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Decentralized Small Community Wastewater Collection Systems

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Wastewater is a significant source of carbon, *sediment*, *nutrients*, *pathogens*, and other potential pollutants. Reducing the quantity of these contaminants before they are discharged to either *groundwater* or surface water is essential to preserve or enhance water quality in receiving waters. This is accomplished through the installation of wastewater treatment and collection systems. The form of these systems can vary substantially. In Virginia, they range in size from 5,000 to 50,000 gallons per day; 49 percent are public systems and the remainder are private (Parten 2008).

All wastewater systems (those serving large and small communities) have a *collection system*. Large communities (i.e., those with more than 2,000 households) tend to use *centralized wastewater systems* in which wastewater is conveyed to a single treatment facility. Smaller communities (i.e., those with 2,000 households or fewer) typically address wastewater management needs differently due to cost. Collection systems that serve households in a small community are widely variable and must adapt to the unique conditions of each. Systems range from an *on-site wastewater system* for single households with a *septic tank* and *drainfield*, to a *cluster wastewater system* or *decentralized wastewater system* for small communities in which wastewater is conveyed to one or more off-site treatment locations. Decentralized systems consist of a unique combination of collection, treatment, and *disposal systems* that are selected based on the characteristics of the community, number of households being served, and the need to minimize capital and maintenance costs (Buchanan et al. 2010). A case study of a decentralized wastewater system is provided by McDilda (2007), which was implemented to replace several individual on-site wastewater systems serving lakeside homes in Minnesota.

The objective of this publication is to provide an overview of decentralized wastewater systems, in particular, small cluster wastewater systems that collect wastewater from a group of homes. This publication is not intended to cover single, on-site septic systems. The reader is referred to "On-Site Sewage Treatment Alternatives," Virginia Cooperative Extension publication 448-407, and "Virginia Farmstead Assessment System: Household Wastewater Treatment and Septic Systems," VCE publication 442-903; for operation of these systems on mined lands, see "On-Site Treatment and Disposal of Residential Wastewaters on Mined Lands," VCE publication 460-142. The intent of this fact sheet is to provide guidance for selecting among alternative collection and *treatment systems* for a small community. A list of references and additional resources with information about decentralized wastewater system design, financing, and operation is also provided.

What Is in *Domestic Wastewater*?

Modern households use significant quantities of water. Understanding the household *water budget* is useful in assessing the potential size of the *wastewater treatment system* needs. According to Mayer et al. (1999), indoor water use, after subtracting for leakage, is approximately 59.8 gallons per capita (person), per day. Fortunately, indoor water use is gradually decreasing as new homes are built and existing homes are renovated under

This fact sheet updates and replaces "Small Community Wastewater Collection Systems" by C. Zipper, VCE publication 448-405 (out of publication).

Terms italicized on first use in the text are defined in the glossary at the end of this fact sheet.

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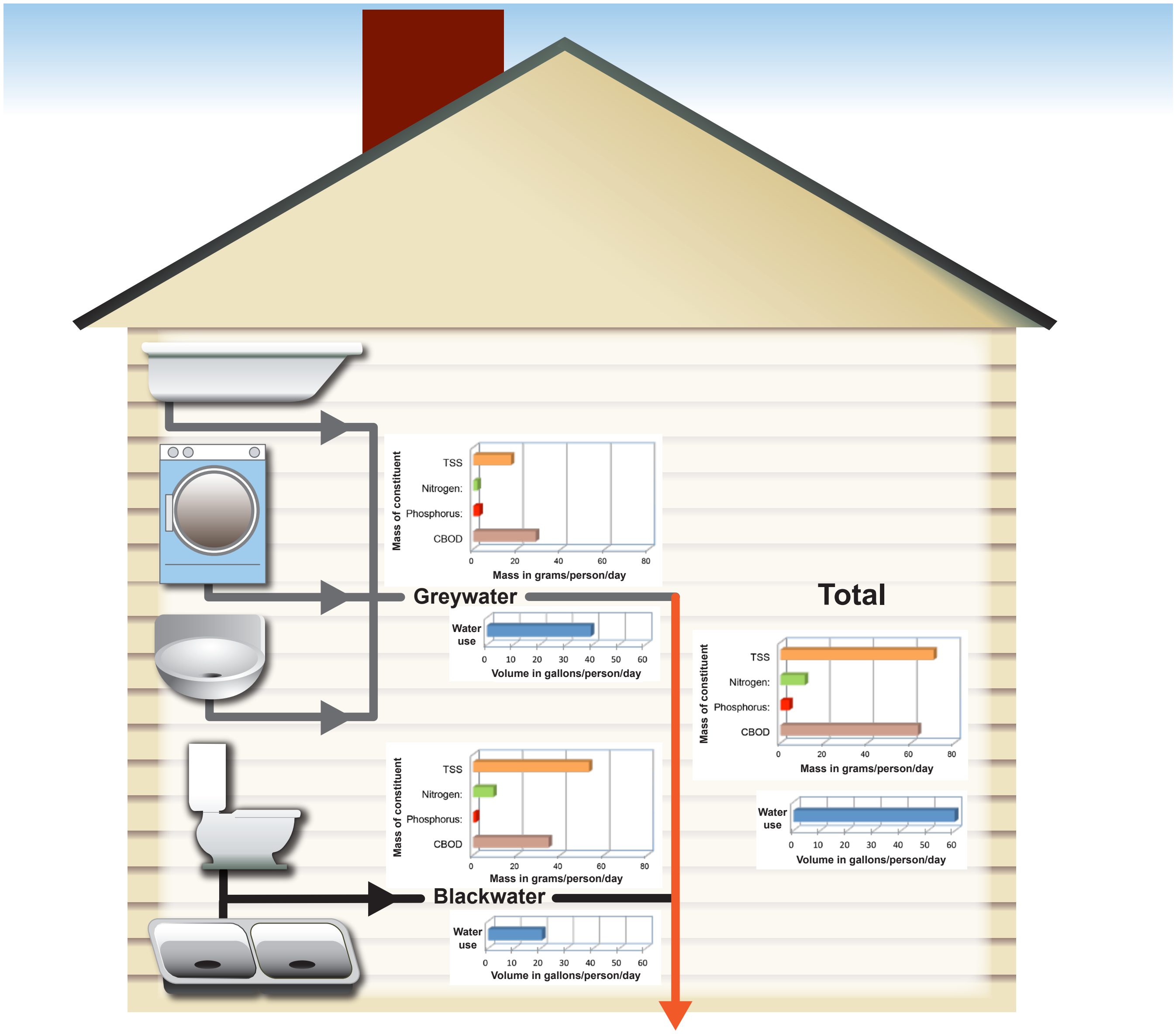

Figure 1. Typical wastewater in gallons per capita, per day and constituents in grams per person, per day generated from a single household. These constituents are expressed as mass loads instead of concentrations as demand (which affects dilution volume) is likely decreasing with water conservation, resulting in increasing concentrations, whereas the mass load will remain the same. Units in mixed form as they commonly are found. To convert gallons to liters, multiply by 3.785. To convert grams to pounds, multiply by 0022.

Note: TSS = total suspended solids, a measure of sediment; CBOD = *carbonaceous biochemical oxygen demand*.

Sources: Water use by Mayer et al. (1999), CBOD and sediment by Siegrist (1978), nitrogen and phosphorus by Herrmann and Klaus (1997).

newer *water-conservation*-oriented building codes and leaks are reduced. Wastewater can be separated into *graywater,* which includes wastewater from bathroom sinks, bathtub/shower drains, clothes and dishwashers, and *blackwater*, which includes wastewater from toilets and kitchen sinks (figure 1). Graywater averages 39.3 gallons per capita, per day, and blackwater averages 20.5 gallons per capita, per day.

Figure 1 provides an estimate of the average *mass load* of biodegradable carbon, *nitrogen*, *phosphorus*, and *total suspended solids* (TSS) — a measure of sediment in wastewater on a basis of grams per capita, per day (gcd). Graywater is not clean water, but because of the absence of toilet waste, it is much lower in sediment and nitrogen than blackwater, has slightly less biodegradable carbon, but has slightly more phosphorus content (Siegrist 1978). In some cases, graywater can be treated and reused. For more information on *water reuse*, see "Water Reuse: Using Reclaimed Water for Irrigation," VCE publication 452-014. The total waste load leaving the household in figure 1 is 63.2 gcd biodegradable carbon, 11.2 gcd nitrogen, 4.1 gcd phosphorus, and 70.4 gcd total suspended solids (Herrmann and Klaus 1997; Siegrist 1978). This load is generalized for residential use only. Commercial and industrial use should be evaluated on a case-by-case basis.

Why Is Wastewater Treatment Needed in Small Communities?

As communities get larger and population density increases, the quantity of biodegradable carbon, nutrients, sediment, and pathogens in wastewater discharges increases, as well as the subsequent impacts on the environment. Discharges of pollutants are regulated under the federal Clean Water Act. Often, smaller communities use on-site or decentralized wastewater treatment systems to avoid regulation and associated compliance costs. While these systems discharge to the land, some portion of their pollutant loading is likely to eventually reach streams, rivers, lakes, and estuaries, which is one type of *nonpoint source* pollution.

Many streams, lakes, and estuaries in the Commonwealth of Virginia have been impaired by nonpoint source pollution. The Clean Water Act requires states to develop a *total maximum daily load* (TMDL) for those water bodies that do not meet applicable water quality standards. In the Commonwealth of Virginia, the Virginia Department of Environmental Quality is typically responsible for developing TMDLs to address water quality impairments. A TMDL defines the amount of a given pollutant a water body can assimilate without violating water quality standards. The Chesapeake Bay TMDL was issued by the U.S. Environmental Protection Agency (2010) to address excessive sediment and nutrient discharges to tributaries of the Bay. The Chesapeake Bay TMDL sets aggressive goals for reducing the amount of nutrients and sediment entering the Bay. These goals will result in higher performance standards (more efficient pollutant removal) for all wastewater systems discharging to ground or surface waters. While only about two-thirds of Virginia lies in the Chesapeake Bay watershed, the higher wastewater treatment standards being driven by the Bay TMDL are being applied statewide. These higher standards mean that septic systems and decentralized wastewater systems likely will have to remove more pollutants more efficiently than current practices.

Within the Commonwealth of Virginia, as of 2008, there were approximately 83 decentralized community systems (Parten 2008). Figure 2 shows where these community systems are located. Approximately 1.7 million gallons per day from approximately 6,000 households are discharged from these systems to the environment.

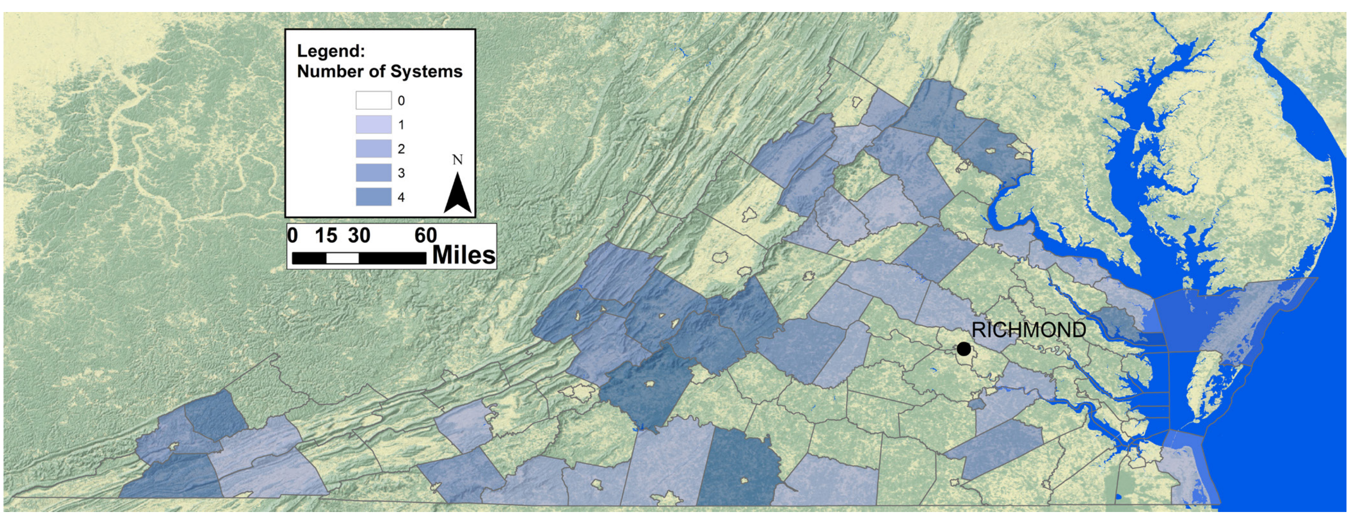

Figure 2. Number of decentralized wastewater systems per county in Virginia in 2008. Statewide total is 83 systems.

Wastewater Collection Systems for Small Communities

Centralized Versus Decentralized Systems

When a community is small — 2,000 households or fewer — decentralized collection systems are often chosen. This is due in part to relative economics and can be explained in a hypothetical relationship provided in figure 3. Larger communities tend to have higher densities (e.g., 25 households per acre); as the number of service connections increases, costs per connection tend to decrease to a relatively constant level. By contrast, costs per service connection in lower density communities (e.g., one household per acre) decrease to a minimum then gradually increase. This is due to the cost of a collection system, which for small systems can be nearly 90 percent of the total construction cost.

Four types of decentralized sewer collection systems are described in the following sections.

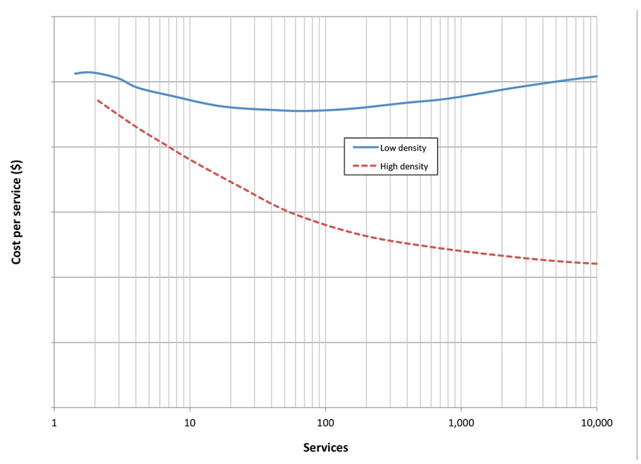

Figure 3. Relative economics of the total cost of low- and high-density communities. Small communities tend to have lower densities and grow outward. Larger communities have higher densities and more uniform economies of scale.

Note: Low density = 1 household/acre; high density = 25 households/acre.

Source: Figure based on Clark (1997); vertical scale omitted, focus is on the general trend.

Gravity Sewer Systems

Gravity sewer systems transport *sewage* from residences by gravity via a service lateral that connects with a *sewer main*, usually located in the roadway (figure 4).

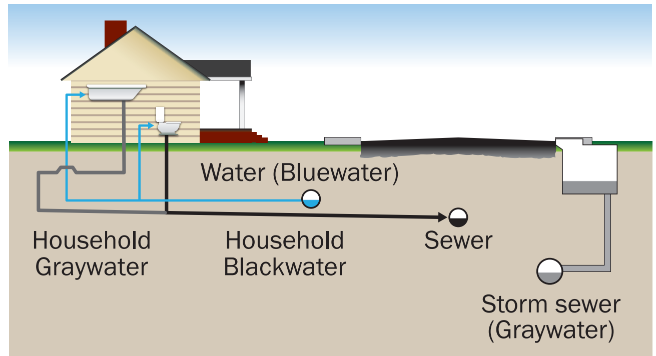

Figure 4. Gravity sewer systems.

Figure 4 illustrates the typical infrastructure that may be encountered in a right of way. Potable, or *bluewater*, is shown in blue. Runoff collecting from streets is called *stormwater*, and it flows through a storm sewer that is part of a *stormwater conveyance system*, usually discharging to a storm drain or creek. Gravity systems follow *watershed* boundaries (i.e., they flow from higher to lower elevations). In order to function properly, gravity flow sewer mains typically have diameters greater than 8 inches with regulated minimum slopes. Too steep a slope will result in high velocities that can cause sewage overflows and scouring. Too shallow a slope can result in sluggish velocities that can cause clogging from the settling of solids contained in the sewage. These constraints may result in larger excavations and disruptions for installation.

For cleaning and maintenance, manholes are usually spaced no farther than 600 feet apart with straight sewer lines between. In many areas, it is impossible to provide complete gravity flow to the central treatment system for all customers. When this is the case, sewage is conveyed to a lift station that contains a pump to provide the hydraulic energy to lift the water to a higher elevation where it can be further transported by gravity. Pipe materials include vitrified clay pipe, polyvinyl chloride (PVC), and ductile iron pipe. These requirements can make gravity sewer systems very expensive to install, especially in small communities with few services and large distances between them. Gravity sewers were designed to serve high-density urban/suburban areas (more than 10 to 25 households/acre). When used as part of a system that serves small or rural communities, gravity sewers often add significant costs. The U.S. Environmental Protection Agency (2005) recommends that small communities consider the use of an alternative to a gravity wastewater collection system or a combination of gravity and alternative collection systems until such time as an economical connection is available to a larger system.

Pressure Sewer Systems

While many sewers use gravity to collect flow from each service, *pressure sewer systems* use smaller diameter pipes and individual pumps at each service to pressurize flow (figure 5).

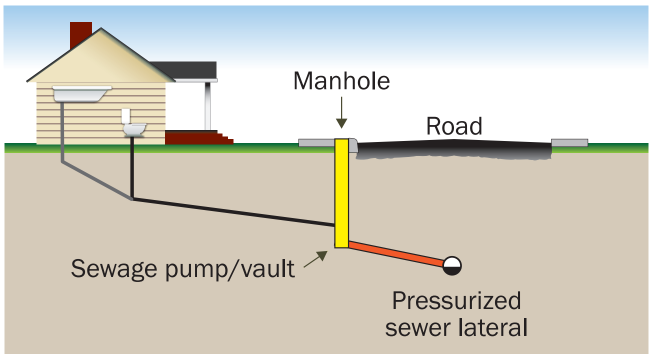

Figure 5. Pressure sewer systems.

A pressure sewer system collects sewage in a tank containing a pump. When the sewage level in the tank reaches a set level near the top of the tank, the pump turns on and delivers the sewage into the collection system until the tank is empty. A backflow prevention valve is installed to prevent system flows from backing up into the tank. Additional pumps are installed in the collection system to convey sewage to a treatment facility.

There are two important advantages of pressure sewers in comparison to gravity sewers.

1. Smaller diameter plastic pipes, usually with diameters between 2 and 6 inches, can be used for shallower slopes.
2. Second, because of the small diameter piping, pressure sewers can also be installed using *directional drilling* technology.

For a small community, the savings of this type of system over a gravity sewer system approach is the reduction in larger diameter (and more costly) pipe in the collection system and the omission of lift stations. Pressure systems are uniquely suited to lower density (one household per acre) communities and areas with rocky terrain or irregular topography because they do not require large diameter pipes or the deep excavations that gravity systems do. Because the system is pressurized, groundwater *infiltration and inflow* into the system is normally not a concern. However, connections from *foundation drains* should be excluded because excess flow could overwhelm the system. The key maintenance point in the system is each individual pump. Because these pumps operate under extremely difficult conditions (such as *anaerobic*, and/or high concentrations of *hydrogen sulfide*), failures can produce sewage backups. Identifying who is responsible for maintaining the pumps is an important consideration. While requiring property owners to assume this responsibility may reduce the installation cost of the system, having the community assume the maintenance responsibility is usually preferred and leads to a reduced total cost of the system.

Effluent Sewer Systems

Effluent sewer systems combine the individual on-site septic system with either of the two previously discussed systems (figure 6) to create the *septic tank effluent gravity* sewer (STEG) or the *septic tank effluent pump* sewer (STEP).

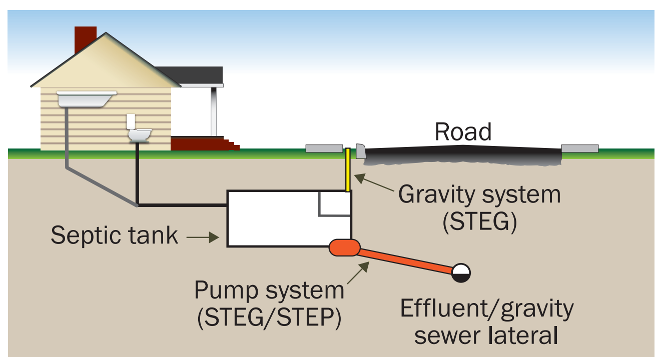

Figure 6. Effluent sewer systems.
Note: STEG = septic tank effluent gravity; STEP = septic tank effluent pump.

The septic tank provides primary sewage treatment (settling of solids and digestion), reducing the solids in the effluent by as much as 70 percent. For both STEG and STEP systems, downstream piping can be reduced in size from that of gravity systems because of the reduced solids load. The collection pipes can also be installed on a more gradual incline. The pipes used for these systems are typically made of lightweight plastic and can be buried at a relatively shallow depth. Clean-out ports instead of manholes are used to service collector pipes. When it is necessary for the flow to be directed upward, effluent pumps can be utilized to move the wastewater to higher elevations. High water alarms are normally installed in the septic tanks to alert property owners of any potential problems with their part of the system.

Effluent sewer systems are well-suited to communities where the houses are far apart (density less than one household per acre), or where most houses are served by an existing septic tank. Operation and maintenance costs for effluent sewer systems are comparable to those of gravity sewer systems. One variation of a STEP system is the use of a grinder pump. Wastewater from each property goes to a tank containing a pump with grinder blades that shred the solids into tiny particles. Both solids and liquids are then pumped into the sewer system. Because the effluent contains a mixture of solids as well as liquids, the diameter of the pipes must be increased over that of pressure systems. However, grinder pumps eliminate the need to periodically pump the septic tanks of all the properties connected to the system.

Vacuum Sewers

A *vacuum sewer system* typically consists of two households connected by a gravity sewer lateral to a *vacuum vault* (figure 7). When the sewage reaches a set point level in the vault, the vacuum valve opens, and the negative air pressure, or vacuum, in the collection sewer pulls the sewage through the system to a central collection or treatment facility.

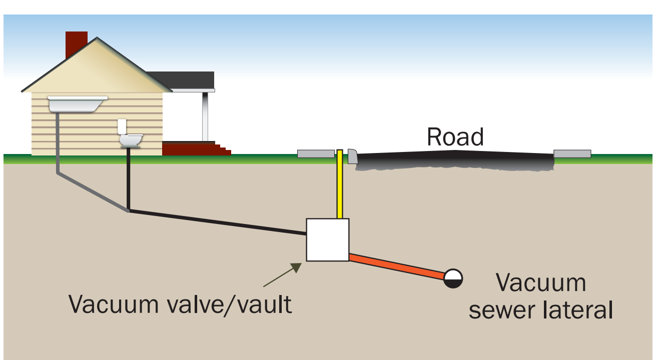

Figure 7. Vacuum sewer systems.

There are no manholes with a vacuum system; instead, access can be obtained at each vacuum vault. The vacuum (low-pressure, suction, or draw) within the collection system is created at a vacuum station. Vacuum stations are small buildings that house a large storage tank and a system of vacuum pumps. Pipes typically consist of O-ring gasketed PVC pipe.

Vacuum sewer systems can be used to a limited extent in hilly terrain; however, they are more economical in flatter areas. Vacuum sewers are often used in small communities with a relatively high density of properties per acre (more than five households per acre). Vacuum sewers tend to have more specialized operation and maintenance requirements than other sewer collection systems. Because of the negative pressure relative to normal conditions, vacuum sewers may be vulnerable to increased flows from infiltration and inflow in areas with high groundwater; this can be minimized with appropriate materials and installation.

Evaluating Wastewater Collection Choices

The principal advantage that alternative wastewater collection systems have over gravity sewer systems is the lower cost of installing the network of collection pipes. The piping network for an alternative collection system can be laid in much shallower and narrower trenches. In addition, the pipes do not need to be laid in a straight line or with a uniform gradient. This means they can be laid in such a manner as to easily avoid obstacles.

Disadvantages to using an alternative collection system include the need for separation of solids before the liquid can enter the network of collection pipes and the need for a pump to propel the sewage through the system. When the population density is high (i.e., 25 households per acre) and the length between service connections is fewer than 500 feet, the additional requirements of alternative collection systems can make them more costly than a gravity sewer system. Buchanan (2010) has developed a cost model spreadsheet that compares estimated costs of the four alternative systems — gravity, pressure sewers, vacuum sewers, and septic tank effluent pump. The model predicts a range of system

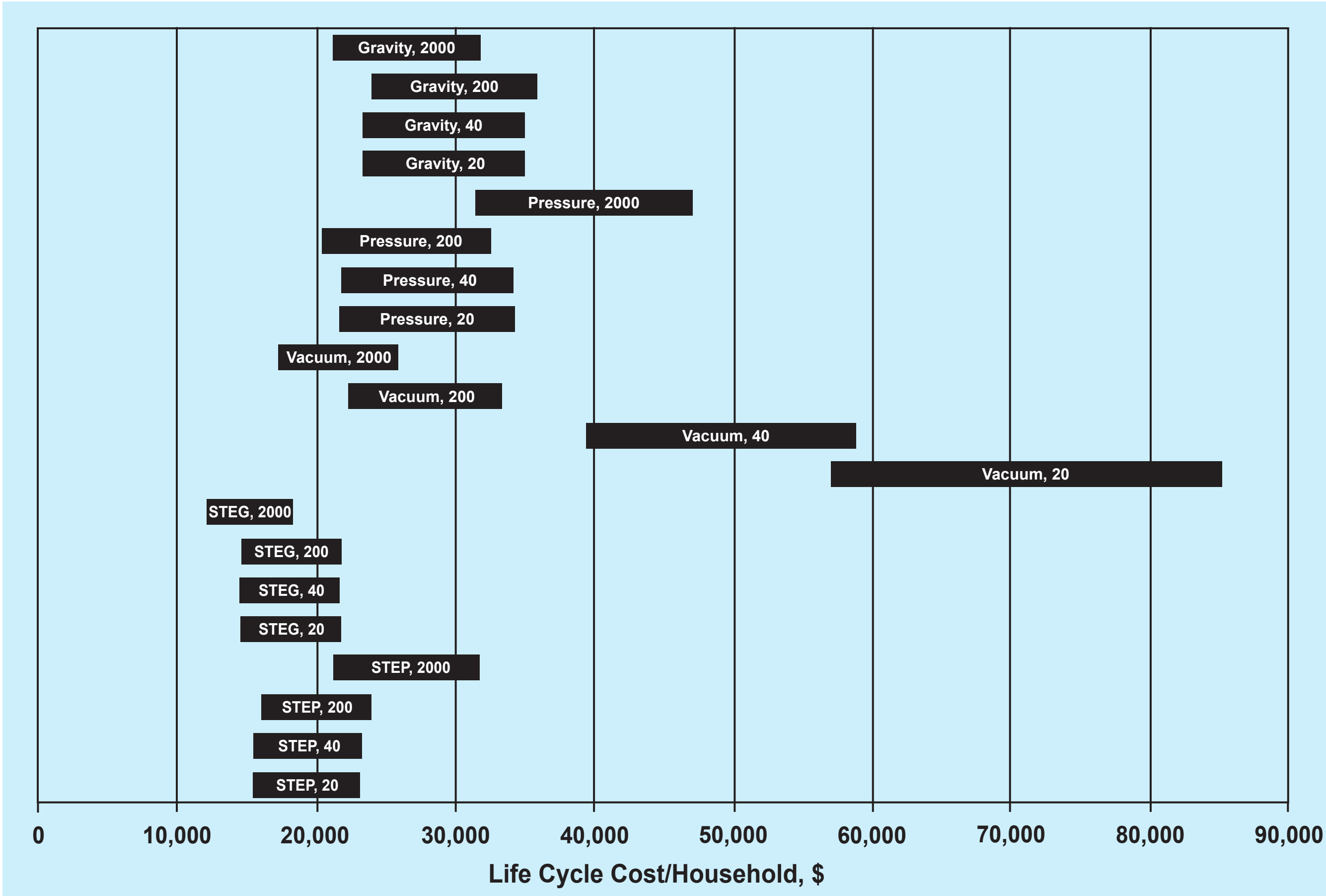

Figure 8. Cost ranges for gravity and four alternative collection systems for systems from 20-2,000 households.

Notes:

1. Due to high costs, vacuum sewers are typically not installed for systems of fewer than 40 households, and they are typically not competitive for systems of fewer than 200. However, systems from 20 to 2,000 households are provided for comparison purposes.
2. STEP = septic tank effluent pump; STEG = septic tank effluent gravity.
3. Costs base, December 2012, based on a cost model from Buchanan et al. (2010). Life cycle is 60 years.

life cycle costs per household. The costs are based on various community characteristics such as density and size. Figure 8 illustrates a hypothetical cost comparison when each system is designed to serve 20 to 2,000 households. The reader is cautioned that these values are for comparison purposes only, and actual costs will vary widely per system.

As is evident in figure 8, the STEG and STEP systems are the least costly alternative in many cases. STEG systems are very economical at the 2,000-household size. While vacuum sewers tend to be generally more expensive, they become competitive in larger systems (200 to 2,000 households) because the central vacuum is a relatively large, fixed cost that is not scalable (Buchanan et al. 2010). Gravity systems tend to be more costly for small communities (20 to 40 households) but decrease in cost at larger system sizes (2,000 households or more). Pressure systems tend to be costly at the smallest range (20 to 40 households) but decrease at the mid-range (200 households), and are more expensive than gravity systems at the 2,000-household system size.

In summary, factors that may trigger consideration of alternative collection systems include:

- The wastewater treatment system will be serving a small community of 2,000 homes or fewer or an equivalent combination of business and residential flows. This consideration is even more warranted for communities of fewer than 200 households.

- Many of the properties currently have on-site systems such as septic tanks or aerobic treatment units.

- The average lot size per property is more than one-half acre.

- There will be fewer than 100 homes per mile of sewer pipe.

- The system will serve a community on either hilly or flat terrain.

- Subsurface obstacles, such as bedrock or groundwater, exist close to the ground's surface.

An important factor to consider when evaluating decentralized systems is that they require a greater amount of participation by homeowners. Therefore, the need for community involvement in the choice of systems is important. Questions concerning homeowner maintenance requirements or the possibility of hiring a contractor to routinely service the system for the community need to be discussed before any final decisions are made. A resource guide to help small communities come together and make these decisions is provided by Olson et al. (2001).

Additional Resources

Online Resources

Consortium of Institutes for Decentralized Wastewater Treatment – www.onsiteconsortium.org/

National Environmental Services Center, National Small Flows Clearinghouse – www.nesc.wvu.edu/wastewater.cfm

U.S. Environmental Protection Agency – www.water.epa.gov/infrastructure/septic/

Virginia Department of Health – www.vdh.state.va.us/EnvironmentalHealth/Onsite/howsystemsworks/

Companion Virginia Cooperative Extension Publications

Haering, K. C., G. K. Evanylo, B. Benham, and M. Goatley. 2009. *Water Reuse: Using Reclaimed Water for Irrigation*. VCE publication 452-014. http://pubs.ext.vt.edu/452/452-014/452-014_pdf.pdf.

Hunnings, J., and R. B. Reneau Jr. 2009. *Virginia Farmstead Assessment System: Household Wastewater Treatment and Septic Systems*. Fact sheet/worksheet No. 3. VCE publication 442-903. http://pubs.ext.vt.edu/442/442-903/442-903_pdf.pdf.

Zipper, C., R. B. Reneau Jr., and A. Jantania. 2009. *On-Site Sewage Treatment Alternatives*. VCE publication 448-407. http://pubs.ext.vt.edu/448/448-407/448-407_pdf.pdf.

Zipper, C. E., R. B. Reneau Jr., and M. A. Saluta. 2009. *Powell River Project: On-Site Treatment and Disposal of Residential Wastewaters on Mined Lands*. VCE publication 460-142. http://pubs.ext.vt.edu/460/460-142/460-142_pdf.pdf.

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References

Buchanan, J. P., N. E. Deal, D. L. Lindbo, A. T. Hanson, D. G. Gustafson, and R. J. Miles. 2010. "Wastewater Basics for Small Community Leaders and Planners." Part 2.0 in *Performance & Cost of Decentralized Unit Processes*. Alexandria, Va.: Water Environment Research Foundation.

Clark, R. 1997. *Optimum Scale for Urban Water System*. Report No. 5 in Water Sustainability in Urban Area Series: An Adelaide and Regions Case Study. Adelaide, Australia: Department of Environment and Natural Resources.

Consortium of Institutes for Decentralized Wastewater Treatment. 2009. *Decentralized Wastewater Glossary*. 2nd ed. n.p.: CIDWT.

Herrmann, T., and U. Klaus. 1997. “Fluxes of Nutrients in Urban Drainage Systems: Assessment of Sources, Pathways and Treatment Techniques.” *Water Science and Technology* 36 (8/9): 167-72.

Mayer, P. W., W. B. DeOreo, E. M. Opitz, J. C. Kiefer, W. Y. Davis, B. Dziegielewski, and J. O. Nelson. 1999. *Residential End Uses of Water*. Denver, Colo.: American Water Works Association and AWWA Research Foundation.

McDilda, D. 2007. “Clean Enough for 10,000 Lakes: Ditching Individual Septic Tanks for Decentralized Wastewater Systems.” *Onsite Water Treatment* 3 (6).

Olson, K., B. I. Chard, D. Malchow, and D. Hickman. 2001. *Small Community Wastewater Solutions: A Guide to Making Treatment, Management and Financing Decisions*. University of Minnesota Extension.

Parten, S. M. 2008. *Analysis of Existing Community-Sized Decentralized Wastewater Treatment Systems*. Report for the Water Environment Research Foundation. Report No. 04DEC9RP. Alexandria, Va.: Water Environment Research Foundation.

Siegrist, R. L. 1978. *Management of Residential Grey Water*. Small Scale Waste Management Project. University of Wisconsin Extension.

U.S. Environmental Protection Agency. 2005. *Handbook for Managing Onsite and Clustered (Decentralized) Wastewater Treatment Systems: An Introduction to Management Tools and Information for Implementing EPA’s Management Guidelines*. EPA Publication No. 832-B-05-001. Cincinnati, Ohio: U.S. EPA.

U.S. Environmental Protection Agency. 2010. *Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus and Sediment*. Philadelphia: EPA.

Glossary of Terms

** Definition adapted from the “Decentralized Wastewater Glossary” (Consortium of Institutes for Decentralized Wastewater Treatment 2009).*

Anaerobic – Chemical reactions that proceed without the presence of oxygen.

Blackwater – Residential wastewater generated from toilets and kitchen sinks.

Bluewater – Potable water piped to residences.

Carbonaceous biochemical oxygen demand (CBOD)* – Quantitative measure of the amount of oxygen consumed by bacteria while stabilizing, digesting, or treating the organic matter under aerobic conditions over a five-day incubation period while in the presence of a chemical inhibitor to block nitrification; CBOD is expressed in milligrams per liter (mg/L).

Centralized wastewater system – A large wastewater system that collects wastewater from households, usually by gravity flow, and provides treatment at one or more central locations.

Cluster wastewater system* – A wastewater collection and treatment system that serves two or more dwellings but less than an entire community. Individual septic tanks or aerobic units may pretreat wastewater from several homes before it is transported through low cost, alternative sewers to a treatment unit that is relatively small compared to centralized systems.

Collection system, wastewater collection system – System of piping, lift stations, and other components that collects and conveys wastewater either by gravity or pressure.

Decentralized wastewater system – Wastewater system for collection, treatment, and disposal/reuse of wastewater from individual homes, clusters of homes, isolated communities, industries, or institutional facilities at or near the point of waste generation.

Directional drilling – A type of drilling technology that is used to horizontally install sewer pipes with a minimum of excavation. Also called trenchless technology.

Disposal system, wastewater disposal system – The way in which wastewater is ultimately dispersed, disposed, discharged, or released into the environment.

Domestic wastewater – See “wastewater.”

Drainfield* – Physical location where final treatment and dispersal of effluent occurs; includes drainfields, drip fields, and spray fields.

Effluent sewer system – A system that uses a septic tank to remove the majority of solids from residential wastewater, and thus conveys the effluent from these systems. See "septic tank effluent pump" and "septic tank effluent gravity" systems.

Eutrophication – The process of enrichment of water bodies by nutrients. Eutrophication is normally a slow aging process during which a lake, estuary, or bay evolves into a bog or marsh and eventually disappears. Waters receiving excessive nutrients may become prematurely eutrophic, are often undesirable for recreation, and may not support normal fish populations.

Foundation drains – A drain installed to reduce groundwater head and subsequent pressure against foundation walls.

Gravity sewer system – A sewer system constructed so that flows travel from households to a collection point using differences in elevation.

Graywater – Residential wastewater from baths, showers, dishwashers, clothes washers, and faucets (except kitchen sink).

Groundwater – Water located beneath the earth's surface and stored in soil pore spaces, rock fractures, and underground aquifers.

Hydrogen sulfide (H_2S) – A gas containing hydrogen and sulfur that is created by bacterial decomposition under anaerobic conditions. H_2S can be toxic in elevated concentrations. It has a characteristic "rotten egg" odor that is present at very low concentrations in air.

Infiltration and inflow (I and I)* – Term used to describe the combined undesirable entry of extraneous water into a wastewater collection system.

Mass load – Refers to the total quantity of a constituent of interest per unit time; for example, grams of sediment per capita, per day (gcd).

Nitrogen (N)* – Essential chemical element and nutrient for all life forms; molecular formula (N_2) constitutes 78 percent of the atmosphere by volume; nitrogen is present in surface water and groundwater as ammonia (NH_3), nitrite (NO_2^-), nitrate (NO_3^-), and organic nitrogen; excess levels of nitrogen in marine areas may contribute to *eutrophication*.

Nonpoint source pollution – Pollution that results from a variety of sources that are hard to identify as individual contributions.

Nutrients – Substances that are required for growth of all biological organisms. When considering water quality, the nutrients of greatest concern in stormwater are nitrogen and phosphorus. Excessive amounts of these substances are pollution and can cause algal blooms and dead zones to occur in downstream waters.

On-site wastewater system* – A natural system or mechanical device used to collect, treat, and discharge or reclaim wastewater from an individual dwelling without the use of communitywide sewers or a centralized treatment facility. A typical on-site system includes a septic tank and a drainfield. Other types of on-site systems include at-grade systems, mound systems, media filters, small aerobic units, and pressure distribution systems.

Pathogens* – Organisms that cause infectious disease.

Phosphorus (P)* – Chemical element and nutrient essential for all life forms, occurring as orthophosphate, pyrophosphate ($P_2O_7^{4-}$), tripolyphosphate ($P_3O_{10}^{5-}$), and organic phosphate forms; each of these forms, as well as their sum (total phosphorus), is expressed in terms of milligrams per liter (mg/L) elemental phosphorus; occurs in natural waters and wastewater almost solely as phosphates; excess levels of phosphorous in fresh surface waters can contribute to eutrophication.

Pressure sewer system – Sewer collection system that uses individual pumps and positive pressure to convey wastewater to a central collection point.

Reclaimed water – Water recovered from domestic, municipal, and industrial wastewater treatment plants that has been treated to standards that allow safe reuse. Properly reclaimed water is typically safe for most uses except human consumption.

Sediment – Soil, rock, or biological material particles that are formed by weathering, decomposition, and erosion. In water environments, sediment is transported across a watershed via runoff and streams. A quantified measure of sediment in water is total suspended solids.

Septic tank effluent gravity (STEG)* – Collection system that uses a septic tank to separate solids and allow gravity flow of effluent to a subsequent component.

Septic tank effluent pump (STEP)* – Collection system that uses a septic tank to separate solids and incorporates a pump tank, pump, and associated devices to convey effluent under pressure to a subsequent component.

Septic tank* – Water-tight, covered receptacle for treatment of sewage; receives the discharge of sewage from a building, separates settleable and floating solids from the liquid, digests organic matter by anaerobic bacterial action, stores digested solids through a period of detention, allows clarified liquids to discharge for additional treatment and final dispersal, and attenuates flows.

Sewage* – Untreated wastes consisting of blackwater and graywater from toilets, baths, sinks, lavatories, laundries, and other plumbing fixtures in places of human habitation, employment, or recreation.

Sewer main – Sewage collection pipes that transport wastewater from a group of homes to a central collection point.

Stormwater – Water that originates from impervious surfaces during rain events, often associated with urban areas; also called runoff.

Stormwater conveyance system – Means by which stormwater is transported in urban areas.

Total maximum daily load (TMDL) – A pollution "budget" used to determine the maximum amount of pollution a water body can assimilate without violating water quality standards. The TMDL includes pollution from permitted point sources (waste load allocations or WLAs) and nonpoint and natural background sources (load allocations or LAs). In addition to the load allocations, the TMDL includes a margin of safety (MOS). The MOS accounts for any uncertainty associated with estimating the load allocations. Mathematically, a TMDL is written as: TMDL = WLAs + LAs + MOS, where a TMDL is developed for a specific pollutant and can be expressed in terms of mass per time, toxicity, or other appropriate measures that relate to the water quality standard being violated.

Total suspended solids (TSS)* – Measure of all suspended solids in a liquid, typically expressed in mg/L. To measure, a well-mixed sample is filtered through a standard glass fiber filter and the residue retained on the filter is dried to a constant weight at 217 to 221 degrees Fahrenheit (103 to 105 degrees Celsius); the increase in the weight of the filter represents the amount of total suspended solids.

Treatment system – Assembly of components for collection, treatment, and dispersal of sewage or effluent. See also "wastewater treatment system."

Vacuum sewer system – A wastewater collection system that uses a negative or suction pressure to convey wastewater from households to a central collection point.

Vacuum vault – A sealed collection sump into which waste flows and that contains a vacuum valve. When sewage collects, and there is sufficient low pressure behind the valve, it opens, transporting the sewage via suction. A failure alarm is usually installed at set points in the vault indicating a lack of low pressure in the conveyance system.

Wastewater* – Water or liquid-carried waste from plumbing fixtures, appliances, and devices such as toilets, bath, laundry, and dishwashers. As used in this fact sheet, wastewater includes both graywater and blackwater.

Wastewater treatment system* – Assembly of components for collection, treatment, and dispersal of sewage or effluent.

Water budget – An analysis of all water flows into and out of any arbitrary object; in this fact sheet, a single household.

Water conservation* – Management of water resources so as to eliminate waste or maximize efficiency using such methods as reusing the same water before it becomes wastewater, installing water-efficient plumbing, or wastewater recycling and reuse.

Water reuse – Use of *reclaimed water* for a direct beneficial purpose. The use of reclaimed water for irrigation and other purposes has been employed as a water conservation practice in Florida, California, Texas, Arizona, and other states for many years.

Watershed – A unit of land that drains to a single "pour point." Boundaries are determined by water flowing from higher elevations to the pour point. A pour point is the point of exit from the watershed, or where the water would flow out of the watershed if it were turned on end.