it affects 34% total land area of the state, at 18 inches it affects 38% of the land area total of the state, and at 24 inches, 51% of the total land area is affected.

The same analysis can be performed for depth to bedrock. The occurrence of bedrock at less than 20 inches occurs in less than 1 percent of the state; at less than 40 inches for 5% of the state total land area, and less than 80 inches for 7% of the state total land area. Therefore a VSD set at 3 feet (36 inches) to bedrock will affect roughly 5% of the state, and a VSD set at 4 feet to bedrock will affect roughly 7% of the state. For the southeast region, a VSD of 3 feet to bedrock will affect less than 17% of the region.

The relative affect of setting a VSD at any particular depth must also be compared with the projected or estimated level of treatment that can be achieved in that same thickness of soil. Research indicates that a minimum of 2 feet of soil is needed for treatment of septic tank effluent, and less soil can be used with pretreated effluent. This level of treatment must also be considered with respect to the sensitivity of the receptor or receiving environment, ie. perched seasonal water vs. drinking water aquifers, vs. fractured bedrock.

Finally, consideration must also be given to the ability of pretreatment, even dispersal of effluent, artificial drainage, or elevated system designs that can be used at sites that have less than the required thickness of soil to meet the set VSD, and the relative additional costs of those system options. For example, while it is noted above that 64% of northwestern Ohio has seasonal perched water within 18 inches of the surface, the use of a pretreatment device that can reduce the needed soil thickness by 1-2 feet now

allows the installation of shallow leach line systems in 27% or greater of that land area at an additional cost of $2,000 – $3,000 (for the pretreatment unit). If the soil can be effectively, artificially drained, this could further reduce the land area affected by providing for an additional reduction in the useable soil thickness needed. If pretreatment is not the preferred option for a site, then an elevated system such as a sand mound with pressure distribution can be used, or very shallow trenches with elevated fill systems.

ODH believes that the soils and bedrock data presented in this section show that a reasonable vertical separation distance can be established for the state that ensures effective treatment of sewage. While some areas of the state will fall under the useable thickness of soil needed, many options exist for system designs that are still reasonably priced to help address site challenges for most areas.

Consideration of Sensitive Ground Water, Surface Water and Drinking Water Protection Areas

The establishment of standards for system design should also consider the relative risk posed to different sensitive ground or surface water resources, or drinking water protection areas. Additional vertical separation distances or treatment levels may be needed in sensitive areas that are at greater risk of contamination. For example, sewage effluent that reaches perched seasonal water table can migrate horizontally to discharge to surface water. Surface water can be evaluated with regard to risk by consideration of existing pollutant loads in a stream and how much more a stream can accept, by identifying surface water resources that are valued for recreational purposes such as lakes or beaches, or through identification of high value watersheds or streams that are pristine or exceptional habitats for fish or wildlife.

Ohio is fortunate to have extensive geologic, hydrogeologic and soils mapping data that can used to support a risk based approach to sewage treatment system management. Figure 10. is a map showing the distribution of sensitive bedrock and sand and gravel aquifers in Ohio. Bedrock in Ohio consists of limestones and dolomites, shale, and sandstones. Due to various geologic processes, much of the bedrock in Ohio has been subjected to chemical and physical actions that have created extensive networks of fractures (in limestone, sandstone and shale) or interconnected fractures. These fractures have been enlarged through the dissolution of limestone by ground water and are known as karst limestone.

Ohio has been covered by glaciers at least three different times in geologic history, and the glaciers have deposited a variable thickness of clay, sand and gravel. Most of this material was deposited as glacial till, which is very dense and of low permeability. This till is the parent material for many of the clay-rich, poorly drained soils in Ohio.

Where the till cover is thin or absent, fractured bedrock is exposed near the surface and is very vulnerable to contamination. Sewage systems that do not provide adequate treatment can allow effluent to infiltrate into these cracks and then travel rapidly throughout the ground water aquifer and cause contamination as identified in Table 2. The gastrointestinal outbreak on South Bass Island was linked to sewage contamination of the limestone aquifer with very thin to absent soils on the island. Other ground water areas with fractured bedrock near the surface have shown sewage impacts including the Wooster Township area in Wayne County (sandstone aquifer), Thompson Township in Seneca County, and Mad River Township in Clark County (both limestone aquifers). Dye trace studies conducted by the Ohio Department of Natural Resources, Division of Water and the Ohio EPA, Division of Drinking and Ground Waters in karst aquifers have documented travel times for ground water in excess of 500 feet per day. Beyond the glacial boundary in southeastern Ohio, the soils have been developing for many years on the weathered bedrock. Where the soils are thin, the fractured bedrock is also vulnerable to contamination.

Ohio EPA used information compiled by the Source Water Assessment and Protection Program to identify sensitive aquifers in Ohio by comparing locations of public water systems with elevated level of inorganic and organic chemical compounds with glacial aquifer attributes presented in the Glacial Aquifer Map of Ohio, published by the Ohio Department of Natural Resources. The analysis focused on identifying sensitive aquifers based on transport of dissolved contaminants, nitrate-nitrogen and volatile organic chemicals. The concept that short or rapid recharge pathways increase aquifer sensitivity was applied for the evaluation. The results of applying this concept to Ohio's aquifers suggest that the sand and gravel aquifers are the most sensitive aquifers. Shallow bedrock aquifers, particularly fractured or karst bedrock aquifers that underlie thin glacial drift (tills or lacustrine deposits) comprise a second group of sensitive aquifers.

In these hydrogeologic settings, effluent from sewage systems can travel rapidly downward through the very permeable sand and gravel or fractured bedrock, and reach the ground water aquifer without adequate retention time in the soil for treatment. In these areas, risks are greater. In higher risk areas, a closer evaluation of site conditions may be warranted, or increase frequency of inspections or monitoring depending on site specific conditions that are identified.

Figure 9 depicts public water systems with elevated nitrate-nitrogen concentrations which occur most frequently in areas identified as sensitive aquifers. The sensitivity of aquifers in the unglaciated areas of Ohio still needs further evaluation.

Drinking water source protection areas identified by Ohio EPA under the federal Safe Drinking Water Act include areas of aquifers actively used for drinking water supplies. Delineation of these areas helps public water systems in developing plans to protect drinking water resources (Figure 10). Sewage treatment systems located in the inner management zones of these areas that are also located in sensitive aquifer settings may need additional engineering designs, greater inspection frequencies, greater vertical separation distances, or higher levels of treatment to protect the drinking water quality.

Figure 9. Public water supplies with elevated nitrate-nitrogen concentrations and sensitive aquifers in Ohio.

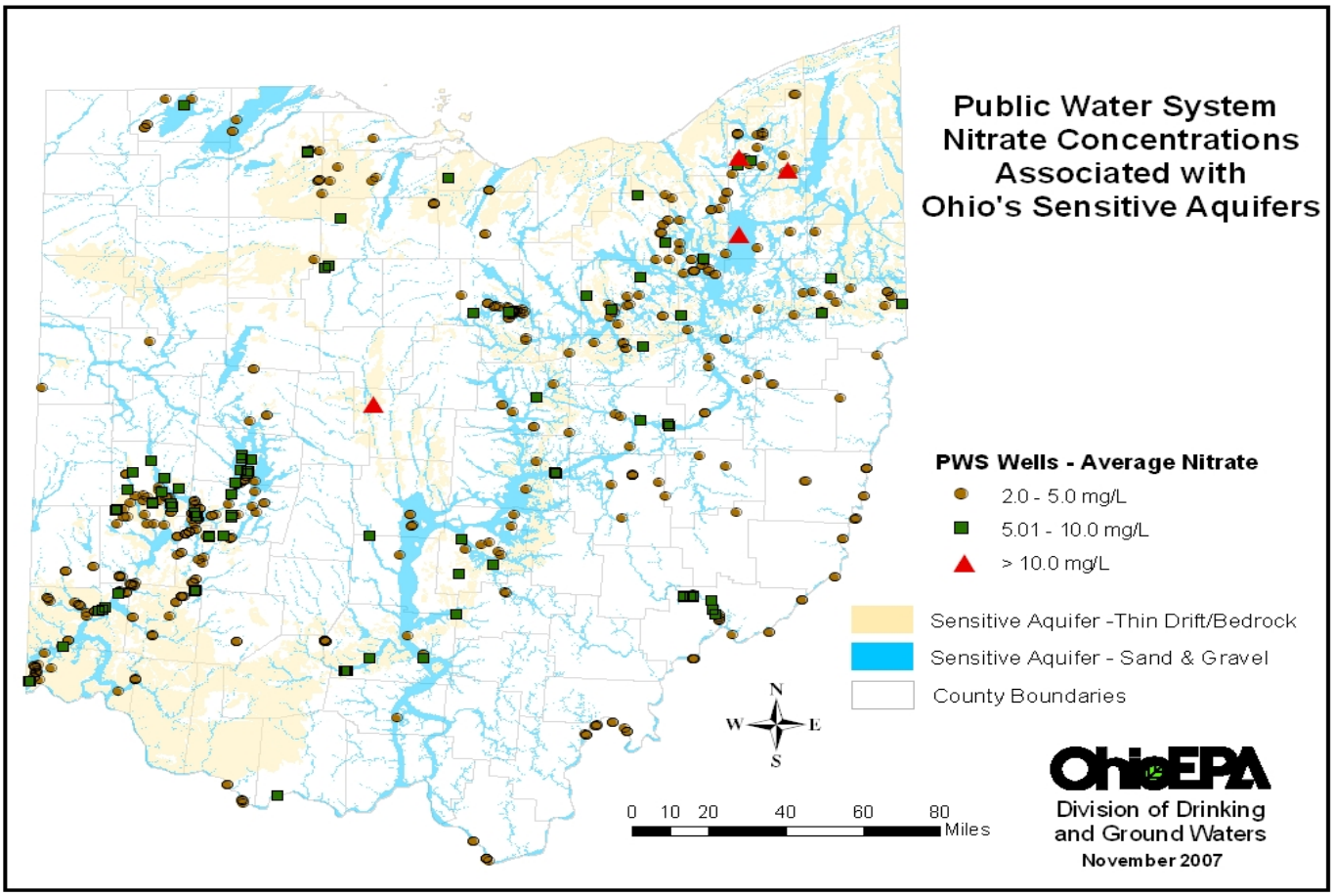
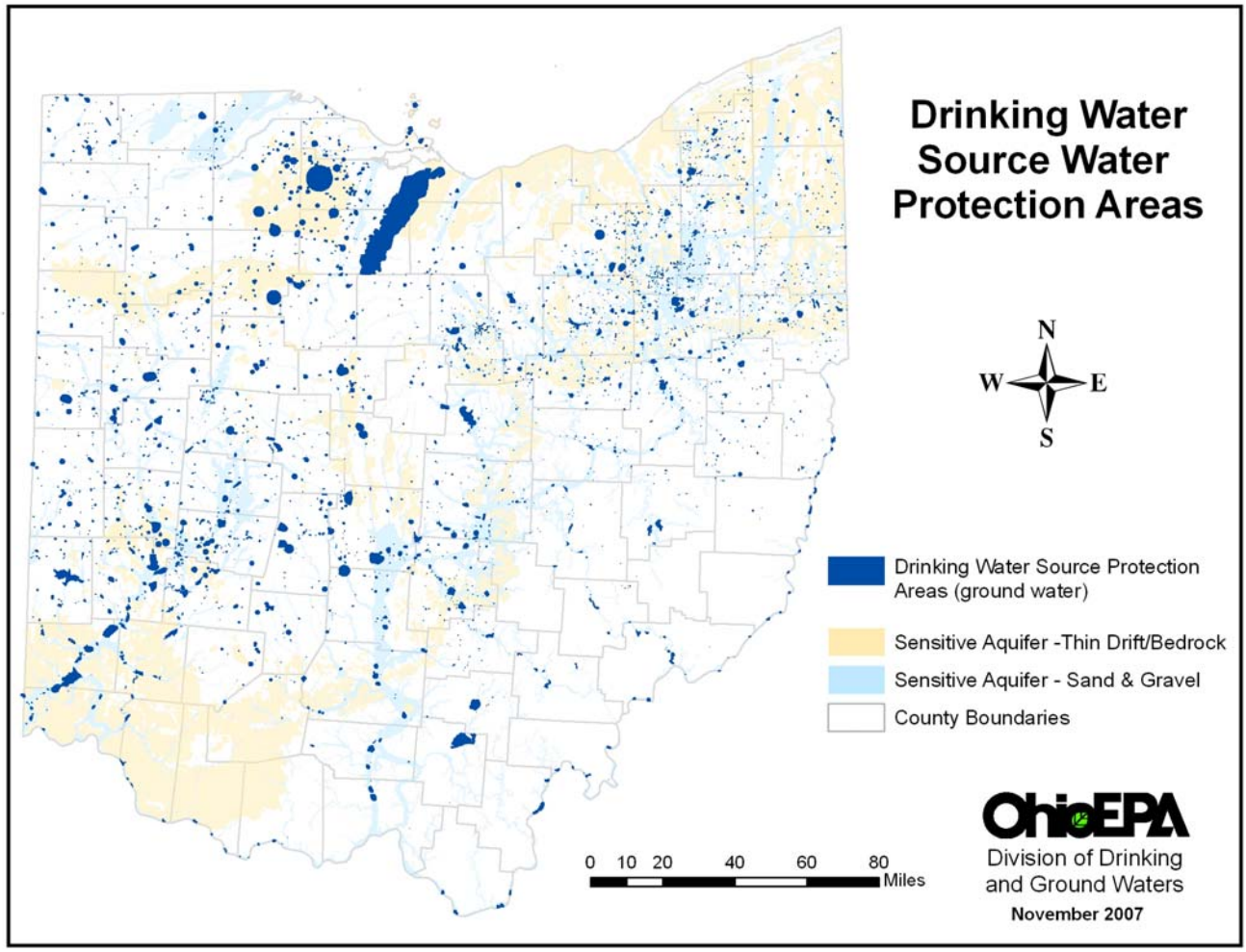


Figure 2 shows watersheds in Ohio that have been impaired by sewage systems. These impaired streams already are carrying some amount of bacterial, suspended solids or organic loads from sewage systems, therefore systems located in close proximity to streams in these areas may need higher levels of treatment, different

engineering designs, or simply an increase frequency of inspection to help identify problems with systems before they become failures and are more expensive to repair.

Figure 10. Drinking Water Source Water Protection Areas and Sensitive Aquifers

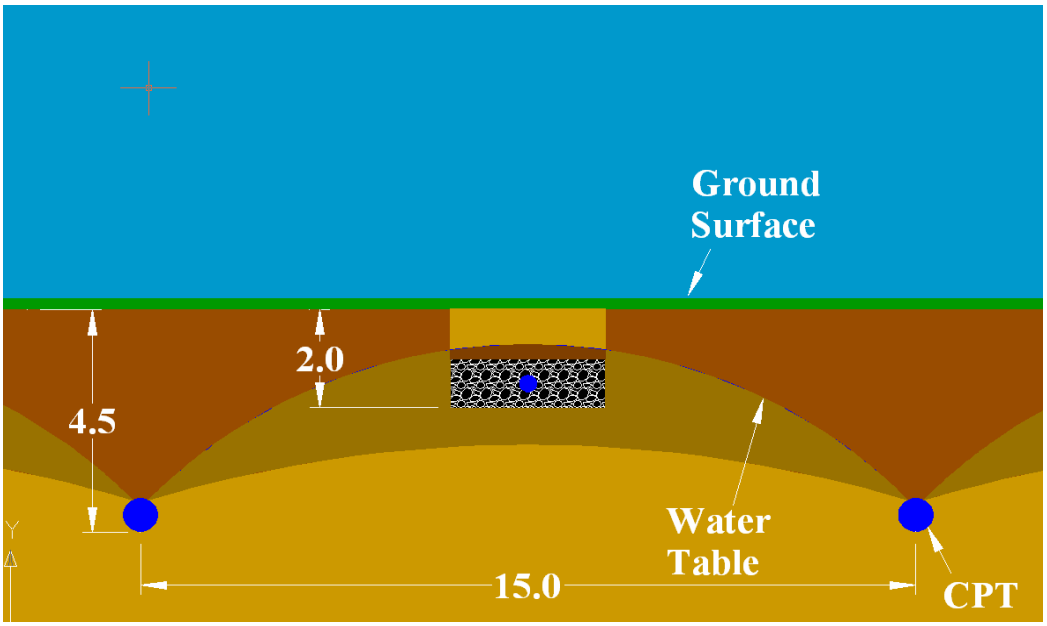


The Use of Engineered Drainage to Lower the Seasonal Perched Ground Water

Curtain drains have been historically used in Ohio as a means to drain water from sites with perched seasonal water tables in the soils. The 1977 sewage disposal rules and the current interim statewide sewage treatment system rules permit the use of curtain drains in soils subject to seasonally high ground water. The drain specifications require installation not less than 6 inches below the leaching trench bottom and at least 8 feet from the center line of any leaching trench.

Many have thought that the construction of a drain around the perimeter of the soil absorption area would uniformly lower the water table beneath a site. The science of hydraulics and flow through porous media, such as soils, shows that uniform lowering of the water table beneath a site with one drain does not occur. What really happens is that the drain creates a slope, or gradient on the water table and induces water to flow from the edges of the absorption area towards the drain. The water table remains mounded beneath the trenches, and the mounding effect continues as effluent is leached out of the trench lines. Little to no lowering of the water table occurs in the center of the absorption area, especially in lower permeability soils (soils that are not able to move water easily). This has resulted in trenches that remain saturated causing ponding or breakout in certain areas of the soil absorption system. Figure 11 shows what the water table surface looks like where drains are installed around and between trenches.

Figure 11. Characteristics of the water table in a soil absorption area with drains.



The effectiveness of curtain drains has been a longstanding debate in the public health community in Ohio, in part due to lack of understanding of how drains actually work and what is really happening under the ground surface, and the anecdotal experience of sanitarians who oversee the installation of drains and reinspect systems with no observation of apparent ponding problems. Artifical drainage can be an effective means to drain water from a site, or intercept water flowing onto a site, but they need to be properly designed and sited to ensure that they achieve either true lowering of the water table, or actual interception of water before it reaches the soil absorption area.

In order to provide scientific data on the ability to effectively use drains in Ohio soils to manage the water table in soil absorption areas, ODH contracted with the Ohio State University to use a widely accepted water table management computer model, DRAINMOD, to analyze the relative effectiveness of different spaced drainage systems in all Ohio soils. This study will evaluate the probability of saturation at depth based on several drain spacing options. This information can be used to identify soils where drains can be more effective and therefore provide a lower risk of effluent going into the seasonal high water table. Conversely, soils that cannot be effectively drained with artificial drainage can also be identified. Upon completion of the study, the soils, and subsequent areas of the state that may be able to use drainage with a lower risk of allowing effluent into the seasonal perched water table can be identified.

The ability to use drains in any given soil can be considered as another factor to consider in a risk based approach to setting technical standards. Where soils can be drained with lower risk, drains may provide another means to reasonably lower the water table to allow the use of more conventional, and thus, less costly systems.

System Type, Costs and Economics

Historical System Type Information

Prior to 2007, local health districts were not required to report to ODH permit information on the types of sewage systems installed, subsequently, little historical information is available. A survey of small sewage treatment facilities in Ohio conducted by Mancl (1990) did reveal some information on the types of systems permitted at that time. Survey results reported that 56% of the counties estimated that 400 to 30,000 septic tank to leach line systems were being used in their county. The survey reports that 96% of the counties were using aerobic treatment systems, with installation estimates of 3,000 to 5,000 in 58 counties. Sixty-five (65) percent of reporting counties estimated between 1 and 100 gravelless systems had been installed in their county. Sand filter systems were reported in use in 64% of the counties. Mounds systems were reported in use for 27% of the counties with an estimated 1 to 100 mounds reported installed per county.

Historical cost information

Information on the costs of sewage disposal systems under the 1977 rules was not collected by ODH or local health districts. At best, anecdotal information on the cost of different systems was available. Due to concerns over costs of the proposed rules, ODH conducted a survey of local health districts in April, 2006. The survey requested information on the estimated number of systems per county, the estimated cost of conventional systems (septic tank to leach lines, or septic tank to sand filter to leach lines) and the average cost range of alternative systems (i.e. improved pretreatment, sand mounds with pressure distribution, drip distribution systems). Costs reported were based on both known information and estimates. Reported/estimated costs for conventional systems ranged from $2,500 to $15,000. Reported/estimated costs for alternative systems ranged from $4,000 to $35,000. The average number of permits issued each year ranged from 45 to 540.

Under the 1977 rules, and the current statewide interim rules, systems that differ in design and function from those whose use are authorized in the rules require either a site specific experimental variance concurrence from ODH, or special device approval. According to ODH records, prior to the adoption of the 2007 rules, over 30% of the county health districts had requested and were actively using alternative systems under the experimental concurrence process. The largest number of experimental concurrence systems installed was mound systems.

2007 System Type Information

Upon adoption of the 2007 sewage treatment system rules, local health districts were required to report information on sewage system permits via a sewage treatment system transmittal and permit report summary. The transmittal summarized the number

of permits issued and the total of the state fee collected and sent to ODH. The permit report required information on system address, permit date, identification of a household or small flow system, identification of a new or replacement system, the system type code (1. below grade; 2 at or above grade, or 3. NPDES discharging), and the system description code as either:

1. pretreatment for soil depth credit
2. pretreatment for soil depth credit with drip distribution
3. drip distribution only
4. spray/surface application
5. none of the above.

Cost data for permits was not collected. Below grade systems reflect the use of soil absorption trenches and may include the use of gravelless or chamber products to disperse effluent in the soil. At or above grade systems reflect the use of sand mounds or other fill material to elevate the system. The system type code of NPDES discharging was requested to capture information on the number of replacement discharging systems installed statewide. The system description code was used to help identify the total use of pretreatment and drip distribution for soil depth credits at sites. The system description code was also used to collect information on the use of spray irrigation systems. An example of the permit report used from January 1 to June 30, 2007 is contained in Appendix 2.

Table 7 shows an analysis of system type codes by region indicating the percentage of system types installed between January 1 and June 30, 2007. The percentages reflect the distribution of system types by region for the state. The data shows that below grade systems were the predominant system type installed during the first six months of 2007 (83%). At or above grade systems consisted of 12% of system installations. NPDES system installations were 1% of the state total.

Table 7. Number and percentage of system type codes installed by region from January 1 to June 30, 2007.

Region Type Code	Northwest Total (%)	Northeast Total (%)	Southeast Total (%)	Southwest Total (%)	Central Total (%)	State Total (%)
1. Below grade systems	244 (13)	669 (35)	382 (20)	375 (20)	266 (14)	1936 (83)
2. At or above grade systems	43 (15)	102 (36)	19 (7)	51 (18)	67 (24)	282 (12)
3. NPDES discharging systems	0	15 (58)	4 (15)	7 (27)	0	26 (1)
Unknown	16 (16)	2 (2)	59 (60)	20 (20)	1 (1)	98 (4)

A summary of the system description data for the reporting period of January 1, 2007 to June 30, 2007 is shown in Table 8. For this table, the percentages reflect the percent of systems installed in each region as compared to the state total. This data shows that 5% of systems installed used pretreatment to achieve a one foot soil depth credit, that is, they used pretreatment to reduce the amount of useable soil needed on the lot. Drip distribution system constituted 4% of the total systems installed. The category "none of the above" constitutes systems that did not utilize any means of credit via treatment or by timed microdosing through drip distribution, which equaled 87% of all system installations (leach lines or mounds).

Table 8. Number and percentage of system description codes installed by region from January 1 to June 30, 2007.

Region Description Code	Northwest (total and % within the region)	Northeast (total and % within the region)	Southeast (total and % within the region)	Southwest (total and % within the region)	Central (total and % within the region)	State (total and state %)
1. Pretreatment for soil depth credit	6 (1)	4 (<1)	38 (9)	33 (7)	25 (7)	106 (5)
2. Pretreatment for soil depth credit w/drip	1(1)	13 (2)	0	4 (1)	6 (2)	24 (1)
3. Drip distribution only	0	21 (3)	2 (<1)	32 (7)	5 (2)	60 (3)
4. Spray or surface application	0	0	0	0	0	0
5. None of the above	281 (93)	748 (93)	368 (80)	364 (80)	268 (86)	2029 (87)
Unknown	15 (5)	16 (2)	56 (12)	20 (4)	10 (3)	117 (5)
Totals	303	803	464	453	314	2337

In order to determine the percentage and types of below grade (conventional soil absorption) or above grade systems (mounds or elevated drip systems), a combination of system type and description codes must be analyzed. System type/descriptions codes of 1 and 5 indicate the use of conventional septic tank to soil absorption trenches (undefined media in trench). System type/description codes of 2 and 5 indicate the use of mounds systems. System type/description codes of 1 and 1 indicate the use of a pretreatment unit to a soil absorption system with the use of a soil depth credit. System type/description codes of 1 and 2 indicate the use of a pretreatment unit with drip distribution to obtain a 2 foot soil depth credit. The percentage of these system uses is described in Table 9. This data shows that 87% of the systems installed from January to June, 2007, were septic tank to soil absorption (leach line) systems. Mound systems accounted for 10% of all system installation reported during the same time period, and pretreatment with drip accounted for 3% of the systems installed.

Table 9. Sewage system type totals and regional percentages from January 1, 2007 to June 30, 2007.

Region **SystemType/Description Code**	**Northwest Total (%)**	**Northeast Total (%)**	**Southeast Total (%)**	**Southwest Total (%)**	**Central Total (%)**	**State Total (%)**
Type 1/Desc. 5 (septic tank to soil absorption)	243 (13)	664 (37)	348 (19)	330 (18)	234(13)	1819 (87)
Type 2/Desc. 5 (sand mounds)	37 (18)	68 (34)	17 (8)	27 (13)	53 (26)	202 (10)
Type 1/Desc. 1 (pretreat for 1 foot soil depth credit)	1 (1)	1 (1)	32 (44)	17 (23)	22 (30)	73 (3)
Type 1/Desc. 2 (pretreat with drip for 2 ft soil depth credit	0	3 (43)	0	1(14)	3 (43)	7 (<1)
Type 2/Desc. 4 (spray or surface application)	0	0	0	0	0	00

Table 10 shows the totals and percentages by region of household sewage treatment systems versus small flow onsite sewage treatment systems installed from January 1, 2007 through June 30, 2007. Household sewage treatment systems accounted for 96%, and small flow onsite sewage treatment systems accounted for 1% of all system installations reported during this time period.

Table 10. Totals and percentages by regions for household and small flow onsite sewage treatment systems installed from January to June, 2007.

Region	**Northwest Total (%)**	**Northeast Total (%)**	**Southeast Total (%)**	**Southwest Total (%)**	**Central Total (%)**	**State Total (%)**
Household	296 (17)	294 (16)	425 (24)	439 (25)	328 (18)	1782 (96)
Small Flow	7 (32)	4 (18)	3 (14)	2 (9)	6 (27)	22 (1)
Unknown	0	5	36	12	0	53 (3)

Table11 shows the totals and percentages by region of the replacement versus new system installations for the reporting period of January 1, 2007 to June 30, 2007. New system installations accounted for 85%, and replacement systems accounted for 13% respectively of all system installations.

Table 11. Totals and percentages by regions of replacement and new systems for January to June, 2007.

Region	Northwest	Northeast	Southeast	Southwest	Central	State
New	222	656	432	385	310	2005 (85)
Replacement	80	141	26	49	21	317(13)
Unknown	1	6	6	19	3	35 (1)

After the adoption of Am. Sub. H.B. 119, ODH modified the permit report to require the collection of cost data, and expanded the system type and description to better capture the types of systems being installed. Information was also collected on when alteration permits were being issued, with the specific category of tank replacement added as a type code. The permit report used between July 1, 2007 and November 30, 2007 can be found in Appendix 2. ODH is continuing to use the revised permit report for collecting data about sewage treatment systems.

Table 12 shows the total number of installations of twelve system types or configurations that were reported to ODH from July 1, 2007 through November 30, 2007 by region. An analysis of this data shows that septic tank to regular depth or shallow leach lines accounted for 60% of all system installations. The use of pretreatment units to achieve 1 or 2-foot soil depth credits accounted for 12% of all system installations during this time period. Sand mounds with or without pretreatment accounted for 10% of all system installations, and drip distribution systems accounted for 3% of all system installations during this time period. The total percentage of NPDES systems was 6% of the state total installations. No low pressure pipe or spray irrigation systems were reported during this time period. The category of “other” system installed reflects systems that had either obtained a “pre-approval” prior to January 1, 2007, or were alterations of existing systems. These numbers reflect the types of systems installed under the statewide interim rules (1977 minimum state rules) with local health districts adopting more stringent rules.

Table 13 shows the number and percentage by region of household sewage treatment systems versus small flow onsite sewage treatment systems installed from July 1, 2007, through November 30, 2007, and the number and percentage by region of new, alteration or replacement systems installed during the same time period.

The majority of systems installed in the latter half of 2007 were reported as new household installations (68%). System replacements and alterations for households were reported as 30% of the total installations. Small flow system new installations, repairs and alterations totaled less than 1% of all state system installations or alterations.

Table 12. Type, number, and percentage by region of sewage treatment system installations reported between July 1, 2007 to November 30, 2007.

Region **SystemType/Description Code**	**Northwest Number (%)(total reported)**	**Northeast Number (%)(total reported)**	**Southeast Number (%)(total reported)**	**Southwest Number (%)(total reported)**	**Central Number (%)(total reported)**	**State Number (%)(total reported)**
1. Septic tank to shallow leach lines	133 (30%)	74 (16%)	120 (27%)	83 (18%)	41 (9%)	451 (18%)
Pretreatment to shallow leach lines	2 (1%)	75 (44%)	52(30%)	5 (2%)	35(21%)	169 (7%)
Septic tank to 18-30" leach lines	106(10%)	298(28%)	224(21%)	249(23%)	189(18%)	1066 (42%)
Pretreatment to 18-30" leach lines	5 (4%)	34(27%)	44(35%)	19(15%)	22(18%)	124 (5%)
Septic tank to sand mound	32(14%)	87(38%)	13(6%)	67(29%)	32(14%)	231 (9%)
Pretreatment to sand mound	8(21%)	4(11%)	0	21(55%)	5(13%)	38 (1%)
Septic tank to drip distribution	0	16(36%)	0	6(13%)	23(51%)	45 (2%)
Pretreatment to drip distribution	1(4%)	10(48%)	0	3(15%)	7(33%)	21 (1%)
NPDES system	12(9%)	113(81%)	1(1%)	11(8%)	3(2%)	140 (6%)
Septic tank to low pressure pipe	0	0	0	0	0	0
Pretreatment to low pressure pipe	0	0	0	0	0	0
Other	24	82	72	67	15	260 (10%)

Table 13. Number and percentage by region of household sewage treatment systems versus small flow onsite sewage treatment systems, and the new, alteration or replacement systems installed from July 1, 2007 through November 30, 2007.

*Unknown status – 9 systems

Region	**Northwest**	**Northeast**	**Southeast**	**Southwest**	**Central**	**State**
House-New	267 (11)	708 (30)	578 (24)	474 (18)	335 (14)	2362 (68)
House-Replacement	130 (20)	318 (50)	46 (7)	104 (16)	38 (6)	636 (18)
House - Alteration	71 (17)	135 (32)	57 (13)	97(23)	63 (15)	423 (12)
SFOSTS - new	4 (13)	7 (23)	8 (26)	3 (10)	9 (29)	31 (1)
SFOSTS - replacement	2 (40)	3 (60)	0	0	0	5 (<1)
SFOSTS - alteration	0	2 (40)	1 (20)	2 (40)	0	5 (<1)
Totals	474	1173	690	680	445	3462

2007 System Cost Data

Sewage treatment system cost data was provided by local health districts on the sewage permit reports provided monthly to ODH. Local health districts reported difficulty in collecting the system cost data from sewage system contractors in some areas. Data on system costs was generally collected in two ways: 1) actual or estimated data by individual permit from the system owner or system contractor, or 2) estimated based on a local survey of system contractors according to system type within the reporting county. Of the 88 counties, 4 counties did not provide cost data at all or through the end of the reporting period. Table 14. summarizes the estimated system costs reported from July 1, 2007 through November 30, 2007. Cost data for July was often incomplete.

Table 14. Estimated sewage treatment system costs by type and region as reported from July 1, 2007 to November 20, 2007.

Region **SystemType/ Description Code**	**Northwest** **Average**	**Northeast** **Average**	**Southeast** **Average**	**Southwest** **Average**	**Central** **Average**	**State** **Average**
Septic tank to shallow leach lines	$7,988	$10,196	$4,926	$7,867	$8,391	$7,555
Pretreatment to shallow leach lines	$8,000	$9,002	$7,443	$11,750	$9,465	$8,752
Septic tank to 18-30" leach lines	$6,038	$7,303	$5,479	$6,708	$6,997	$6,590
Pretreatment to 18-30" leach lines	$8,650	$7,547	$6,537	$10,625	$9,741	$8,117
Septic tank to sand mound	$11,355	$13,214	$7,192	$17,792	$14,710	$14, 154
Pretreatment to sand mound	$12,937	$18,250	None reported	$22,000	$16,250	$19,051
Septic tank to drip distribution	None reported	$19,375	None reported	$30,797	$17,158	$19764
Pretreatment to drip distribution	$18,000	$18,210	None reported	$29,697	$17,821	$19,711
NPDES system	$11,607	$10,037	$7,500	$15,067	$11,293	$11,612
Other	$8,583	$8,191	$7,037	$6,551	$5,624	$7,473+
Septic tank to low pressure pipe	None reported	None reported	None reported	None reported	None reported	None reported
Pretreatment to low pressure pipe	None reported	None reported	None reported	None reported	None reported	None reported

The state average estimated cost of septic tank to shallow or regular depth soil absorption (leach line) systems ranged from $6,950 to $7,555. This data can be compared to the April, 2006 survey data collected which showed that conventional system costs (septic tank to leach line) ranged from an average of $5,388 to $8,048. The use of pretreatment units to shallow or regular depth soil absorption systems ranged from an estimated cost of $8,117 to $8,752. The state average estimated cost for mound systems with septic tank effluent was $14,154 and the addition of pretreatment increased costs to an average of $19,764. Septic tank and pretreated effluent to drip distribution average state costs were estimated at $19,764 and $19,711 respectively. The state average for NPDES system costs was estimated at $11,612, however, this cost is suspect due to the low cost reported for NPDES systems in Southeast Ohio. ODH believes the cost values reported in southeast Ohio were coded incorrectly on the permit reports based on cost data provided by the manufacturer's on the actual base costs of NPDES systems. A more accurate value of NPDES costs can be calculated by considering the average costs from the other four regions for a cost value of $12,158.

The overall estimated cost for alternative systems can be compared to the April, 2006 cost survey which showed a range of $11,129 to $16,847 for estimated or known alternative system costs. A comparison of 2006 and 2007 cost survey data shows that system costs, on average did not change significantly with the inception of the January 1, 2007 rules.

During July to September, 2007, local health districts reported to ODH that some sewage system contractors were refusing to provide data on system costs because the specific address data was being provided to the local health districts with the cost data and their competitors could obtain that information through a public records request. Subsequently, in October, 2007, ODH sent a letter to nearly 3,000 sewage system installers, service providers and septage haulers advising them of the new law changes that had occurred and the requirements of Am. Sub. H.B. 119. The mailing also contained a cost survey asking for average costs of system types, and the area of the state the contractor worked in. No specific company or contractor name information was requested, and contractors could report the survey data anonymously. ODH received about 100 responses to the system cost survey that clearly demonstrates the reluctance of industry to provide the system cost data. Estimated system cost data as reported from the installers is list on Table 15. The average system cost is provided for each region followed in parentheses by the total number of estimates received for that system type for that region. While some system types, such as septic tank to shallow and regular depth leach lines had more cost estimates provided, some system types had very few cost estimates provided, thus the true reliability of the cost data is lower. The cost of NPDES systems in southeastern Ohio is also suspect because it is lower than base system costs provided by the manufacturers of NPDES compliant systems. No low pressure pipe systems have been installed yet in Ohio; therefore, these costs truly reflect estimates provided by the installers that responded.

Table 15. Sewage system installer survey reported average system cost, October, 2007.

Region System Type/Description Code	Northwest Estimated cost (number of installer estimates provided)	Northeast Estimated cost (number of installer estimates provided)	Southeast Estimated cost (number of installer estimates provided)	Southwest Estimated cost (number of installer estimates provided)	Central Estimated cost (number of installer estimates provided)	State Average
Septic tank to shallow leach lines	7,857 (28)	11,141 (27)	5,907 (13)	8,115 (21)	6,120 (5)	7,828
Pretreatment to shallow leach lines	9,300 (13)	12,235 (28)	8,072 (11)	11,200 (10)	7,800 (5)	9,721
Septic tank to 18-30" leach lines	7,975 (26)	10,542 (33)	8,768 (11)	7,786 (19)	6,505 (9)	8,315
Pretreatment to 18-30" leach lines	9,183 (12)	12,314 (26)	9,200 (9)	11,250 (11)	8,000 (7)	9,989
Septic tank to sand mound	14,961 (18)	17,075 (20)	18,375 (4)	17,762 (16)	16,800 (5)	16,994
Pretreatment to sand mound	16,550 (10)	19,184 (19)	20,333 (3)	22,277 (9)	18,800 (5)	19,428
Septic tank to drip distribution	17,600 (5)	20,350 (10)	18,000 (1)	23,200 (5)	15,000 (1)	18,830
Pretreatment to drip distribution	19,333 (3)	23,145 (11)	20,000 (1)	26,833 (6)	17,000 (1)	21,262
NPDES system	15.500 (4)	12,500 (25)	7,675 (4)	12,642 (7)	None reported	12,079
Septic tank to low pressure pipe	12,166 (3)	12,325 (4)	None reported	16,800 (2)	7,000 (1)	12,072
Pretreatment to low pressure pipe	14,000(3)	14,250 (4)	None reported	27,500 (2)	8,000 (1)	15,937

State, Community and Individual Costs of Sewage Treatment System Failure

When sewage treatment systems fail there is a cost to the property owner, the neighborhood or community, the watershed, and the state. Nuisance conditions are created that can negatively affect the health of the property owner or their neighbors, the environmental conditions (surface or ground water) in a community or watershed, and the value of homes. Nuisance conditions can result in sewage in yards, ditches or streams resulting in degradation of surface water or can infiltrate into ground and contaminate drinking water supplies. Without corrective action to fix the failing system and the nuisance conditions, enforcement actions from Ohio EPA often result in areas of failing systems. As noted previously, Ohio EPA records show that between 1986 and 2007, over 240 communities are under enforcement or have been identified as having significant impacts from failing systems. Costs are not always tangible and can be related to quality of life impacts or loss of real estate value that are difficult to

quantify The cost of failing systems at different levels of application can be summarized below.

Table 16. Costs of failing systems.

Individual	Community	County	Watershed	State
Costs for repair or replacement	Loss of real estate values	Cost for water treatment plant and sewer lines	Degradation of surface water quality	Increased funding expenditures to communities and counties to fund treatment plants and sewer lines
Loss of property values – impacted home sales	Affected recreational areas	Urban sprawl issues and costs for related infrastructure (fire, police, roads)	Loss of biota, fish and wildlife	Impact to state tourism and recreational use of water resources (fishing in streams, bathing beaches)
Cost of illness	Affected drinking water resources	Loss of tourism dollars	Loss of recreational uses	Funding for extension of water lines to impacted areas
Quality of life – enjoyment of property	Enjoyment of community	Negative impact to financial rating of county		
Assessment, tap in fees and monthly bill for pubic sewers		Funding for extension of water lines to impacted areas		
Affected drinking water resources				

Documented State Costs

ODH has collected information from state and local agencies on the costs of failing sewage systems. The Ohio Water Development Authority (OWDA) works with Ohio EPA, Division of Environmental Financial Assistance to provide low interest loans to communities from the State Revolving Loan Fund to assist with the costs for construction of new wastewater treatment plants, expansion of existing plants and extension of sewer lines to areas of failing systems. Since 1989 the OWDA has tracked these projects and the related costs. A summary of this information for the time period of 1989 to 2004 shows that Ohio has spent over 1 billion dollars (low interest loans and planning grants) to correct areas of failing systems. As required by the Clean Water Act, Ohio EPA participates in a national survey of water and wastewater infrastructure needs. The Clean Watersheds Need Survey includes an estimate of the costs to repair areas of nonpoint sources of contamination with a specific reporting category for sewage systems. This survey was last conducted in 2004 and will be conducted again in 2008. The 2004 data shows a reported need of $874 million dollars to correct areas of failing systems. This cost estimate includes repairs, replacements of existing systems, or extension of sewer lines/construction of new plants.

Documented Community/County Costs

Failing systems are a substantial financial burden to a community and affect both surface and ground water resources in an area. The cost of failing systems not only includes community costs to fund sewage treatment plants and sewer line extensions, but costs to communities in the loss of real estate values, or impacted recreational areas. Some counties have experienced substantial economic hardship as a result of poor design and management of sewage systems. Trumbull County currently has over 17 communities under Findings and Orders to correct areas of failing systems with public sewers at a cost exceeding 100 million dollars, and is currently under a consent agreement establishing requirements for replacement onsite sewage systems and construction of new systems.

The extension of sewer or water lines to a community usually results in other significant burdens or impacts to the infrastructure and services base of the community. Extension of sewer lines leads to higher density development of land. Higher density housing leads to increased demands on roads, schools, fire and police protection that are often not anticipated, nor paid for with the increased development. The extension of sewer lines also leads to increased urban sprawl and loss of valuable farmland.

The gastrointestinal outbreak on South Bass Island during the summer of 2004 caused substantial cost to the community in terms of lost revenue from travel and tourism to the island. Due to the sensitive ground water aquifer beneath the island, public water and sewers for the entire island have been recommended by Ohio EPA and ODH at a projected cost exceeding $100,000,000. The community has recently installed public water to major businesses, the airport and the state park at a cost of $4,804,978. Costs

to the community for medical bills and lost wages due to absence from work have not been calculated but are certain to be significant.

The new Ground Water Rule (40 CFR, Parts 9,141, and 142, November 8, 2006) identifies requirements for extended sampling and monitoring, corrective action in the form of water system source replacement, or installation of disinfection/treatment for public water supplies that show repeat total coliform and fecal coliform sample results. Not only does the Ground Water Rule affect large public water supplies, it also applies to non-community, non-transient systems such as businesses, churches and organizations that are public water supplies. Subsequently, contamination of ground water from failing or poorly designed sewage systems can have other costly impacts.

The following examples show the community costs of failing systems.

Surface Water Contamination from Failing Systems

Chickasaw Sewers and Wastewater Treatment Plant – Mercer County

Population: 364 (149 homes, 10 business buildings, plus public buildings)

History: Concern about sewage entering Chickasaw Creek from septic systems led to a 1993 wastewater feasibility study for Chickasaw and a 1995 water quality study of the stream by the Mercer County Sanitary Department. The presence of sewage was inferred from the chemical results and fecal coliform counts. Based on the study, the Ohio Environmental Protection Agency (EPA) Northwest District Office in 1995 advised the Mercer County Commissioners to eliminate the discharge of improperly treated sewage to Chickasaw Creek. Chickasaw Creek runs north through Chickasaw into the east end of Grand Lake St Marys and is considered a tributary to the St Marys River, which drains to the Maumee River and then Lake Erie. Chickasaw Creek is designated warmwater habitat (WWH) in the Ohio Water Quality Standards. For more than two decades, the creek in and downstream of Chickasaw has had fecal coliform counts that suggest sewage contamination.

Treatment System: Chickasaw proposes constructing a conventional gravity sanitary sewer collection system in the village, consisting of a main trunk sewer (4,500 linear feet of 12" diameter pipe), 13,400 linear feet of 8" diameter collector sewer pipe, and two pump stations. A three-cell facultative lagoon will be constructed southeast of the village beside an industrial park. It will have a treatment capacity of 105,000 gpd, sized for six months of wastewater flow. Weather permitting; effluent may be sprayed on cropland near the lagoons. In winter and during periods of excessive rainfall, treated water will drain to Chickasaw Creek under a National Pollutant Discharge Elimination System (NPDES) permit

Costs: Chickasaw plans to borrow approximately $1,480,000 from the WPCLF at the "hardship" interest rate (0.0%). The estimated project cost is $2,280,000, financed with the WPCLF, $500,000 from the Community Development Block Grant program, and a $265,000 grant and $35,000, 0% interest rate loan from the Ohio Public Works Commission. The village will start monthly sewer billing

after the bids are accepted and the actual project cost is known. Assessments will be paid as part of the monthly bill, with no interest charged.

Village of Morristown Sanitary Sewer System

Population: 299 (116 failing HSTS)

History: The entire village is served by private septic systems, which were constructed in the early 1900s. Most of these systems are well past their useful life and are no longer providing adequate treatment. In 1992, the village was informed by Ohio EPA that the headwaters of McMahon Creek were experiencing severe impact from raw sewage originating from Morristown. An inspection of the village at that time determined that raw sewage was discharging into the street. Odor from the existing septic systems has also been a problem. Once the sewer system is constructed, septic systems will be properly abandoned and water quality impacts from failing septic systems will be eliminated. The village recently signed Findings and Orders for the project.

Treatment System: The Morristown project involves construction of a new gravity sanitary sewer system to serve the village, with wastewater treatment to be provided by Belmont County. Morristown is currently served by failing home sewage treatment systems. Once construction of Morristown's sewer system begins, the county will begin construction of a pump station and force main to carry the wastewater to its Fox Shannon WWTP. The county will be responsible for construction, operation, and maintenance of the pump station and force main. The village will operate and maintain the gravity sewer system and grinder pumps. Belmont County's WWTP has ample capacity to serve the village.

Cost: A $747,726 WPCLF loan was awarded to the Village to assist in the construction of a gravity sanitary sewer. Project cost is estimated at $1,771,726. Funding was also obtain from a Public Works Commission - Ohio Small Government Program $200,000 grant.

Ground Water Contamination from Failing Systems

Wayne County, Wooster Township, Batdorf Road area

Population: Approximately 75 homes

History: At the request of the Wayne County Board of Health, ODH conducted a prelimary investigation of the water quality of water wells (nitrates and pathogens) in the vicinity of Batdorf Road, in part of Wooster Township. At Wayne County Combined General Health District Board of Health's request, an investigation into unsanitary conditions was performed by Ohio EPA's Division of Surface Water of a common collector tile discharging effluent from several household sewage treatment systems. The surface water sampling results did not indicate a public health nuisance based on water quality criteria established for surface waters in the Ohio Administrative Code 3745-1-04. Subsequently the Board of Health renewed the public health nuisance declaration for the area and in January 2006 requested Ohio EPA conduct an Unsafe Water Supply Investigation of the area per Ohio Revised Code (ORC) 6103.17.

After reviewing the available information and establishing the goals of the investigation, Ohio EPA, in cooperation with the United States Geologic Survey Ohio Water Science Center, conducted a two phase investigation in the study area. The goal of the investigation conducted between April and June 2006 was to determine whether local ground water supplying private water systems has been affected by the effluent from individual household sewage treatment systems within the subdivision or from other potential contaminant sources. Specifically, the investigation was designed to identify the probable source(s) of *E. coli* and nitrate contamination in the water well samples collected previously by the Wayne County Health Department and the Ohio Department of Health.
The investigation results document that the geologic setting within the study area is sensitive to ground water contamination from household sewage treatment systems. Due to the complex nature of fractured bedrock aquifers and multiple local sources of effluent from household sewage treatment systems (leach fields) in the study area, this study does not identify any single household sewage treatment system as the cause for the unsafe water supply conditions. However, the results from the sampling and understanding of the hydrogeologic conditions in the study area suggest the household wastewater treatment systems installed into or just above bedrock are likely to have a greater impact on the water quality of the aquifer then those systems with adequate soil material to treat the effluent.

Treatment System: The alternative treatment plan chosen will combine gravity sewer installation with transport to Wooster, and replacement of failing on-site or new systems as warranted. The gravity sewer installation will involve 16,500 feet of 8 inch sewer lines, with some rock excavation, pump stations, 2,000 feet of 3 inch force mains, and 4,100 feet of 6 PVC laterals. The wastewater will be transported to the Wooster Wastewater Treatment Plant.

Cost: Total system costs include a total construction cost of $1,760,000, engineering and design costs of $298,000, other of $51,000 and an annual charge by Wooster for treatment of $46,224. Individual property assessments will range from $6,735 to $11,878 depending on the level of USDA funding provided. Monthly billing rates of $75.00 are estimated with approximately $3,500 projected individual property costs for existing system abandonment.

Village of Hanover, Licking County

Population: 885

History:The Village of Hanover currently relies on septic systems for treatment of its wastewater. The Village is experiencing wide-spread failures of its septic systems, resulting in a significant health threat, including potential contamination of the individual drinking water wells located within the Village, as well as untreated sewage that is finding its way into the streams, ditches, and drainage tiles that are tributary to Rocky Fork Creek. These discharges have impaired the water quality and aquatic life of Rocky Fork Creek, while unsanitary conditions are evident in the Village neighborhoods from the odors, solids deposits, and high bacteria counts. As a result of small lot sizes, poor soils, and unsuitable hydrologic conditions, replacement or repair of the existing on-lot systems to remedy the unsanitary conditions is not an option over the long-term.

Treatment System: Hanover has decided to address its wastewater needs by installing a conventional gravity sanitary sewer collection system, two pump stations, force main, and an US Filter Kruger oxidation ditch, to be located in “Old Hanover” at

the south end of town. Effluent from the WWTP will discharge to Rocky Fork Creek approximately 1.2 river miles upstream of its confluence with the Licking River in the Black Hand Gorge Nature Preserve.

Cost: For the proposed Hanover collection system and WWTP project, the estimated average monthly sewer charge is $47.50. There will be no property assessment or connection fees for current residents who signed up for service before August 18, 2006, and have been paying the $15.00 per month pre-construction sewer charge. All others, including all new homes, will have a tap fee of $5,000. This would affect two existing residential property owners, who so far have refused to sign up for sewer service. The costs to all homeowners to abandon their septic tanks and construct lateral sewer lines to the new collector sewers will range from $1,000 to $2,000.

According to the 1999 census, Hanover's median household income (MHI) was $50,313. However, based on a 2003 income survey accepted by the Ohio Department of Development Data Users' Center, the current MHI estimate for the Village is $35,000. Based on the estimated average monthly bill, the annual cost for sewer service of $570 comprises 1.6% of the MHI. This annual user charge is similar to the average annual user charges found in other Licking County communities, for example: Granville (population 1,194) pays $463 per year; Hebron (population 2,034) pays $525 per year; and Pataskala (population 10,249) pays $442 per year. Hanover had a year 2000 population of 885.

The cost to abandon septic tanks and construct lateral sewers, if amortized at a 5% interest rate over a 10 year period, would add an additional $256 per year to the average user cost, bringing it up to $826. This would represent 2.4% of the MHI for the Village. This cost is comparable to what many unsewered areas have to initially pay for new service. The community is generally in support of the project with these costs, given their desire to eliminate the current problems with failing septic systems.
Source of community cost data: Ohio EPA, Division of Environmental and Financial Assistance.

The Amesville Decentalized Sewage Treatment Project – An Alternative Solution to Failing Systems for Villages

Population: 84

History: The Village of Amesville, located in Athens County, is a small, rural village of approximately 84 residents, a few small businesses, and the Amesville Elementary School. All of the structures in the Village except the school are served by privately owned on-site sewage treatment systems. The school had a treatment plant comprised of an aeration system and sand filters. Due to poor soil conditions, age, and neglect, many of the existing treatment systems were ineffective and allow improperly treated sewage to enter roadside ditches and streams. The health hazards and odors from these conditions have been a concern in the Village for many years, and were well documented by Ohio EPA and the Athens County Health Department. The purpose of the Village's proposed wastewater improvements was to eliminate these nuisances and health hazards.

The Rural Capabilities Assistance Program (RCAP) provided support and assistance to the village during their planning process for a decentralized

approach to wastewater management. Amesville decided on this approach to avoid the high costs a small community typically faces building sewers to a new central treatment facility. The clustered treatment systems will use septic tanks to recirculating textile filters and ultraviolet light disinfection. Treatment centers were sited at three separate locations in the Village – two on school properties and one near the Village office. New sewers then carry the treatment centers' effluent to three separate locations where they discharge treated wastewater to Federal Creek and an unnamed tributary to the Creek. The NPDES discharge permit uses an innovative approach that allows the Village to operate the multiple treatment systems without multiplying the operation and monitoring requirements as three separate permitted discharges normally would require.

Treatment System: The provision of three separate treatment centers allows shorter, shallower and smaller-diameter sewers in the collection system, and minimizes wastewater pumping. New individual and clustered septic tanks at various sites will be used to provide primary wastewater treatment upstream of the recirculating textile filter units. The collection system therefore will use a combination of some conventional gravity sewers, more small-diameter septic tank effluent gravity lines, and several pump stations and force mains.

Cost: The total cost of the proposed project was approximately $1,525,000. Amesville received financial assistance for project implementation from several sources including a $600,000 CDBG grant, a $250,00 Appalachian Regional Commission grant, a $59,998 grant/$90,000 loan from the Ohio Public Works Commission, and a $415,103 loan from the Ohio Water Pollution Control Loan Fund (WPCLF). The WPCLF assistance was in the form of a twenty-year, fixed rate, 0% hardship loan for project construction. The WPCLF's hardship interest rate, when applied to an eligible loan amount of $415,103, is estimated to save the Village over $228,094 compared to a standard 4.67% market rate loan.

The Amesville decentralized collection system and cluster wastewater treatment units project has an estimated average monthly sewer charge of $32.74. There were no property assessment or connection fees associated with the project. Homeowners will have to pay for septic tank abandonment and connection costs from their homes to the new individual or cluster septic tanks. A $100,000 grant to pay for septic tank abandonment and connection construction costs was provided to assist Amesville's low to moderate income residents. Other residents will pay for these costs and they are estimates to be around $1,000 to $1,500. If the $1,500 cost is amortized at 5% interest over a 10 year period, this will add an additional $15.91 to the monthly user rate.

According to the 1999 census, Amesville's median household income (MHI) was $35,000. Thus, based on the estimated low to moderate income residential monthly bill, the annual cost for sewer use of $392.88 comprises only 1.1% of the MHI and for the non low to moderate income residential user it will be $583.80 which comprises only 1.6% of the MHI which is within accepted EPA affordability guidelines. For comparative purposes, the annual average costs for wastewater service in two other similarly-sized Athens County communities are $464 for Jacksonville (population 544) and $482 for Trimble Township. The Amesville system went on-line in August, 2007 and is the first existing, incorporated community in Ohio to use a decentralized wastewater system that is publicly owned and operated.

Individual Costs of Failing Systems – Connection to Public Sewers

Failing sewage systems are a substantial economic burden on a property owner and negatively impacts the value of their home. When a system fails, the property owner has lost their original investment in the sewage system, and now has to pay again for either a replacement system or for a connection to public sewers with a monthly bill. Several examples of the costs of public sewers including the lateral connections costs, connection fees, and monthly bills have been provided in the prior section.

Monthly sewer bills across Ohio are surveyed and reported annually by the Ohio EPA (Ohio EPA, 2006). Ohio EPA surveys 566 municipalities and districts on monthly sewer rates based on a rate of 7,756 gallons per month. The average state monthly sewer rate for 2006 was reported as $442.00, with a maximum monthly rate of $1271.00 and a minimum monthly rate of $24.00. Costs for lateral and connection fees for the individual property can range from $2,000 to $25,000 depending on the system design and supplemental funding obtained by the community.

Individual Costs of Failing Systems - System Replacement Costs

During 2007, 60-87% of the replacement systems installed represented septic tank to soil absorption systems at an estimated cost of $6,500 to $7,500. A smaller percentage of replacement system costs ranged from $7,500 to 19,500. The system replacement cost is very dependent on the lot's size and soil conditions. To protect the investment that a property owner makes in a replacement or new sewage treatment systems, it is critical that siting criteria and design ensure treatment and long-term sustainability. These system costs can be evaluated by examining actual monthly costs of systems based on average installation costs and annual operation and maintenance over a 30 year period (term of a mortgage).

Table 17 shows the average cost of several system costs from the 2007 permit data, average annual operation and maintenance (O & M), costs for operation and maintenance over the life of the system, total system costs, and then monthly system costs based on 360 months of payment.

The monthly system costs reflected in Table 17 can be compared to the costs for connection to sewer lines and a monthly sewer bill when connected to public sewers. Assessment fees range from $2,000 to $25,000 with an average annual sewer rate bill of $442. Multiplying the annual sewer rate bill of $442 x 30 years equals $13,260 for a 30-year term. Adding the range of costs of sewer connections, the 30-year costs range from $15,260 to $38,260. Dividing this range by 360 months equals true monthly costs of public sewer connections of $42 to $106. The costs for on-site sewage treatment systems fall either below or well within the range of average public sewer costs to a property.

Real estate property value losses due to failing systems have been anecdotally reported by the real estate industry but are difficult to quantify. Loss of home sales has also been reported due to the presence of a failing system on the property. At the very least, failing system reduce property values an amount equivalent to the cost of a replacement system if not more.

Table 17. Initial and amortized costs, and resulting true monthly costs of various sewage treatment systems and public sewers.

Cost (dollars) **System Type**	**Installation Cost**	**Annual Operation and Maintenance**	**Total O &M for systems life (30 years)**	**Total system cost for 30 year period**	**Monthly system cost**	**True Annual System Cost**
Septic tank to leach lines	7,550	85	2,550	10,100	28	336
Pretreatment to leach lines	8,700	300	9000	17,700	49	588
Septic tank to sand mounds	14,150	200	6000	20,150	56	672
Pretreatment to sand mounds	19, 000	300	9000	28,000	77	924
Drip distribution	19,700	400	12000	31,700	88	1056
NPDES	12,158	250	7500	19,658	55	660
Public sewer	$2,000 to 25,000 - connection cost	$442 - average annual sewer bill (Ohio EPA, 2006)	$13,260 - 30 year sewer bill costs	$15,260 to 38,260 total public sewer costs for 30 years	$42 to 106	$504 to 1272

Approximately 6,000 total permits for new and replacement systems, and system alterations have been issued to date (January to November) for 2007. The percentage of alteration and replacements, according to the 2007 permit data is 30%, which equals approximately 1800 repairs or alterations in 2007. The type of replacement system that would be required for any lot is dependent on the site conditions such as soils, topography, drainage, isolation distances required, and available space for the replacement system. In some cases, the replacement or alteration of a system is due to system age or homeowner neglect. In some cases, replacement or alteration of a system is due to failure because of poor design or siting issues for the lot. A very rough estimate of system replacement and alteration costs can be calculated by looking at the percentage of each type of system installed and the total cost of that system installation statewide. Using the 30% rate of system replacement and alteration, the total system installation cost for each system type can be multiplied by 30% to obtain the replacement/alteration cost statewide for each system type. This calculation for each

system type is shown in Table 18. This table provides a rough estimate of the total dollars spent on all sewage system installations (new, replacements and alterations) and the estimated cost of replacements and alterations alone.

This table shows that roughly $49 million is spent annually on new and replacement system construction, and system alteration. This means that the average reported system cost in Ohio is $8,100. An estimated $14.6 million is spent on system alteration and repair. These costs reflect systems repairs and alterations made to systems installed prior to 2007, under the older standards in place in Ohio. ODH believes that the use of outdated standards that do not reasonably consider site and soil conditions and provide for designs that ensure reasonable treatment have led to the 27-30% failure or replacement/alteration rate that the state is experiencing today. This is at a substantial cost to tax payers in the form of system replacement/alteration costs or the costs to extend sewer lines and expand treatment plant capacities across the state.

Table 18. Statewide sewage treatment system installation, replacement and alteration costs.

System Type	System Average Cost	State % of Installations for each system type	Number of each type of system installed (state total x % of systems installed)	Total Estimated State Cost for each system type (includes new, replaced and altered)	Total state replacement or alteration costs (30% of state total cost for each system type)
Septic tank to shallow or regular depth leach lines	6,590 7,550	18 42	1080 2520	7,117,200 19,026,000	2,135,160 5, 707,800
Pretreatment to shallow or regular depth leach lines	8,752 8,117	7 5	420 300	3,675,840 2,435,100	1,102,752 730,530
Septic tank to sand mound	14,154	9	540	7,643,160	2,229,548
Pretreatment to sand mound	19,051	1	60	1,143,160	342,948
Septic tank to drip distribution	19,764	2	120	2,371,680	711,504
Pretreatment to drip distribution	19,711	1	60	1,182,660	354,798
NPDES	12,500	6	360	4,500,000	1,350,000
Totals		91% (excludes other)	5460	$49,094,800	$14,665,040

Illness Costs to Individuals from Exposure to Sewage

Limited actual data on the cost of illness related to ingestion or exposure to surface or ground water contaminated with sewage in Ohio is available. Reported illnesses to the gastrointestinal outbreak at South Bass Island can be considered as an example of illness cost related to contamination of ground water by sewage. Between July 23 and September 12, 2004, 1,450 residents of or visitors to SBI reported a gastrointestinal illness. Seventy three percent of the cases reported a duration of symptoms greater than 2 days (range >2 days to 52 days); 27% of cases reported symptoms for ≤ 2 days. Consuming increasing amounts of tap water on the island was associated with increasing odds of becoming ill (CDC, FDDB, 2004). Table 19 summarizes the demographics of ill persons, and the type and duration of illness.

Table 19. Demographic and clinical information for cases reporting illness, South Bass Island, Ohio, May 30-September 10, 2004 (N=1,450) (O'Reilly, 2005)

Characteristic	N	%
Island resident	25/1450	2
OH resident	1217/1450	84
Female	884/1450	61
Median age in years (range)	40 (<1 – 83)	
Cases < 5 years old	48/1395	3
Median visit start date (range)	08/01 (4/07 – 9/06)	
Median illness onset dates (range)	08/05 (5/30 – 9/08)	
Median duration of illness in days (range)	4 (1 – 52)	
Duration of illness ≤ 2 days	312/1145	27
Duration of illness > 2 days	833/1145	73
Symptom		
Diarrhea	1199/1450	83
Bloody diarrhea	66/1450	5
Vomiting	728/1450	50
Nausea	1110/1450	77
Cramps	1162/1450	80
Fever	650/1450	45
Sought medical care	114/1450	8
Hospitalization	21/1450	1
Deaths	0	0

The National Primary Drinking Water Regulations: Ground Water Rule, 71 Fed. Reg. 216 (November 8, 2006) (amending 40 CFR Parts 9, 141, and 142) provide information on the average cost of a viral illness associated with exposure to contaminated water. Two approaches for calculating cost-of-illness (COI) were used, traditional and

enhanced. Additionally, U.S. EPA considered two types of viral illnesses in the analysis, where a Type A virus (such as rotavirus), that is highly infectious but has only mild health effects, and Type B virus (such as enterovirus or echovirus) that is moderately infectious, but can have severe health consequences, though the majority of illnesses are also mild. U.S. EPA characterizes these **costs per person** as:

Cost Type	***Direct Indirect per person*** (outpatient/inpatient care)	***Indirect cost per person*** (work days lost, value of productivity, Value of caregiver days lost)
Type A	$0 to 4,486	$103 to 2,136
Type B	$0 to 23,431	$336 to 2,990

Higher illness costs are associated with either more severe cases, or cases related to persons who are immunocompromised, very elderly or very young (<5 years).
Data collected from the South Bass Island outbreak showed the presence of E. coli, *Clostridium perfringens, salmonella, Cryptosporidium, giardia,* enterovirus and adenovirus. Using these cost values associated with a Type B virus as a baseline, and a conservative estimate of 25% of the maximum illness value, the cost of illness for the South Bass Island outbreak could be estimated at $5,857 for direct costs for those that sought medical care or were hospitalized, and $84 to $747 for indirect illness costs x 145 persons who sought medical care or were hospitalized. This equals an estimated range of $849,625 to $1,283,175 total cost for those who sought medical care or were hospitalized as a result of this outbreak. This calculation does not include lost work days or wages for those ill persons who did not seek medical care or were hospitalized (1,450-145 = 1,305 persons who reported illness).

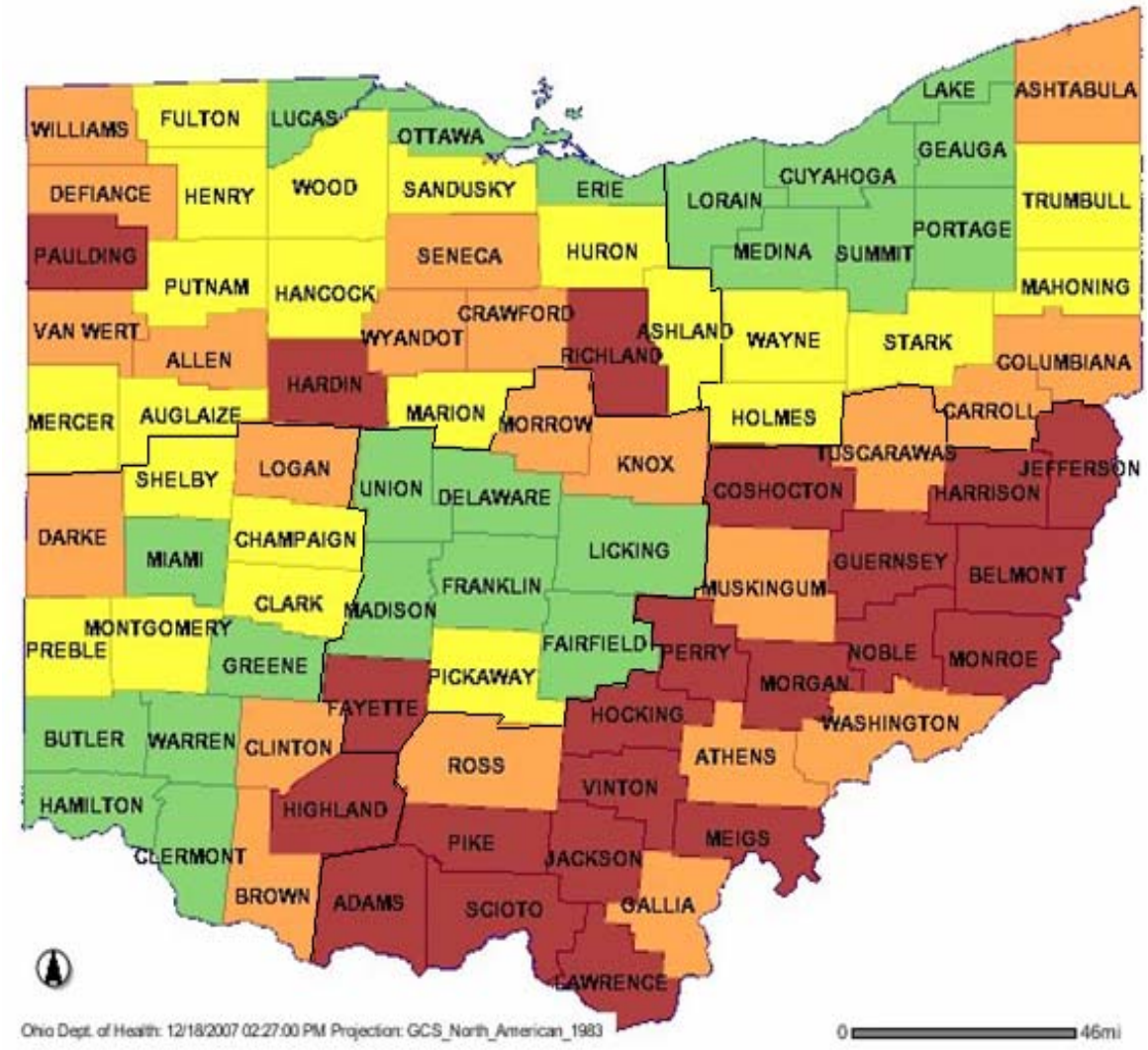
In summary, the cost of illness resulting from exposure to sewage pathogens in surface or ground water can also create a substantial financial burden to a family that must also be considered in any cost analysis. While these costs are not easily documented, they likely exist and represent an additional cost of failing sewage systems.

State Socioeconomic Data

Consideration and review of current and alternative sewage treatment system costs in Ohio, the costs of new systems, and the costs of replacements or alterations can also be evaluated against state socioeconomic data. When providing guidance to states for determining the level of financial assistance provided in the form of low interest loans, U.S. EPA has identified a benchmark of affordability for sewer rates of 2% of the annual median household income of a community. Table 20 shows the regional socioeconomic statistics for Ohio based on the 2000 census data. Figures 12, 13, and 14 are maps depicting statewide average median housing values, average median annual incomes, and percentage of the population with income levels below 200% of poverty values for persons located outside of municipal boundaries who would not be served by public

sewers. A complete table of this socioeconomic data by county can be found in Appendix 3.

Figure 12. Average Median House Value – Non Municipalities

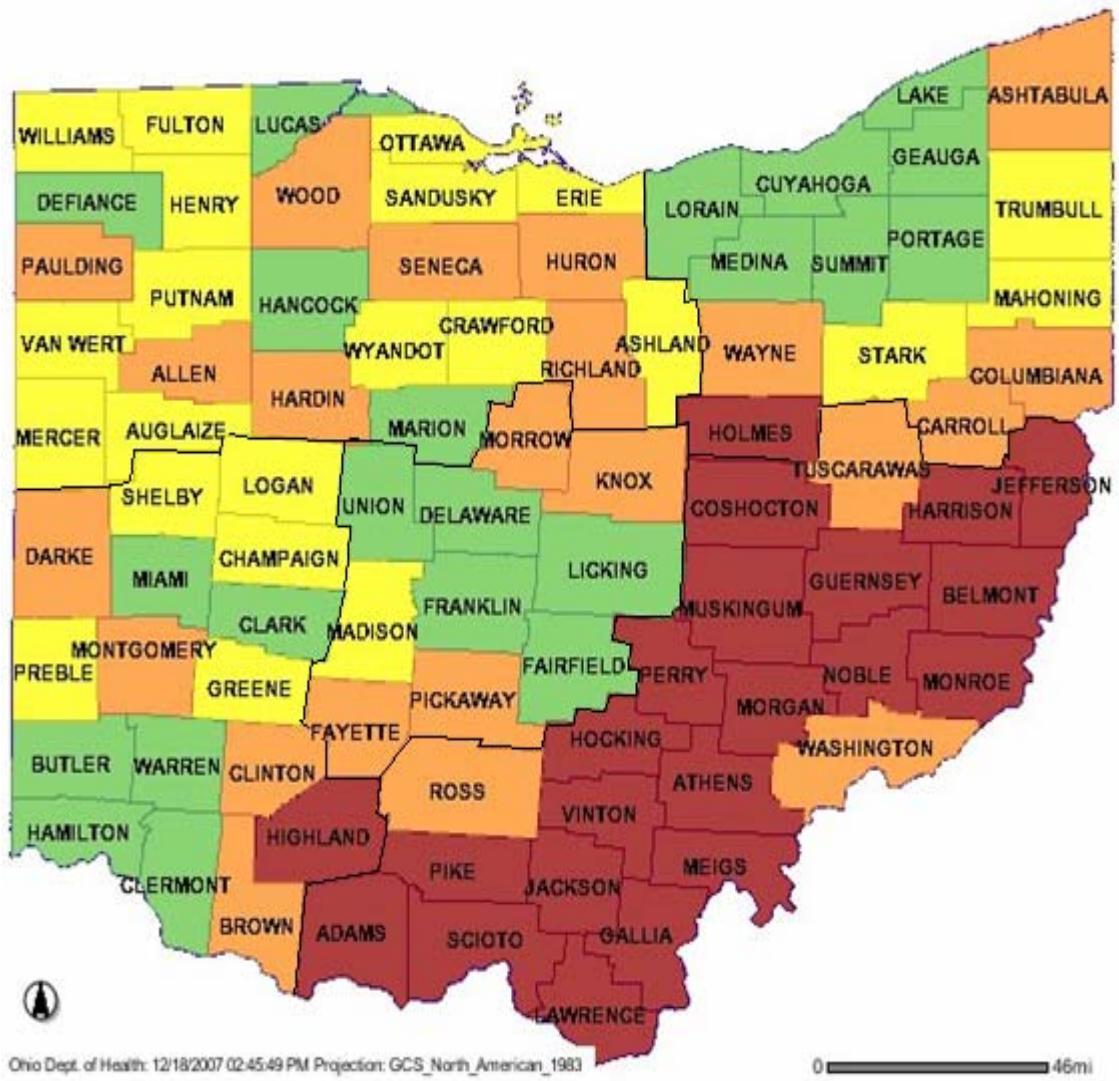


- **$32,900 - $45,199**
- **$45,200 – 53,699**
- **$53,500 - $66,299**
- **$66,300 - $114,000**

Figure 13. Average Median Incomes – Non Municipalities

- **$26,000 - $35,299**
- **$35,300 – 40, 599**
- **$40,600 - $46,799**
- **$46,800 - $68,000**

Figure 14. Percentage of Population that is 200 Percent of Poverty Level – Non Municipalities



- **32.3% - 44.8%**
- **24.7% - 32.2%**
- **19.5% - 24.6%**
- **12% - 19.49%**

An analysis of the socioeconomic data shows that for each region of the state, 2% of the annual median income falls within the range of projected annual costs for most system types (Table 22).

Table 20 Select regional socioeconomic data.

Region	Households	Total Resident Civil Population	Avg Median Household Value	Total population below 200% poverty	% population below 200% poverty	Avg Median Income	2% of median income
Northwest	415395	1161736	56941	278227	23.95	41686	833
Northeast	654276	1870372	81109	362104	19.36	49828	996
Central	170161	522092	58455	121162	23.21	43421	868
Southwest	621104	1759803	66927	408314	23.2	44489	889
Southeast	308760	850785	44040	305459	35.9	32999	660

Table 21. System type and total annual system cost.

System Type	Total Annual System Cost $
Septic tank to leach lines	336
Pretreatment to leach lines	588
Septic tank to sand mounds	672
Pretreatment to sand mounds	924
Drip distribution	1056
NPDES	660

System costs can also be considered in terms of the additional monthly bill that can occur if funds are borrowed to pay for the system. Considering average state system costs ranging from $7,500 to 19,000, at a rate of 6% installment loan for 120 months, monthly payments will range from $83 to $210. If the interest rate is subsidized, as available through the linked deposit program to 3%, monthly payments range from $72 to $183 per month. If costs are amortized over the terms of a 30-year mortgage, the additional monthly costs at 6% range from $45 to $113 per month.

Sewage treatment system costs can also be considered in terms of rates of inflation. Based on documented rates of inflation as determined by the Consumer Price Index, inflation has averaged 2.77% per year from 1983 to 2006. This equals a 63% increase in the cost of goods and services over this time frame. Considering an average state cost of $7,500 in 2007 for septic tank to leach lines, equivalent systems costs in 1983

would be $2,775. Based on inflation, it is reasonable to assume that system costs will increase an average of 2-3% per year.

To summarize the data presented in this section:

- Total costs for system replacement and alteration in Ohio for January to November of 2007 is estimated at $14,665,040, representing about 30% of the system installations annually
- Average true annual total costs for sewage treatment systems installed in Ohio ranges from $336 to $1056.
- Total annual sewage treatment system costs fall within the benchmark of affordability range of 2% of annual median household income across the state
- In contrast, state costs for sewer line installations since 1989 are over 1 billion dollars at a rate of 55 million per year.
- Average property owner costs to connect to public sewer of $25,000 plus an annual monthly sewer bill of $442.
- Illness costs for a disease outbreak associated with sewage can range from $0 to $25,000 depending on the health of the affected persons.

Safe Systems
Recommendations for Standards

U.S. EPA has identified the key elements of a successful sewage treatment system management program:

1. Clear and specific program goals,
2. Public education and outreach,
3. Technical guidelines for site evaluation, design, construction and operation/maintenance,
4. Regular system inspections, maintenance and monitoring,
5. Licensing and certification of all service providers,
6. Adequate legal authority, effective enforcement mechanisms and compliance incentives,
7. Funding mechanisms for state/local level programs and public assistance,
8. Adequate record management,
9. Periodic program evaluation and revisions.

ODH agrees that these program elements are critical for a successful sewage treatment system program at the state and local level. ODH believes that many of these program elements were incorporated into the requirements set forth in Chapter 3718.02 of the Ohio Revised Code. ODH recommends that those sections of Chapter 3718 of the Ohio Revised Code that were tolled under Am. Sub. H.B. 119 be retained after July 1, 2009.

Performance and Prescriptive Approaches to Sewage Treatment Standards and Management

Traditional sewage management programs at the state level focused on prescriptive requirements for set types of sewage treatment systems. Ohio's 1977 rules were fairly prescriptive in their approach, with specific requirements for four system types; septic tanks to leach lines, aerobic treatment units, surface/subsurface sand filters and privies. Prescriptive approaches lead to a number of critical program management problems as identified by U.S. EPA (2002), including insufficient funding and public involvement, inappropriate system design and selection process (need to consider and design to the site conditions), and poor inspection, monitoring and program evaluation components.

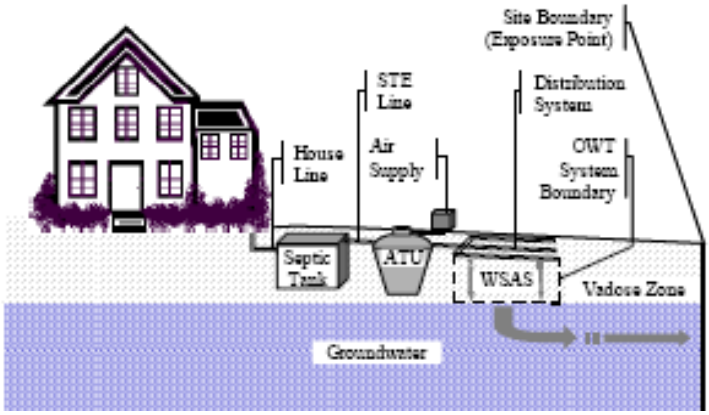
The need for improved approaches to sewage management nationally have led to the concept of performance based management programs. Many federal agencies, national organizations, academia, and private industry have worked together to develop a framework for performance based programs such as the Model Code developed by the National Onsite Wastewater and Recycling Association (NOWRA) and Hoover, et al. (1998).

Model framework for onsite wastewater management (NOWRA, 1999)

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

Performance ranges have been established for many alternative systems that operate under a range of site, wastewater load, and climatic conditions. A performance based management program makes use of the latest technologies and knowledge to design and select a system that best suites a site. Performance requirements provide the regulatory agency with an objective basis to oversee system siting, system selection and design, installation, maintenance, and monitoring of sewage systems in order to protect an identified resource or achieve a stated public health goal. Compliance with performance requirements is measured at a specified performance boundary that can be a physical boundary or a property boundary as demonstrated in Figure 15. The compliance boundary can also be the infiltrative surface where sewage effluent is in contact with the natural environment on a lot. For example, moderate treatment levels could be required in soils with lesser vertical separation distances if isolation distances are increased to ensure treatment is achieved by the time the effluent moves past the property boundary.

Figure 15. Schematic showing a site boundary for possible regulation.



U.S. EPA (2002) has identified the following key performance based program elements:

1) *Obtain or define legal authority to enact management regulations.*
2) *Identify management area and program goals.*
3) *Identify specific resource areas that need an additional level of protection, e.g., drinking water aquifers, areas with existing water quality problems, and areas likely to be at risk in the future.*
4) *Establish performance goals and performance requirements for the management area and specific watersheds, subwatersheds, or source water protection areas.*
5) *Define performance boundaries and monitoring protocols.*
6) *Determine and set specific requirements for onsite systems based on protecting specific management areas and achieving of a specified level of treatment (e.g., within a particular subbasin*
7) *Develop or acquire information on alternative technologies, including effectiveness information and operation and maintenance requirements.*
8) *Develop a review process to evaluate system design and system components*

Prescriptive regulatory codes that specify technologies for installation under a defined set of site conditions have worked reasonably well in the past in many localities. The use of this approach, in which baseline design requirements and treatment effectiveness are estimated based on the use of the specified technology at similar sites, will continue to be a key component of most management programs because it is practical, efficient, and easy to implement.

According to U.S. EPA (2002) many states have chosen to take a practical hybrid approach to sewage management that combines performance based objectives with some prescriptive technologies that have proven effective under known range of site conditions. Hybrid approaches can integrate risk assessment into the setting of performance standards and prescriptive requirements, with the consideration of economic factors as required by the legislature in Ohio.

The risk based approach values and prioritizes these higher sensitivity or priority resources and then considers appropriate treatment levels, design or management approaches for those resources and balances those requirements against socioeconomic factors such as cost. This can be accomplished in many ways including consideration of available engineering designs or systems that can provide adequate treatment or protection, by increasing vertical or horizontal isolation distances in those sensitive areas, or by increased inspection and monitoring of systems. Conversely, in areas of lower risk or sensitivity, such as areas with greater natural protective soils or geology or areas that are greater distances from vulnerable surface water bodies, the required treatment levels, engineering design requirements, or system inspection and monitoring frequencies could be less.

Performance levels can be established that define varying levels of treatment, from low treatment levels to levels that meet surface water discharge quality or body contact.

Based on a risk assessment approach, performance levels are then set for different resources areas like sensitive aquifers, or high quality watersheds. Another example of using different performance based treatment standards with regard to the sensitivity or ability of the soil to receive effluent would be to vary the level of treatment needed based on the depth to seasonal perched ground water.

Figure 16. Integrated risk assessment framework for sewage treatment systems (Jones, et al., 2004)

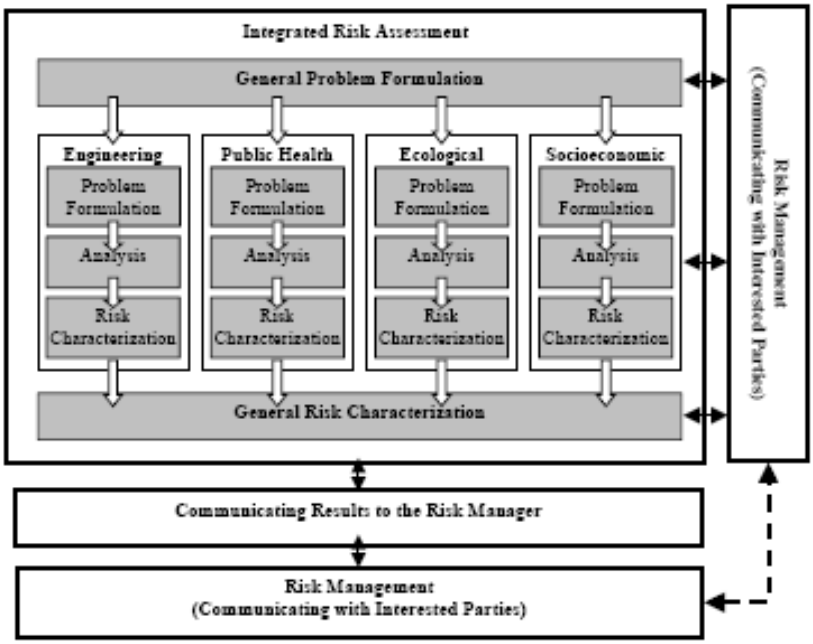


Figure 16 depicts an integrated risk assessment approach for establishing regulations. In developing the following recommendations for sewage treatment system siting, design, installation, monitoring and maintenance and abandonment, ODH considered the components outlined in this integrated risk assessment model. Prior sections of this report described the public health affects that result from improper treatment of sewage and the related risks to public health. Another section of this report described the soils and bedrock data for the state with regard to setting specific engineering standards (i.e. the vertical separation distances) and the relative risk to the different regions of the state. The identification and discussion of sensitive ground water conditions such as fractured sandstone areas, karst limestone or porous sand and gravel aquifers, and the delineation of source water protection areas for public drinking water supplies evaluates the risk to both public health and ecological or environmental factors. Finally, socioeconomic factors were analyzed and evaluated in the context of the final recommendations for systems that are provided in this report. ODH believes that using an integrated risk assessment model, the technical and economic analysis performed as part of this report can be used to establish combined performance and prescriptive standards with consideration of relative risk.

ODH also identified and considered other types of information believed to be important in providing sewage treatment systems recommendations, including an evaluation of the standards set by surrounding states, and the more stringent rules that local health districts have adopted and have been using for the last five months. This information is presented in the following sections, and then the final recommendations of the report are presented.

Comparison of Local Health District soil absorption standards and requirements

During the interim period set forth under Am. Sub. H.B. 119, local health districts may establish vertical separation distances and soil absorption requirements for sewage treatment systems. Local health districts that adopt more stringent rules are also required to provide a copy of the rules to ODH. A review of local health district rules reveals the following range of requirements:

Table 22. Summary of local health district interim rule requirements.

Requirement	**Survey Results - Number of County Health Departments**
Vertical Separation Distances Seasonal perched ground water Bedrock	 0 to 4 feet (39 at 2 ft, 10 at 18 inches, 13 at 1 ft, 2 at 8 in., 2 at 6 in., 9 at >0, and 4 do not consider seasonal perched water) All at 4 feet based on state law
System Sizing Basis	Tyler Table – 52 Adaptation of Tyler table to local conditions – 16 Set trench footage per bedroom - 23
Apparent Water Table (ground water) determination	20
Requirement for site and soil evaluation	All but 1 said yes
Requirements for soil scientists/designers for some or all sites	Yes – 59 Others use LDH staff
Use of soil depth credits	Yes- 59, No - 30

A complete listing of specific local health district rule requirements under this interim period can be found in Appendix 4. In summary, the majority of local health districts (49) set a vertical separation distance at 18 inches or greater, and an additional 13 established a vertical separation distance of 12 inches. The majority of local health districts use the Tyler Table or a similar adaptation for sizing the soil absorption area, and many local health districts require site specific site and soil evaluations. Many local health districts have noted that using the Tyler Table actually reduces the total

footage of absorption trenches as opposed to the prescriptive approach of 300 feet of leaching trench per bedroom under the state interim sewage rules.

Comparison of sewage treatment system standards from other Midwestern states with similar soils and geology

ODH contacted other Midwestern states surrounding Ohio to obtain information on requirements for site and soil evaluations, vertical separation distances used, loading rates, the types of soil based treatment systems used, the use of drains to lower the water table, system costs estimates if available, and the last year rules were adopted or revised. The states surveyed included Indiana, Pennsylvania, West Virginia, Kentucky, Michigan and Illinois. Appendix 5 provides the results of that survey.

To summarize this data:

- All states except Illinois require a site and soil evaluation to ensure proper system siting and design
- Vertical separation distances to the seasonal perched water table ranged from 18 to 48 inches. Some states required pretreatment with less vertical separation to the perched seasonal water table.
- Vertical separation distances to bedrock ranged from 16 inches to 48 inches with most states requiring pretreatment over fractured bedrock with lower vertical separation distances.
- All states use loading rate tables based on either soil evaluations or percolation tests.
- The types of systems used in all states are very similar to the types of system used in Ohio today.
- Four states allow the use of drains with certain design specifications. Two states do not typically allow the use of artificial drainage to lower the water table.
- Two states had revised their rules since 1990, 3 states had revised rules since 2002, one state had no statewide rules (Michigan).
- Limited system cost data from 3 states was provided with costs ranging from $3,000 to 15,000.

Recommendations for Sewage Treatment System Siting

1. Requirement for a site and soil evaluation for new system installations or replacements (soil evaluation waived where lot conditions dictate off-lot discharge due to size, etc.)

2. Local health districts should be provided the option of using trained local health district staff for site and soil evaluations or the use of trained professionals, with recognition of national or state certifications of such professionals.

3. Proactive approaches to system siting in subdivisions or other developments with consideration of local planning, zoning, availability of existing or projected sanitary sewers, and support for innovative system siting practices such as conservation developments. Local health districts should be proactively involved in review of proposed subdivisions.

4. Local consideration of sensitive hydrogeologic or watershed conditions as related to higher density system areas.

5. Requirements for soil based systems for new lots, with systems meeting reasonable isolation distances from properties, and water resources.

6. Continue the use of the General NPDES permit and allow discharging systems where existing on-lot or off-lot systems have failed, and the only option is a discharging system that meets effluent quality standards.

7. Continue prohibitions on discharge to high risk conditions such as sinkholes and dry wells, discharge to water resources without NPDES authorization, sanitary isolation radii of public water supplies, etc.

Site and soil evaluations are the fundamental basis for ensuring that systems designs will effectively treat sewage, prevent or minimize ponding in yards, and promote system sustainability for 30-40 years or more. A careful site evaluation should include consideration of the landscape, slope, vegetation, drainage, erosion and other natural features. Site evaluations should identify specific risk factors such as the presence of fractured bedrock or other sensitive conditions. Detailed site soil descriptions through the use of hand augers or test pits are necessary to clearly determine the presence of limiting conditions such as seasonal perched water table, bedrock, fragipans or thick clay layers such as dense till. Consistent evaluation of soil conditions through the use of a standardized form will help ensure uniform system performance statewide.

The majority of local health districts historically and currently have continued to use site and soil evaluations under the interim rule period. The majority of surrounding states also require the use of site and soil evaluations, and this practice is recognized in the national technical literature as a basic fundamental requirement to support safe, proper and sustainable system designs.

Recommendations for Sewage Treatment System Design

1. Establish a system performance goal of sewage system safety through effective treatment designs and standards.

2. Work with the state and national organizations to establish standards for sewage treatment system tanks, dosing or treatment tanks, etc. to ensure watertightness and structural integrity.

3. Continue the use of the Tyler Table (Tyler, 2001; Tyler and Kuns, 2000) for determining soil and linear loading rates for system designs to ensure hydraulic performance of systems. The soil loading rate tables developed by Tyler (2001) and Tyler and Kuns (2000) for use in Ohio soils provide loading rates using either septic tank or pretreated effluent, with consideration of soil texture and structure, and site hydraulic linear loading based on slope and distance to the limiting condition.

4. Allow for a 25-30% reduction in the size of the total soil absorption area needed when pretreatment is used to reduce the levels of total suspended solids or biochemical oxygen demand to less than 30 mg/l each. This reduction is provided under the sizing specifications in the Tyler Table using pretreated effluent.

5. Establish vertical separation distances for low to high-risk site receptors such as seasonal perched water versus fractured bedrock or sand and gravel aquifers. Require a minimum vertical separation distance to the seasonal perched water table or other limiting conditions of 18 inches and a minimum vertical separation distance to fractured bedrock and coarse sand and gravel formations of 36 inches.

Receptor	**Relative Risk**	**Vertical Separation Distance Needed**
No limiting condition	Low	Minimum of 18 inches
Seasonal perched water table	Low to Moderate	18 inches
Ground water/drinking water source	High	36 inches
Fractured bedrock or karst limestone	High	36 inches
Coarse Sand and Gravel	High	36 inches

6. Authorize a minimum of 6 inches of suitable soil above limiting conditions such as seasonal perched water table and 12 inches of suitable soil above fractured bedrock or coarse sand and gravel with pretreatment, as long as the infiltrative surface is placed into the native soil. (Can be combined with the use of artificial drainage in identified soils to address seasonal perched water table conditions)

7. Establish levels of system or component treatment performance with base treatment equivalent to a conventional septic tank to soil absorption system, and increasing treatment levels based on nationally accepted treatment standards for use in higher risk sites or conditions. Manufacturer's produce components that already design and treat to these national standards. Establish the performance boundary as the infiltrative surface to the soil.

Vertical Separations Distance Required to the Receptor	**Minimum Treatment Level**	**Treatment Value at the Infiltrative Surface**		
		BOD	**TSS**	**Fecal coliform**
Seasonal perched water at 18 inches Bedrock, sand and gravel at 36 inches	T1 – primary	300	300	10,000,000
Seasonal perched water at 12 inches Bedrock or sand and gravel at 24 inches	T2 – secondary	30	30	10,000
Seasonal perched water at 6 inches Bedrock or sand and gravel at 12 inches	T3 – advanced secondary	<30	<30	1,000
Seasonal perched water - 0 –6 inches Bedrock or sand and gravel at 12 inches	T4 - NPDES	15	18	2,000 *also includes ammonia of 2.0 to 4.5
Seasonal perched water at 0 - 6 inches Bedrock or sand and gravel at 12 inches	T5 – surface application – body contact	10	10	200
Seasonal perched water at 0 - 6 inches Bedrock or sand and gravel at 12 inches	T6- wastewater reuse	5	5	<20

8. Establish methodologies to reduce the vertical separation distance required for sites by:
    a. The use of pretreatment components that reduce the total number of fecal coliforms, BOD and TSS to specified treatment levels to reduce the total native soil thickness needed at a site as listed in the table.
    b. Utilize artificial drainage as described in recommendation number 9 for a maximum of 1 foot reduction in the elevation of the perched seasonal water table in approved soils
    c. System elevation at a 1 to 1 ratio of thickness
    d. Timed microdosing at 0.25 gallons per day per foot squared for a 1 foot reduction in soil thickness.

9. Allow the use of artificial drainage at sites where specific soil and topographic conditions can support their practical use and installation to achieve reasonable lowering of the seasonal perched water table for a maximum of a 1 foot reduction. These soils are to be identified based on current soil/water table modeling being conducted by the Ohio State University. Continue the use of interceptor drains to divert water from soil absorption areas.

10. Establish minimum standards for commonly used systems that have known performance under specified site conditions, i.e. septic tanks to soil absorption systems in unsaturated soils, sand mounds with pressure distribution or timed-micro-dosing with drip distribution using adequate separation distances to limiting conditions.

11. Continue to allow the use of alternative aggregate or chamber products in soil absorption systems.

12. Conduct a statewide evaluation to determine the need for nitrogen or phosphorous performance standards for systems located in highly sensitive surface or ground water areas.

13. Continue the use of the Sewage Treatment Systems Technical Advisory Committee to evaluate and provide recommendations on new system technologies to allow more rapid implementation across the state.

The following example shows how these recommendations can work to offer an economic system design in an area where seasonal perched water is at 12 inches from the surface. At this hypothetical site, one or more options can be used to make up for the additional 6 inches needed to meet the VSD required to seasonal perched water of 18 inches (and retain 6 inches of native soil). The property owner could do one of the following:

1. Select a pretreatment device that treats to treatment level TS2 combined with shallow trenches set 6 inches into the soil with two inches of fill material.

2. Select a pretreatment device that treats to level TS2 and use an artificial drain where the soils are approved.
3. Install a shallow, 1 foot high sand mound with pressure distribution.
4. Install a pretreatment device to TS4 – NPDES level and still go into the soil recognizing that ponding of water may occur in the yard during certain times of the year.
5. Install a pretreatment device to achieve level TS5 and spray irrigate the soil absorption area.

Upon consideration of the cost data and employing a risk-based approach, ODH has made several key changes in the recommendations for system design. The recommended vertical separation distance is reduced from 2 feet in the prior rules to 18 inches. ODH has also reduced the vertical separation distance needed with increasing levels of treatment, and with advanced levels of treatment, trenches may be placed just above the seasonal perched water table. The minimum thickness of suitable soil recommended is 6 inches versus the 12 inches required in the 2007 rules. ODH is recommending that artificial drainage may be used in soils that can be effectively drained with proper design and installation, which was disallowed in the 2007 rules.

These proposed performance and risk based recommendations offer a variety of economical system options to address limiting conditions, especially seasonal perched water table conditions that are present on many sites in Ohio. Total monthly system costs as collected from permit data reported are within the range of the benchmark of affordability as set by U.S. EPA for public sewer rates. Property owners have the ability to choose a variety of system designs and configurations using pretreatment where needed, or other methodologies as listed, to reduce the vertical separation distance where a limiting condition such as perched seasonal water is shallow. This risk based approach allows for the use of more traditional soil absorption systems using either traditional aggregate on alternative aggregate options.

Recommendations for Sewage Treatment System Installation

1. Recommend the continued use of local health district for system application, permitting, installation inspection and review.

2. Recommend continuing the requirement for registration of sewage treatment system installers, service providers and septage haulers with demonstration of competency through the use of state and national certification programs, competency testing, and requirements for continuing education. ODH recommends accepting past state testing achievement by contractors when new rules are adopted.

3. Recommend the use of nationally recognized and developed best standards of practice for sewage treatment system installations, especially those practices

that are protective of site conditions, soils and replacement areas, and those practices that ensure proper installation for system sustainability and consumer protection.

4. Recommend the requirement for the submittal of design plans and minimum design plan contents, and the requirement for as-built drawings or similar information to ensure records of actual system installation specifications are maintained for future troubleshooting, system diagnostics or repairs.

ODH suggests that system record keeping requirements for system designs and as-built drawings can be simplified from those required previously in the rules.

Recommendations for Sewage Treatment System Abandonment

1. Recommend the use of nationally recognized best practices for system abandonment based on the system type installed on the site.

2. Recommend the requirement for notification to local health districts when a system is to abandoned, and proper and thorough documentation and record keeping for systems that are abandoned.

Recommendations for system operation, monitoring and maintenance

1. Recommend the use of a proactive and preventive approach to managing sewage treatment systems that combines public education, local health district involvement, local planning and management factors, and consideration of area risks to sensitive water or ecological resources.

2. Continue the use of operation permits through local health districts with the provision of flexibility to establish local operation and maintenance management programs that recognize priority protection areas, high risk water or ecological resources, or existing unsanitary conditions due to a high incidence of system substandard performance or failure.

3. Rely on the system manufacturer's recommendations for proper system operation and maintenance and require service contracts where recommended by the manufacturer or as recommended by the Sewage Treatment Systems Technical Advisory Committee as part of system or component approval.

4. Recommend the continued option for establishing household sewage treatment management districts to help provide proactive or responsive approaches to resolve sewage treatment problems in an area.

5. Recommend continued requirements for the management of system residuals and the collection, transportation, disposal and land application of septage in accordance with CFR Part 503 federal regulations. Allow for local decisions regarding the use of land application of septage as a treatment and disposal practice.

6. Recommend coordination with Ohio EPA, and the Operator Training Committee of Ohio to promote wastewater treatment plant acceptance and knowledge of domestic septage, and provide low interest loans and other incentives to existing wastewater treatment facilities for plant upgrades to allow the ready acceptance of domestic septage to ensure adequate treatment facilities statewide.

Recommendations for Progressive System Repairs

1. Continue to recommend that system repair be the first option considered for correcting a failing system, and when that is not possible, then consideration of options for system replacement.

2. ODH recommends the review and development of a progressive, step-wise approach where possible for repair of failing or substandard systems that are creating public health nuisance conditions or contamination of water resources.

3. A progressive, step-wise approach would allow the incremental replacement or alteration of system components as appropriate for site conditions to allow the system owner to gradually upgrade the existing failing system and minimize immediate system replacement costs.

4. ODH recommends the evaluation of the use of pretreatment components and other system rejuvenation products or procedures, through the Sewage Treatment System Technical Advisory Committee, as a means to repair failing systems where appropriate, and to help ensure consumer protection.

ODH recommends that addition of a rule that specifically addresses options for progressive, stepwise repairs of existing systems with consideration of costs while achieving elimination of nuisance conditions.

Additional recommendations

ODH does recommend that any proposed future legislative changes to Chapter 3718 of the Revised Code continue to include:

1) Clear direction on the public health goal that sewage systems need to achieve, and a mechanism to ensure public education and outreach, and state level program funding (RC 3718.02, 3718.05).

2) The requirements for the registration and continuing education of all installers, service providers and septage haulers (contractors) should be continued to help ensure a level playing field for the sewage system market in Ohio, which helps control and even out costs statewide. Recognition of national contractor certification programs and resulting continuing education should be continued and encouraged.
3) Local health districts clearly need the ability to provide for funding of local sewage programs and adequate enforcement capability to deal with public health nuisance and contamination conditions and clear and expeditious mechanisms to correct problem situations to help reduce negative impacts to neighbors, communities and watersheds (RC 3718.06, 3718.08, 3718.09. 3718.10 and 3718.99).
4) Continuation of program survey authority for ODH and records management for local health districts to help ensure the consistent implementation of the program statewide (RC 3718.07).
5) Continuation of the use of the Sewage Treatment Systems Technical Advisory Committee to provide a mechanism for the rapid approval of new system technologies (RC 3718.03 and 3718.04) and continuation of the Sewage Treatment System Innovation Fund.
6) Continuation of local health district discretionary permitting of small flow onsite sewage systems (RC 3718.021).

And further, ODH recommends:

7) ODH would seek the assistance of the Study Commission to help identify the incentives that may be used to help achieve the program goals, and help property owners repair, replace or build new systems that ensure treatment while being cost effective, sustainable, and protective of their investment in their property.
8) Support pilot programs or seek new funding for innovative or alternative funding mechanisms to assist with repairs, replacements, and new installations for low to moderate-income property owners. Please refer to the following section for recommendations for financial and management solutions.
9) Continued compliance with the five-year rule review requirement established in statute to promote continuous program improvement and recognition of new technology and research.

System Costs
Recommendations for Financial and Management Solutions

The information provided in this report on system alternatives, costs and economics has shown that conventional and alternative systems can be affordable in Ohio while still providing adequate protection of public health and the environment. ODH recognizes, however, that replacement of an existing system can present a significant financial hardship to some property owners, and can impact the affordability of new homes for certain income groups. While annual and monthly true sewage treatment system costs can be demonstrated to be within the range of national benchmarks of affordability, the reality is that some homeowner are unable to afford an initial large system replacement cost, due to either monthly cash flow restrictions, or creditworthiness, or both. Similarly, families seeking to own a home may have limitations on the amount of money they can afford or qualify to borrow.

Current research indicates that households earning below the 200% poverty level have no discretionary funds for household repairs such as replacement of a failing sewage system. Using the socioeconomic data from the 2000 Census for households outside of municipal boundaries, an estimate can be made of the number of households below the 200% poverty level in each region and the state total (Table 23).

Table 23. Total number of households outside of municipal boundaries for each region earning below 200% of the poverty level.

Region	Households	Avg Median Household Value	Total population below 200% poverty	% population below 200% poverty	No of households below 200% poverty level	Avg Median Income
Northwest	415,395	56,941	278,227	23.95	99,487	41,686
Northeast	654,276	81,109	362,104	19.36	126,667	49,828
Central	170,161	58,455	121,162	23.21	39,494	43,421
Southwest	621,104	66,927	408,314	23.2	144,096	44,489
Southeast	308,760	44,040	305,459	35.9	110,844	32,999
Totals	2,169,696				520,588	

ODH believes that systems experiencing failure are equally distributed across income levels, and has no data to show otherwise. This data shows that approximately 520,000 homes statewide earn below 200% of the poverty level representing 24% of the state total number of households (outside of municipal boundaries). Based on historical information collected by ODH from local health districts, approximately 10,000 to 13,000

sewage permits are issued each year (2007 being non-typical due to the large number of permits issued in 2006 and economic conditions). Assuming that 20% of these permits are associated with system replacements (based on the 2007 permit data), then an estimated 2,600 systems would require replacement annually (20% of 13,000 systems). This would then equal approximately 520 (24% of 2,600) households annually that would likely need financial assistance to replace a failing system. Based on 2007 reported data, the average new system installation costs are $8,100. Providing 100% of system cost funding would be $4.2 million, and 50% of system cost funding would be $1.2 million annually. In comparison, based on the examples provided in this report under the County/Community Cost section, the average cost to install public sewers was $20,000 per household (not including connection and annual fees).

Given these financial challenges, ODH has worked with state and federal agencies to identify existing financial resources that are available in the form of grants and low-interest loans, and proposed new ways to provide for local financing of systems. ODH and the Ohio Water Development Authority (OWDA) have also conducted research on financing or cash management options that have been used in other states.

Existing Financial Resources to Assist System Owners

Some existing state and federal financial resources are available to assist property owners with system repairs or replacements. The most commonly used financial assistance resources used by system owners are the Ohio Department of Development (ODOD), Community Block Development Grants/Community Housing Improvement Program (CBDG/CHI). These funds are competitive, and in high demand. The allocation of funds for project types is established locally; total funds available are typically exhausted before the end of the fiscal year. Another commonly used resource is the U.S. Department of Agriculture, Rural Development, 502 Home Ownership and 504 Home Repair Grants and Loans. These loans and grants set specific income and eligibility requirements and can be used to repair or replace sewage treatment systems.

Other possible, but less commonly used resource include Federal Housing Administration HUD funds and the Ohio Housing Trust Fund. Another existing source of funding that has not been commonly used statewide, but can be widely available, are linked deposit funds established through local banking institutions through subsidization of bank loans by the Water Pollution Control Loan Fund through Ohio EPA. This program requires local health districts to coordinate with Ohio EPA to determine levels of failing systems within a county, establish a management plan, and in turn, Ohio EPA works with local banks to buy down interest rates for qualified loan applicants. Ohio EPA has $10 million available to commit to this loan program that is currently in use in 9 counties. Challenges to the use of this program are local health district interest, creditworthy loan applicants, and relatively short loan terms (set by the bank) of 5-10 years maximum.

Alternative Funding Sources

The OWDA conducted a survey of five states to determine funding of home septic systems (Grossman, 2007), and summarized the level of funding spent by states using the Clean Water Act, State Revolving Loan Funds for individual or decentralized treatment from 1987 through mid – 2006. This survey showed that states use direct assistance loan programs through state agencies or housing authorities targeted for system replacements, or through loans provided to various local government agencies that in turn loan the funds under various terms to system owners. Funding sources include state general revenue funds and federal state revolving loan funds.

OWDA has suggested a funding model whereby county governments can apply to either the OWDA for the Ohio EPA State Revolving Loan Fund for a low interest loan (i.e. 1-2%). The county government could then in turn provide loans to system owners in their county at a slightly higher rate, and keep the interest for administration of the loan program. The county government would set the terms and qualifications for the loan, and can place loan defaults on the tax assessment if necessary. County governments often have existing management structures in place to administer loans through their local programs that implement CBDG or CHIP programs. Counties may also choose to use interest accrued to provide grants at their discretion.

Other funding or financial management models have been proposed or implemented in other states. These models involve the use of a responsible management entity (RME), which can be either public or private in organization. An RME is defined as a legal entity that has the technical, managerial, and financial capacity to ensure viable long-term, cost-effective, centralized management, operation, and maintenance of decentralized wastewater systems in accordance with regulations and generally accepted accounting principals (English and Yeager, 2002). Viability is defined as the capacity for the RME to provide these services to protect public health and the environment consistently, in perpetuity, and at a minimal cost to taxpayers.

Public sector management entities include county sanitary districts, or water and sewer districts. Private sector management entities include utilities, rural cooperatives, or privately owned and operated utilities. The premise of the responsible management entity model is that the entity has sufficient capital to pay for the installation of a replacement or new system on private property within the district, is responsible for the operation and maintenance of that system, and the property owner pays a monthly bill for the service. This helps property owners with the initial large cash outlay that occurs with a replacement system, or assist property owner who are having difficulty funding a system under a new loan. Easements or other legal agreements between the property owner and the public management entity may be necessary. County sanitary districts and water and sewer districts in Ohio already have statutory authority to finance, build

and manage public water and sewage services, and the installation and management of decentralized sewage services is a logical extension of the services these public entities could provide. These districts have sufficient financial authority to apply for and access funds, impose service charges or special assessments on properties, and issue revenue or special assessment bonds. Deitzmann and Gross (2003) discuss an example of a public water supply district that is providing centralized management of decentralized systems in Missouri.

County sanitary districts or water and sewer districts who manage the replacement and operation of failing on-site systems may be a less expensive approach for some areas than extension of public sewer lines and expansion of wastewater treatment plants. Cost savings through the implementation of a decentralized approach to waste management for small communities and villages has already been demonstrated in Amesville, Ohio as discussed in the section on Documented Community/County Costs.

A similar approach for decentralized management is feasible through a privately owned utility or a rural cooperative utility. The utility pays for system installation, and manages the operation and maintenance of the system, and the property owner pays a monthly bill. This approach helps property owners manage cash flow and outlay issues that are common to replacement situations, and can also be applied to new home construction for those who are unable to merge system costs into the traditional mortgage. A private utility approach to decentralized wastewater management has been implemented in Tennessee (Stiles, 2002).

Given the possible range of financial and management options presented in this section, ODH recommends that the Study Commission further review and evaluate these options, and recommend implementation of one or more pilot projects in Ohio to evaluate the possibility for expanded implementation in more areas of the state. These approaches could provide very cost effective solutions to correcting existing areas of failing systems, and adequate financing to achieve this goal is feasible through existing federal and state funding programs, or through private capital investments.

References

Centers for Disease Control and Prevention, 2006. Surveillance for Waterborne Disease Outbreaks Associated with Drinking Water and Water not Intended for Drinking- United States, 2003-2004. Morbidity and Mortality Weekly Report. Volumber 55, No. SS-12, pps. 31-65.

Converse, J.C. and E.J. Tyler, 1998a. Soil Dispersal of Highly Pretreated Effluent – Considerations for Incorporation into Code. Proceedings of the Seventh Annual Confeence, National Onsite Wastewater Recycling Association, Northbrook, Ill.

Converse, J.C. and E.J. Tyler, 1998b. Soil treatment of aerobically treated domestic wastewater with emphasis on modified mounds. On-Site Wastewater Treatment: Proceedings of the Eighth National Symposium on Individual and Small Community Sewage Systems, ed. D.M. Sievers, American Society of Agricultural Engineers, St. Joseph, MI.

Deitzmann, E.M. and M.A. Gross, 2003. Phelps County Update: Case Study of a Public Water Supply District Providing Centralized Management of Decentralized Wastewater. Small Flows Quarterly, vol. 4, no. 3, National Small Flows Clearinghouse, pps. 25-34.

Dumouchelle, D.H. and D. M. Stoeckel, 2005. Preliminary Investigation of Wastewater-Related Contaminants near Home Sewage Treatment Systems in Ohio. U.S. Geological Survey Open File Report 2005-1282. 31 pp.

English, C.D. and T.E. Yeager, 2002. Responsible Management Entities as a Method to Ensure Decentralized Wastewater System Viability. Small Flows Quarterly, vol. 3, no. 2, National Small Flows Clearinghouse, pps. 25-35.

Grossman, S., 2007. Survey of State Funding of Home Septic Systems. Ohio Water Development Authority. 5 pp.

Hoover, M.T., D. Seivers, and D. Gustafson, 1998. Performance standards for on-site wastewater treatment systems. Proceedings of the Eighth National Symposium on Individual and Small Community Sewage Systems. American Society of Agricultural Engineers, St. Joseph, MO. pps. 346-355.

Jones, D. S., R. A. Efroymson, A. Q. Armstrong, M. D. Muhlheim, and S. A. Carnes. 2004. *Integrated Risk Assessment for Individual Onsite Wastewater Systems*. Project No. WU-HT-01-18. Prepared for the National Decentralized Water Resources Capacity Development Project, Washington University, St. Louis, MO, by Oak Ridge National Laboratory, Oak Ridge, TN. Iii.

Mancl, K., 1990. A Survey of Small Sewage Treatment Facilities in Ohio. Ohio Journal of Science, Vol. 90(4), pps. 112-117.

Morrone, M., and T.J. Ryan, 2000. Ohio County Health Professionals Assessment and Perception of Environmental and Human Health Conditions. Ohio Journal of Environmental Health, January-February, 2000, pps. 19-21.

National Center for Environmental Health, 2005. Environmental Health Assessment for Epi-Aid 2004-076: Outbreak of gastroenteritis with multiple etiologies among resort island visitors and residents—Ohio, 2004. Division of Emergency and Environmental Health Services, Environmental Health Services Branch, Technical Assistance Team, 74 pp.

Ohio Department of Health, 2005. Director Investigation of Gastrointestinal Illness, South Bass Island, Lake Erie, August 2004, 6 pp.

Ohio EPA, 1995. State of the Environment Report. Ohio Comparative Risk Project. Ohio EPA, December, 1995. pps. 71-86.

Ohio EPA, 2004 – Clean Watershed Needs Survey data tables.

Ohio EPA, 2005. South Bass Island, Ottawa County, Gastrointestinal Illness Summer 2004, Ohio Environmental Protection Agency Investigation and Actions. 48 pp.

Ohio EPA, 2006. 2006 Sewer and Water Rate Survey. Office of Fiscal Administration, Economic Analysis Unit.

Ohio EPA, 2007. Map of aquatic life use impairments with failing on-site systems identified as a contributing source (1995 –2004 data). Division of Surface Water.

O'Reilly, C.E., 2005. Epi-Aid # 2004-076 Final Trip Report: Outbreak of gastroenteritis with multiple etiologies among resort island visitors and residents – Ohio, 2004. Centers for Disease Control and Prevention, Foodborne and Diarrheal Disease Branch, DBMD, NCID (A-38), 55 pp.

Ohio Water Development Authority (OWDA), 2006. Ohio Water Development Authority, tables of Water Related Environmental Infrastructure by County.

Salvato, J.A., 1992. Environmental Engineering and Sanitation. Fourth Edition. John Wiley and Sons, publisher. 1417 pps.

Siegrist, R.L., E.J. Tyler, and P.D. Jenssen, 2000. Design and Performance of Onsite Wastewater Soil Absorption Systems. National Research Needs Conference, Risked Based Decision Making for Onsite Wastewater Treatment, Washington University, St. Louis, MO.

Stiles, N., 2002. Brothers Create First Onsite Wastewater System Public Utility in Tennessee. Small Flows Quarterly, vol. 3, no. 2, National Small Flows Clearinghouse, pps. 22-23.

Tyler, E.J., 2001. Hydraulic Wastewater Loading Rates to Soil. Proceedings of the 9th International Symposium on Individual and Small Community Sewage Systems. ASAE. Saint Joseph, MI. pps. 80-86.

Tyler, E.J. and L.K. Kuns., 2000. Designing with Soil: Development and Use of a Wastewater Hydraulic Linear and Infiltration Loading rate Table. Conference Proceedings. National Onsite Wastewater and Recycling Association. Grand Rapids, MI.

U.S. EPA, 2002. Onsite Wastewater Treatment Systems Manual. Offices of Water and Research and Development. EPA/624/R-00/008.

U.S. EPA, 2004. Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems. Office of Water. EPA 832-B-03-001, March 2003, 62 pp.

www.epa.state.oh.us/dsw/tmdl/index.html, 2007.