Alternative Energy Sources To Treat Wastewater
From the Editor

In this issue, we lead off with a look at how water softener backwash affects the performance of onsite wastewater treatment systems (page 7). There have been some scientific studies done, and there are plenty of people with years of field experience in observing and working with these effects, including engineers and system manufacturers. We have pulled these together to create a picture of a controversial subject about which much is not known.

I grew up in a hard water situation, and I’m glad we had a water softener. I am also a proponent of onsite wastewater treatment, and so I’m happy to see that the two technologies don’t always work together is something that concerns me. If we are going to successfully manage decentralized onsite wastewater treatment, we need to be able to identify the combinations of soil and system types that work in conjunction with water softener backwash.

People are searching for alternatives to fossil fuels as sources of energy in a number of industries, from home heating to fueling cars. Wastewater treatment is no exception, and in this issue (page 12), we are offering a few examples of treatment technologies that have put the power of the sun and wind to use.

We are also offering the example of Sedgwick County, Kansas, as an excellent model to consider for any community that is faced with the interrelated problems of failing septic systems and changing land use (page 15), and a look into the current status and future of national water and wastewater infrastructure security and emergency response planning (page 20). We’re covering a lot of ground, so have a good read.

On the Cover: Ancient cultures identified the sun as a god.

Design by Julie Black
Designing Cluster and High-Density Wastewater Soil Absorption Systems to Control Groundwater Mounding
by Eileen Poeter, P.E., Ph.D., John McCray, P.G., Ph.D., Geoff Thyne, P.G., Ph.D., and Robert Siegrist, P.E., Ph.D.

If daily hydraulic loading rates exceed the hydraulic capacity of the subsurface beneath cluster and high-density wastewater soil-absorption systems, groundwater mounding may occur and negatively impact treatment system performance. Mounding can occur as perched water on low hydraulic conductivity lenses or as excessive elevation of the water table. It may alter flow directions, result in effluent seeps at the surface, and/or cause lateral movement of water, affecting nearby water supplies or water bodies. Most critical is evaluating the potential for reduction of the vadose zone thickness, which could result in inadequate conditions for treatment of wastewater pollutants. This article presents a flow chart and decision-support tool that establish the strategy level for site investigation and evaluation based on the potential for groundwater mounding and the consequences should it occur. The strategy level indicates the appropriate characterization activities and modeling approaches.
Office of Water Launches New Watershed Discussion Board

As part of its second Webcast, the U.S. Environmental Protection Agency’s (EPA) Office of Water launched a new, online watershed discussion board. This forum offers watershed protection practitioners and citizens a platform to exchange ideas, so that innovative solutions and ideas can be easily shared in (near) real-time cyberspace. EPA hopes to engage watershed leaders from around the country in these interactive, online discussions. Share your expertise so that others can learn from your experiences. The Forum currently includes the following six categories:

Discussion Item Titles:
- Community Involvement
- Smart Growth/Low Impact Development
- Source Water Protection
- Stormwater Best Management Practices
- Sustainable Financing
- Watershed Planning Tools

Please visit [www.epa.gov/owow/watershed/forum/forum.html](http://www.epa.gov/owow/watershed/forum/forum.html) and join in. Anyone can view the discussion, but one must register to post messages and receive customized updates.

ASAE Changes Name

The American Society of Agricultural Engineers has changed its name to the American Society of Agricultural and Biological Engineers (ASABE). The name change provides formal acknowledgement of the close integration and shared history of agricultural and biological engineering.

Melissa Moore, ASABE Executive Vice President, explains that the change more clearly represents the breadth and depth of the profession.

“Biology has always been at the core of the profession,” says Moore, “and the profession has taken the lead in developing the engineering, the educational curriculum, and the applied research for systems dealing with plants, animals, humans, and the environment.”

The action also reflects changes at universities, whose agricultural engineering departments now often include the word biological, or such variations as biosystems or biore-sources in their names. Accordingly, graduates of these programs possess the engineering skills to deal with all agricultural and biological systems, including the entire food and fiber chain.

ASABE headquarters is located in St. Joseph, Michigan. For more information, visit their Web site at [www.asabe.org](http://www.asabe.org), or call (269) 429-0300.

LGEAN Launches Online Land-Use Decision-Making Tool

In partnership with the U.S. Environmental Protection Agency (Region 5) and Purdue University, the Local Government Environmental Assistance Network (LGEAN) recently launched an online tool to help local government planners measure the water quality impacts of land-use changes. Specifically, local governments provide information about their location, the proposed land-use change, and the area’s soil type. Based on community-specific climate data, the Long-Term Hydrologic Impact Assessment (L-THIA) model estimates changes in recharge, runoff, and nonpoint source pollution resulting from proposed development.

As a quick and easy-to-use approach, L-THIA’s results can be used to generate community awareness of potential long-term problems and to support planning aimed at minimizing disturbance of critical areas. L-THIA is also an ideal tool to identify the best location of a particular land use so as to have minimum impact on a community’s natural environment.

L-THIA is available for free on the LGEAN Web site, and users only need an Internet browser to use the tool. A downloadable GIS extension is also available for local government officials with ArcView software.

To use L-THIA, visit LGEAN’s [Tools and Resources page at www.lgean.org/html/exchange.cfm](http://www.lgean.org/html/exchange.cfm) and select the “Land Use Impacts on Water Quality Model.”
Calendar of Events

OCTOBER

On-Site Wastewater Treatment Conference
North Carolina State University
October 25–27
Raleigh, North Carolina
Joni Tanner (919) 513-1678
joni_tanner@ncsu.edu

Community Planning Collaborative Summit
Community Planning Collaborative
October 27–30
Orlando, Florida
(407) 836-5600
www.placematters.com/CPCI/registration/register.php

WEFTC 2005
Water Environment Federation
October 29–November 2
Washington, D.C.
(800) 666-0206
www.weftec.org

NOVEMBER

Groundwater Under the Pacific Northwest: Integrating Research Policy, and Education
CSREES Pacific Northwest Regional Water Quality Program
November 2–3
Stevenson, Washington
(800) 942-4978
watercenter@wsu.edu
http://capps.wsu.edu/groundwater

The Groundwater Foundation Annual Meeting and Youth Groundwater Congress
November 2–4
Nebraska City, Nebraska
(800) 858-4844
info@groundwater.org
www.groundwater.org/pe/conference/conference.html

2005 Annual SWWA Conference and Trade Show
Saskatchewan Water and Wastewater Association
November 2–4
Saskatoon, Saskatchewan
(306) 694-4479
rmoore@city.moose-jaw.sk.ca
www.swwa.sk.ca/2005Conference/Conference.htm

NWRA 74th Annual Conference
National Water Resources Association
November 7–10
Honolulu, Hawaii
(800) 631-9675
Fax (770) 424-9468
travworldnet@mindspring.com
www.nwra.org

AWRA Annual Conference
American Water Resources Association
November 7–10
Seattle, Washington
(540) 687-8300
www.awra.org
info@awra.org

NALMS 2005: 25th Annual Symposia
National Lake Management Society
November 9–11
Madison, Wisconsin
(608) 233-2836
www.nalms.org
winge@nalms.org

Portable Sanitation Association International (PSAI) Convention & Trade Show
November 9–12
Ontario, California
(800) 822-3020
Fax (952) 854-7560
www.psaio rg

New England Residuals and Biosolids Conference
New England Biosolids and Residuals Association
November 15–16
Westborough, Massachusetts
603/323-7654
www.nebiosolids.org

International Rainwater Catchment Systems Conference
Action for Food Production (AFPRD)
November 15–18
New Delhi, India
contact@ircsa2005.org
www ircsa2005.org

Septic System Options for Difficult Sites
North Carolina Soils and On-Site Wastewater Training Academy, North Carolina State University
November 29–30
Winston-Salem, North Carolina
(see Web site below for additional dates, locations, and courses)
(919) 513-1678
soils_training@ncsu.edu
www.soil.ncsu.edu/swetc/soilacademy/2005/soilsacad05.html

Activated Sludge Process Evaluation and Control
Missouri Water and Wastewater Conference
November 29–30
Springfield, Missouri
(573) 761-0376
Fax (573) 761-5544

ACWA 2005 Fall Conference and Exhibition
Association of California Water Agencies
November 29–December 2
San Diego, California
(888) 666-2292
www.acwa.com/events/FC05/FC05_Reg-Info.asp

DECEMBER

4th Biennial IWHA Conference
International Water History Association
December 1–4
Paris, France
post@iwha.net
www.iwha.net

APHA 133rd Annual Meeting
American Public Health Association
December 10–14
Philadelphia, Pennsylvania
(202) 777-APHA
www.apha.org

Mathematics for Water and Wastewater Operators
Maryland Center for Environmental Education (MCET), December 6
College of Southern Maryland
(See Web site below for additional dates, locations, and courses)
(301) 934-7517, Tyler Milbrook
www.mcet.org/Technical/Training/environment/et%20submission.html

Ohio Onsite Wastewater Association/Ohio Land Improvement Contractors Conference
January 5–6
Dayton, Ohio
(866) 843-4429
oowa@ohioonsite.org
oowa.nowra.org

Pennsylvania Septage Management Association Conference and Trade Show
January 16–17
Grantville, Pennsylvania
(717) 763-7762
psma.net

If your organization is sponsoring an event that you would like us to promote in this calendar, please send information to the Small Flows Quarterly, Attn. Cathleen Falvey, National Environmental Services Center, West Virginia University, P.O. Box 6064, Morgantown, WV 26506-6064. Or you may contact Cathleen at (800) 624-8301 or (304) 293-4191, ext. 5526, or via e-mail to cfalvey@wvu.edu.
Environmental Inquiry (EI) for High School Students
http://ei.cornell.edu/
EI is a Web site and curriculum series developed at Cornell University to help high school students conduct environmental science research. Students use standard laboratory and field methods modeled after research activities conducted by professional scientists. After completing their experiments, students present and discuss the results with their peers either face-to-face or electronically. There is a section for students and one for teachers. The site includes information about conference papers, reference manuals, videos, Web sites, and peer-reviewed articles relevant to the Environmental Inquiry program. There are also discussion boards for both teachers and students; sections about toxicology, ecology, biodegradation, and watersheds; and useful links. In 2003, EI won an Environmental Quality Award from EPA for Excellence in Environmental Education.

Pennsylvania Organization for Watershed & Rivers
www.pawatersheds.org/
This site includes watershed awareness and education, information about the state’s watershed monitoring network, publications, watershed directory, calendar of events, glossary, resources and links, lists of potential funding sources, regulations, lists of training organizations, and fact packs. Membership can be done online.

National Association of Wastewater Transporters (NAWT)
www.nawt.org
NAWT is dedicated to serving the interests of the liquid waste pumping and drain cleaning industries. The site includes a database of certified inspectors, certification training courses, industry news, a listing of state associations, and links to other associations.

National Onsite Wastewater Recycling Association, Inc. (NOWRA)
www.nowra.org/
NOWRA was founded in 1991 by public health and industry specialists to promote the onsite wastewater industry through leadership, education, training, and communication. NOWRA is non-profit and serves all aspects of the industry, including governmental regulatory personnel, installers, field practitioners, suppliers, distributors, engineers, research professionals, designers, consultants, educators, soil scientists, and manufacturers. This site includes an onsite journal, calendar of industry events, news updates, information about recent conference proceedings, a homeowner’s system guide, and a listing of NOWRA education and training programs.

Federal Emergency Management Agency (FEMA)
www.fema.gov
FEMA helps people both before and after disasters, such as floods, hurricanes, or fires. Although the organization is concerned with all aspects of disaster relief, the site offers many examples of FEMA’s capacity to solve or prevent wastewater problems. FEMA has funded many projects, such as preventing wastewater spills in the event of a disaster, and has provided assistance to damaged wastewater treatment plants all over the country.

Atlantic States Rural Water and Wastewater Association (ASRWWA)
www.asrwwa.org
ASRWWA is a private, non-profit organization founded to help rural water and wastewater systems in the Atlantic states provide safe drinking water and protect the environment at an affordable cost to users. Operated by rural utility systems, this site provides operator training; onsite technical assistance for leak detection, process control, compliance, source water protection, budgeting and collections; consumer confidence reports; grant and loan information; certification exam review; rate and salary surveys; job listings; compliance information; a training calendar; online course registration; and a directory of related links. There are also a variety of technical bulletins, brochures, newsletters, an emergency response plan, and vulnerability assessments.
Hard water is hard on the homeowner; you have to use more soap, it makes your skin itch, and has a number of unpleasant effects on fixtures and appliances. A water softener does away with those problems. The question that has been plaguing both water and wastewater industries for decades, however, is whether or not a water softener is hard on an onsite wastewater treatment system.

**Why Use Water Softeners?**

In rural areas where septic systems are commonly used, groundwater is typically the water source. Frequently, this water contains calcium and magnesium deposits that it has picked up from various layers of underground rock. Water with substantial amounts of calcium and magnesium minerals is referred to as “hard water.” The more calcium and magnesium that is dissolved in the water, the harder the water becomes.

Hard water is not a health risk, but it is a nuisance; so while it is suitable for drinking, cooking, and gardening, it is unsuitable for many household chores. For instance, it can cause a build-up of calcium and magnesium deposits (scale) in pipes, reducing the water’s flow to taps and appliances, and a build-up in water heaters, reducing their efficiency and life. Calcium and magnesium react with soap to form insoluble deposits that dull the color of clothes, leave spots on dishes, and soap scum on bathtubs. Hard water can also leave skin feeling dry and itchy. Commonly, homeowners solve hard water problems with a water softener.

**Classifications of Hardness in Water**

The harder the water, the more problems it creates for the homeowner. Water hardness is often expressed in grains of hardness per gallon of water (gpg), using the classifications in the table on page 8.
Public water companies can tell homeowners the hardness level of their water. Water hardness can also be tested by laboratories, some local health departments, and water treatment equipment dealers. For less than $10, a homeowner can purchase a water testing kit from a swimming pool supply store and quickly and easily determine water hardness level.

How Water is Softened
Most water softeners use the ion exchange principle, where one set of ionized chemicals (calcium and magnesium) is exchanged with another set of ionized chemicals (sodium and/or potassium). The sodium and potassium ions are then released into the water, softening it. (There are also magnetic water conditioning devices on the market, but the reviews of these conditioners are mixed.)

Water Softener Regeneration
Over a period of time, the ion exchange will cause the resin beads to become saturated with calcium and magnesium ions, stopping the water softening process. To restart the water softening process, the resin bed must be flushed and regenerated.

Regeneration has three phases and lasts between one to three hours, depending upon the make and model of the water softener. The first step, called the backwash phase, lasts approximately 5 to 10 minutes and reverses water flow to flush dirt and sediments down the drain.

Next, a concentrated sodium or potassium chloride solution flows from the brine tank into the mineral tank and flushes the resin bed of small plastic beads. The positively charged sodium or potassium ions attach to the beads, replacing the negatively charged calcium and magnesium.

In the final phase, the mineral tank is flushed with fresh water, washing the excess brine, calcium, and magnesium down the drain. The brine tank refills, making it ready for the next regeneration cycle.

The regeneration process can be controlled by a timer, a flow meter, or a hardness sensor. A timer regenerates on a preset schedule, regardless of the amount of water used. A flow meter regenerates based on the volume of water used, and a hardness sensor monitors the hardness level of the water and regenerates when necessary. This last sensor uses less salt and regenerates less frequently than do the other types.

The number of times the tank is regenerated, the amount of salt used, and the volume of backwash produced depends upon a number of factors, including the hardness of the water, the volume of water used, the size of the water softener, and the capacity of the resins to remove calcium and magnesium, but there are some guidelines.

A water softener used by an average family of four would need to regenerate approximately two or three times a week, according to the Water Quality Association (WQA) and would discharge approximately 50 gallons of backwash per regeneration. Canada Mortgage and Housing Corporation estimates the volume of backwash flow to be 140 to 400 liters per week, the equivalent of one to two standard filled bathtubs (Water Softener Fact Sheet CE41D), and the University of Minnesota Extension Service estimates 30 to 80 gallons per regeneration. According to some industry professionals, between 2.5 to 7 pounds of salt will be used to regenerate.

Regulations and Research
Since the 1970s, many communities and states have enacted regulations that ban the disposal of water softener backwash into onsite
systems based on the following assumptions:

• backwash contains high brine concentrations that can be harmful to the biological functions of the septic tank,

• regeneration of the water softener increases the hydraulic burden upon the septic system, adversely affecting its performance, and

• sodium from water softener discharge could cause changes in soil chemistry, making the soil less suitable to treat and dispose of effluent.

The Water Quality Research Foundation (WQRF, formerly known as the Water Quality Research Council) has maintained that these regulations were based on false assumptions and funded two studies in the late 1970s designed to answer these claims.

One of the WQRF-funded studies, titled “The Effect of Home Water Softener Waste Regeneration Brines on Individual Aerobic Wastewater Treatment Plants,” was done by the National Sanitation Foundation (NSF; now NSF International) in Ann Arbor, Michigan, and dealt with aerobic systems. The other study, “Potential Effects of Water Softener Use on Septic Tank Soil Absorption On-Site Waste Water Systems,” was done by the Small Scale Waste Management Project (SSWMP) at the University of Wisconsin in Madison and dealt with backwash effects on soil structure and permeability in anaerobic systems.

Research Results

The NSF study compared aerobic units with water softener brine to aerobic units without water softener brine. The salt concentrations used in these experiments were less than 1,500 milligrams per liter of sodium chloride.

NSF researchers found that brine wastes did not negatively affect the bacterial population living in the aerobic treatment tank, even when the system was loaded with twice the normal amount of brine. Instead, tests showed that water softener wastes actually helped with treatment processes.

The Wisconsin researchers also found that the additional amount of water discharged to a treatment tank during water softener regeneration did not negatively affect the septic system’s drainfield. According to the study, the volume of regeneration backwash discharged was no more than the volume of wastewater discharged from many automatic washing machines or other household appliances. Also, the regeneration backwash flowed slowly into the treatment tank to avoid causing hydraulic overload problems.

“A properly operating water conditioner should not cause a hydraulic overload on a properly functioning on-site sewage treatment system,” Roger E. Machmeier, Ph.D., P.E., Professor Emeritus, University of Minnesota, said. “If the onsite sewage treatment system is at full capacity, then additional water volume could cause some backup or sewage surfacing problems. The way to overcome that problem is to use less water elsewhere in the household or to expand the size of the soil treatment area. If the water conditioner is not maintained properly and recharges too frequently, a hydraulic overload could be entering the septic tank.”

The SSWMP study found that water softener regeneration backwash did not interfere with the percolation rate of water in the absorption field of a normally operating septic system. “Water softener effluents contain significant amounts of calcium and magnesium, which counteract the effect of sodium and help maintain and sustain soil permeability,” the SSWMP states.

WQRC said that the results of these two studies confirm that water softener regeneration backwash do not cause operational problems in the typical anaerobic or the newer aerobic home treatment plants. Both reports are available through the WQRC Web site (www.wqrc.org).
**Other Views**

Some wastewater system designers, manufacturers, regulators, and service providers have had experiences that contradict what WQRC contends. “In systems with water softener discharge, I have seen reduced scum layer development and a less distinguishable clear zone that could mean solids are remaining suspended instead of settling in the tank,” Terry Bounds, an engineer with Orenco Systems said. “Although the Water Quality Association has advocated for the discharge of softener brine to wastewater treatment systems, its references are limited to two specific and limited studies.”

Bounds points out that the studies do not reflect actual field conditions, including water softener malfunctions and too-frequent water softener regeneration. “Over the past 25 years, Orenco’s staff has seen repeated instances of impaired treatment system performance due to water softener discharge, especially with advanced treatment processes. Consequently, Orenco, like nearly a dozen other manufacturers of onsite wastewater treatment equipment, prohibits the discharging of water softener backwash into its advanced treatment systems.”

In 1973, “Wastewater Treatment Systems for Small Communities,” published by the Commission on Rural Water, stated that “High concentrations of sodium ions exchange with calcium and magnesium ions in the clay matrix. The exchanging ions alter the forces that hold the clay together and cause it to lose its structure... the clay becomes tighter and seals.”

“Calcium and magnesium salts usually aid in flocculating/aggregating clays to promote soil structure development and improve soil permeability,” Jim Gorman, soil science research instructor, West Virginia University, said. “Sodium salts do just the opposite. Sodium disperses clay particles and thereby reduces soil permeability. It is used for this purpose in pond and landfill liners where you would want to restrict water movement.”

**Iron Content in Water**

Iron in the water can also cause problems with the conditioner if proper maintenance is not done. “Iron in the household water will tend to cover portions of the resin beads, depleting the number of sites that can hold the sodium ion,” Machmeier said.

“Unless the homeowner has a management program of constantly cleaning the iron out of the resin bed, the bed will become less and less efficient. The conditioner will need to recharge more frequently. There will be a greater volume of water added to the onsite sewage treatment system. There will be more sodium chloride salt added since the amount of sodium chloride in the recharge has not changed, but now most of the sodium chloride cannot be used by the resin bed and ends up in the backwash water and the septic tank.”

**State Regulations**

Some states have recently rescinded bans that they previously placed on the discharge of water softener backwash into septic systems. “We were concerned that the salt from the backwash would cause clay soils to swell, reducing its hydraulic conductivity,” said Eleanor Krukowski, supervising environmental specialist with the New Jersey Department of Environmental Protection. "Discussions with soil scientists led us to conclude that the type of clay soil that would react to water softener backwash is rare in New Jersey, which has predominantly sandy soils, and studies linking backwash problems with drainfields have been inconclusive.”

In February 2003, the Montana Department of Environmental Quality created the DEQ Circular, which stated that “back flush water from water softeners must be excluded from sewer systems.” Water softener manufacturers balked at this statement, prompting Ray Lazuk, a subdivision program manager with the Montana Department of Environmental Quality, to issue a survey to sanitarians throughout the state asking about their experiences with backwash on septic system drainfields.

“Responses to the survey showed that some sanitarians believed that backwash could be a problem in clay soils, causing a hydraulic overload, and, therefore, the water department should be contacted for guidance,” Lazuk said. “Other sanitarians responded that if a water softener is properly operated and a drainfield correctly sized, then there should not be a problem. Since the evidence was inconclusive, Montana plans to revise the statement about backwash included in its technical circular.

Ken Spach, a manager with the Environmental Management Branch of Kentucky’s Department for Public Health, isn’t convinced that backwash is harmless to the drainfield. “There were only two studies (NSF and SSWMP), and they were completed in only six months,” Spach said. “I’d like to see more studies done over a longer period of time.”

Kentucky had planned to restrict discharging water softener waste into septic systems, but before they could submit this proposed regulation, along with others, to the legislature, the Water Quality Association threatened to sue. “We couldn’t hold up all the other regulations for just this one, so we took it out,” Spach said.

**EPA Fact Sheet**

In its Onsite Wastewater Treatment Systems Special Issues Fact Sheet 3: Water Softeners, EPA states “Home
water softeners, which periodically generate a backwash that is high in sodium, magnesium, and calcium concentrations, can affect wastewater treatment processes and the composition and structure of the infiltration field biomat and the underlying soil. However, attempts to predict whether impacts will occur and to estimate their severity are difficult and often inconclusive."

The fact sheet cites the studies conducted by SSWMP and NSF and lists some of the studies’ conclusions. The fact sheet neither endorses nor denounces the claims made in these studies.

**Septic Tank Corrosion**

There are no studies to confirm that water softener salt increases the degradation of concrete tanks, according to the Concrete Precasters Association of Ontario, Canada. Water pH, dissolved oxygen content, ammonia, chloride and flow velocity cause corrosion, and these factors are unaffected by the softening process.

"Concrete septic tanks manufactured in accordance with ASTM standard C1227 and the National Precast Concrete Association's Septic Tank Manufacturing Best Practices Manual should not have any problems with corrosion from salt," Machmeier said. "Corrosion of concrete tanks would be more likely in areas where there is drinking water containing high sulfides. Sodium chloride may get blamed for the concrete corrosion caused by the high sulfides."

Some wastewater professionals, however, believe that over a long period of time, backwash will create a saline environment, causing concrete tanks to corrode. Salt does not affect a septic tank made of either fiberglass or polyethylene plastic, because it is buried, it won’t degrade from ultraviolet light.

**Using Softened Water Outdoors**

Using softened water for lawn watering and other outdoor uses will increase the frequency of system regeneration and raise the costs of operating the water softener. In addition, the high sodium content of the softened water can also adversely affect the growth of grass and vegetation. “Although potassium chloride is commonly used as a grass and vegetation fertilizer, too much of it can be harmful to growth,” Gorman said.

**Health Risks**

Studies have shown that elevated levels of sodium in drinking water may have an adverse affect on health. Persons who suffer from high blood pressure or are on a sodium-restricted diet should check with their physician before drinking softened water or should have the kitchen cold water faucet bypass the water softener.

**Possible Solutions**

Concerns about water softening brine and its possible effects on septic systems can be reduced in a number of ways. Installing a water softener that regenerates based on need rather than on a timer will increase the length of time between regeneration cycles.

Substituting potassium chloride for sodium chloride to soften water reduces the amount of sodium in drinking water, contributes potassium to people’s diets, eliminates the addition of sodium from water softeners into a septic tank and drainfield, and is as effective as sodium chloride. The water softening process works the same for potassium chloride as it does for sodium chloride.

An offsite water softener has a portable exchange unit that a service provider periodically replaces. The brine is disposed of in a manner that does not involve a wastewater system. For onsite water softeners, homeowners can establish a separate drainfield for brine. Carbon filtration units and catalytic devices remove hardness minerals from household water without generating brine or adding salt to the drinking water. Newer home construction could separate drinking and external water usage lines from those involving washing, showering, water heating, etc.

**Future Research**

One thing that everyone agrees on is that more research is needed. In 1984, researchers E.J. Tyler, R.B. Corey, and M.U. Olotu, from the University of Wisconsin in Madison developed a research report for the Water Quality Research Council. Titled “Potential Effect of Water Softener Use on Septic Tank Absorption in On-Site Wastewater Systems,” the report recommends that studies be initiated to determine the effects of solutions containing conductivities of natural soil columns and actual salt concentrations in various zones of septic tanks with and without the addition of water softener wastes."

Machmeier agrees with the statement in EPA’s fact sheet that says the influent (to the water conditioner) with its high concentration of sodium ions is very different than the effluent (from the water conditioner), which has a high concentration of calcium and magnesium ions. He contends, however, that the statement that says, “Consequently, the potential for chemical clogging of clayey soil by sodium ions is reduced. The calcium and magnesium input may even help improve soil percolation,” needs to be more carefully evaluated. “The caveat words are ‘potential’ and ‘may,’” Machmeier said. "The calcium and magnesium ions as carbonates or bicarbonates would be contained in the septic tank effluent if no water conditioner were used. With the use of a water conditioner, the carbonates and bicarbonates are sodium and the chlorides are calcium and magnesium."

“So far, I have not seen any research that compares to typical environmental engineering sciences in anaerobic digesters,” Bounds said. “Most of the reports that I’ve seen suggest that this research still needs to be done.

**Responsibility of Water Softener Manufacturers**

“Water softener manufacturers must help customers deal properly with the residual product that their appliance generates, Bounds said. “This waste product is not the result of a biological process, nor does it contain coliforms or other microbial contaminants. For these reasons and others, it does not belong in a biological wastewater treatment system, at least not in the manner as currently practiced, without limits or controls.”

For more information, contact your local county extension office or state health department, the National Precast Concrete Association at [www.precast.org](http://www.precast.org), the University of Minnesota Extension Service at [http://septic.umn.edu/homeowner/index.html](http://septic.umn.edu/homeowner/index.html), Gorman at [jjgorman@wwu.edu](mailto:jjgorman@wwu.edu), Krukowski at [Eleanor.Krukowski@dep.state.nj.us](mailto:Eleanor.Krukowski@dep.state.nj.us), Lazuk at [rlazuk@mt.gov](mailto:rlazuk@mt.gov), and Spach at [Ken.Spach@mail.state.ky.us](mailto:Ken.Spach@mail.state.ky.us).
To ancient cultures, the Sun was identified as being a god. The Egyptians saw the Sun as the eye of Ra, the falcon-headed god, creator of light and all things. To the Aztecs, the Sun was the result of Huitzilopochtli, the god of war, jumping into a fire as commanded by the four gods of creation. Apollo was the Greeks’ Sun god, responsible not only for illuminating the Earth with light, but with illuminating the human mind with understanding.

There is no doubt that the Sun was of great importance to the ancient cultures. As we know today, without the Sun, life on Earth would not exist at all. The Sun’s light and heat influence all objects in the solar system and allows life to exist on Earth. The Sun provides the Earth with vast amounts of energy every day. The oceans and seas store this energy and keep the temperature of the Earth at a level that allows a wide variety of life to exist. Plants use the Sun’s energy to make food, and plants provide food for other organisms.
With the depletion of natural resources such as oil and natural gas, many are now turning to the Sun as well as other alternative energy sources to treat wastewater.

**Solar Energy**

Over the course of two years, the Sewerage Commission-Oroville Region (SCOR) wastewater treatment plant in Oroville, California, saw its energy costs skyrocket by 41 percent. The treatment plant has 16,000 service connections and is designed to treat 6.5 million gallons of wastewater a day.

“Our facility is entirely supported by user fees, so if our cost of treatment goes up by a dollar we have to split that dollar up amongst all of our ratepayers in order to keep the business in the black,” said Bill Lampkin, environmental compliance manager at SCOR.

To alleviate the problem, the treatment plant converted to 80 percent solar energy, making it the first predominantly solar wastewater treatment plant in the nation in 2002. A 520-kilowatt solar power system was installed by Sun Power and Geothermal Energy of San Rafael, California. The system is composed of solar photovoltaic (PV) array panels that convert sunlight directly into electricity. The panels are mounted in a three-acre field next to the wastewater treatment plant on dual-tilt supports.

So far, the solar-powered system has saved the plant hundreds of thousands of dollars and helped them avoid large rate increases. Lampkin said the key to the wastewater plant’s savings is that their local electric utility company, PG&E, has set up a net metering program. With net metering, the excess energy that is produced from the PV system during the day is credited by the electric company to the customer.

“The thing that makes it work out dollar wise for us is that we actually produce more power than we use during the day, and since you can’t store electricity, PG&E credits us for that excess production during the day. We use that credit as an offset for the electricity we buy,” Lampkin said. “PV can be used anywhere in the country for residential or commercial use. For it to work, you need sunlight, you need to have the land area to set it up, and you need to have net metering legislation in place.”

Net metering policies vary from state to state, and some states have no net metering legislation at all. To find out if your state offers net metering, visit the U.S. Department of Energy The Green Power Network Web site at [www.eere.energy.gov/greenpower/](http://www.eere.energy.gov/greenpower/).

**Solar- and Wind-Powered Aerators**

In 2001, Hopland Utility District in Hopland, California, became the first utility district in the state to use a solar-powered wastewater mixer called the Pond Doctor, which has allowed the district to cut their power costs by 90 percent.

The town of Dickinson, North Dakota, has 15 Pond Doctors in its lagoons. The mixers’ total cost was $176,000 but the mixers have already paid for themselves. The city’s electricity bill from its wastewater system decreased by about $14,000 in its first year. But the largest cost savings comes from not having to improve a temporary wastewater holding site, which the cost estimate for it was $500,000.

Wayne Ruzicka, president and inventor of the Pond Doctor, Inc. said, “My primary purpose in developing the pond doctor was to improve consistency and performance with low energy, put these systems back into compliance, and provide these communities with another option besides installing expensive conventional aeration equipment.”

Customers have also reported significant sludge and odor reduction with the Pond Doctor, which Ruzicka attributes to the device’s unique aeration system called controlled mix stabilization (CMS)™. Typically, aerators either take oxygen from the surface of the water and force it to the bottom, or throw water into the air, or operate like a fish tank and diffuse air from the bottom. With the CMS process, the oxygen-deficient water at the lower levels of the pond is brought to the oxygen at the surface.

“The Pond Doctor is much like your heart,” Ruzicka said. “Your heart is simply a muscle that pumps oxygen-deficient blood from your toes back up to your lungs where it receives oxygen. The oxygen is transferred to the brain and the heart pumps it back again, very much like the Pond Doctor does. It pumps oxygen-deficient water from the ex-

In the photo below, ripples are created by a solar powered Pond Doctor, providing surface renewal (re-aeration). This "stretching" of the pond surface increases oxygen absorption and improves oxygen distribution deeper into the pond, thus creating an aerobic layer to control odors and improve aerobic digestion.

Photo courtesy of Pond Doctor, Inc.
tremities of the pond to the Pond Doctor and to the surface, where it gains oxygen in a thin film and then pumps it back again. It’s a circulation process.”

Ruzicka has been in the wastewater pond business for more than 15 years. So far, there are more than 200 Pond Doctor installations throughout the U.S. It wasn’t easy initially for Ruzicka to convince city councils that the Pond Doctor would help their failing lagoons.

“We didn’t have a track record, so we offered 100 percent money back guarantee if it didn’t work,” Ruzicka said. Since that time, research on the CMS process has been compiled, along with many satisfied customers to prove that it works.

There are also several different wind-powered pond aerators on the market. One example is Koenders Pond Aeration Windmills and another one is called Wind Driven Pond Mills. These aerators use wind to power an impeller that creates a vortex in the water to circulate and aerate. The vortex action brings oxygen-depleted water from the bottom of a pond to the surface where absorption of atmospheric oxygen takes place.

WASTEWATER GREENHOUSES

The Ashfield Wastewater Treatment Plant is the first municipal Solar Aquatics System wastewater treatment plant in the state of Massachusetts. This plant serves about 165 households. The Solar Aquatic Process takes up about 10,500 square feet of greenhouse space. The greenhouse is not only functional but aesthetically pleasing with banana trees, flowers, a parrot flying free, numerous turtles, fountains, and even a daily monsoon, complete with sound effects.

Demonstrating the future—children learn about solar energy cells by observing a solar water pump at the Clearwater Festival in New York State. Photo by Augusto Menezes.

The Solar Aquatics System is a patented ecological technology for purifying wastewater that duplicates, under controlled conditions, the natural purifying processes of fresh water streams, meadows, and wetlands. The Solar Aquatics System was invented by John Todd, Ph.D., a professor of ecological design at the University of Vermont who was named “Hero for The Planet” by Time magazine in 2000.

With this process, the wastewater flows through a series of biosystems where plants, algae, and other organisms remove contaminants such as bacteria, organic nutrients, pathogenic bacteria, suspended solids, and biochemical oxygen demand.

The whole system is contained in a greenhouse to sustain year-round operation. The abundance of plants helps to clean the water and air, resulting in a quiet and odorless treatment plant.

MICROBIAL CELL RESEARCH

If waste produces energy, can we really call it waste? Research conducted by scientists at Pennsylvania State University in University Park, may leave some pondering this question.

The research, called microbial fuel cell research, is a new method of renewable energy recovery. The microbial fuel cell captures electrons that are naturally released by bacteria as they digest organic matter and then converts the electrons into electrical current.

Bruce E. Logan, Ph.D., professor of environmental engineering at Pennsylvania State University, has been working to develop the microbial fuel cell for the past two years. Logan reports that so far, the microbial fuel cells can only produce a minimal amount of energy, but hopefully that will change as technology improves.

This technology would be ideal for wastewater treatment plants, which could power themselves as they treat the water. “Ultimately, I think this will lead to a process that will replace trickling filters and activated sludge,” Logan said, “a process that produces energy instead of consuming it. It could even eventually turn your local wastewater treatment plant into your local energy plant.”

For more information on these alternative energy resources, contact Lampkin at (530) 534-0353 or scor-bill@oroville.net, Ruzicka at (701) 258-6236 or wayner@ponddoctor.com, the Ashfield Wastewater Treatment Plant at (413) 628-0110, and Logan at (814) 863-7908 or blogan@psu.edu.
Sedgwick County, Kansas, had a problem. Years of functioning under an inadequate wastewater code had led to failing onsite wastewater systems, limited lot sizes, and a shrinking supply of agricultural land. An outcry for a solution came from industry professionals and the general public.

In response, county officials incorporated an “Onsite Wastewater Section” into the existing Sedgwick County Department of Code Enforcement, initiating a major revision of the existing code.

The way they went about it, and the apparent success of the program, might help other like-minded communities crack the code for managing onsite wastewater treatment systems.

The situation prior to the code revisions of 2002 was dire. The antiquated code allowed the use of outdated materials for septic systems and prevented the use of the more advanced wastewater treatment options available today.

Septic systems from one to 10 years old had been failing, older subdivisions with limited lot sizes were running out of room to install replacement systems, and because of existing acreage requirements for lagoons, large amounts of valuable agricultural land was disappearing.

“We have multiple types of soil,” said Glen Wiltse, director of the code department. “We have very tight clay soil in parts of the county, sandy soils in others because of the many rivers, and a high groundwater situation. In addition, we have a lot of sand pit operations, which are ultimately being used for housing development.”

Although the exact number of failing systems has never been documented, Wiltse said “a significant number” of the county’s systems were failing, inadequate, or in violation, which can impact water quality and overall public health.

The city of Wichita is located in Sedgwick County, which covers a total of 1,007 square miles. Population of the county is in excess of 400,000.

The 2000 U.S. Census report shows that approximately 30,000 homes in the county are served by some type of onsite wastewater treatment systems. The situation prior to the code revisions of 2002 was dire. The antiquated code allowed the use of outdated materials for septic systems and prevented the use of the more advanced wastewater treatment options available today.

Septic systems from one to 10 years old had been failing, older subdivisions with limited lot sizes were running out of room to install replacement systems, and because of existing acreage requirements for lagoons, large amounts of valuable agricultural land was disappearing.
The existing code the county had been operating under through the county/city organization had not been updated since 1985, when it was first adopted. “It had been pretty much left in the same condition with the same requirements,” said Wiltse, adding that it was obsolete.

One reason for the failure rate is the number of subdivisions with small lots that were installed 30 to 40 years ago, according to Wiltse. “Due to minimal space availability, some of these homes have multiple systems—basically septic systems installed on top of older septic systems. In some of these subdivisions, it was not uncommon to be working on the second or third treatment system due to the premature failures caused from the use of such materials as unwashed gravel, which was permitted by the code at the time,” he said.

In addition, Wiltse noted that these older systems were designed for less water usage than is prevalent today from dishwashers and increased washing machine loads.

An urban sprawl has also added to the county’s wastewater dilemma and highlighted the urgency for better management of codes. “There has been considerable movement to the exterior of the city limits,” said Wiltse. “We issued 400 onsite wastewater permits last year.”

By establishing the new code, Wiltse said, “We could eliminate the use of damaging materials and incorporate more advanced technologies and ongoing maintenance activities.”

Tim Wagner, water quality specialist with the department of code enforcement, said, “The process began by establishing a procedure to permit onsite wastewater systems, manually, in order to keep the operations moving forward with very little interruption of services, as they moved from a combined city/county health department to a county code enforcement agency. During the transition, the county started following up on existing permits issued before the county took over, as well as issuing permits and inspecting those permits.”

The county, which already issued building permits and did inspections on homes and commercial buildings, hoped to create a one-stop area for contractors to come and get all their building permits and other information from one agency.

**Inventing the Wheel**

Wiltse said the first step in adopting any new codes is to get the building trade, plumbing, mechanical, and electrical boards involved. “When you bring the industry into the process of developing the codes, it is much easier to get the codes approved later. We had everybody on board who wanted this code and the new technology before we took it to our respective governing bodies,” he said.

Wagner echoed Wiltse’s comments, adding that beginning a dialogue with these groups of installers was important to determine what changes were needed, as well as what changes were wanted by the industry.

Wiltse’s department drafted the initial code, then held meetings with wastewater installers, the Wichita Area Builders Association, and the Kansas Department of Health and Environment. The next step was to establish a wastewater advisory board.

The advisory board consists of five members: one licensed onsite wastewater installation and maintenance person, one licensed sanitary service provider, two members of the general public residing within the county, and one professional engineer who practices in Sedgwick County. The board members are appointed by the Sedgwick County Commissioners and serve four-year terms.

The board’s purpose is to advise the county commissioners and code enforcement department on policies and procedures of onsite wastewater management.

The board also hears appeals of orders, decisions, or determinations by the code enforcement office concerning applications, licenses, or permits.

Construction standards for different types of onsite systems were not included in the sanitary code. Instead, they were established as separate construction policies within the department and are being constantly reviewed and changed, according to Wagner.

In addition, through a separate resolution, a licensing program was instituted to license installers. In a
second resolution, the septage pumpers were licensed, which allows the county to request a log of all pump outs and disposal locations of the waste.

“We have upgraded construction standards for both conventional septic systems and lagoons,” Wiltse said. “We have also revised the licensing resolution with continuing education requirements in order to renew their licenses annually. A license may contain two designations of wastewater installer or advanced system wastewater installer. Each designation requires separate requirements and different continuing education requirements.

“The initial license is for the installation of conventional septic systems and lagoons and requires eight hours of classroom time per year. The advanced wastewater designation requires testing and 16 hours of classroom time per year. We’ve had virtually no opposition whatsoever with all of the changes that we’ve taken to the governing bodies. The industry people actually come to the meetings in support of the new codes.”

Homeowners are not permitted to install their own wastewater systems and are not allowed to service their own systems. Despite this stipulation, Wiltse said there have been no complaints from homeowners, either.

The code enforcement office is currently working toward a countywide drinking water code program as well. “Currently, wells are under the jurisdiction of the Wichita Health Department. On July 1, 2005, that division will also come over to our department. We have not formally adopted anything at this moment, but we are in the process of drafting some water codes,” Wiltse said.

“We’ve met with the well drillers and gotten some consensus on what they would like to see. We will be preliminarily setting up a committee for a combined wastewater/water advisory board—the same process we used for the wastewater codes.”

**Code Specifics**

The wastewater code applies to areas of Sedgwick County excluding properties that exceed 640 acres that are used for only agricultural purposes. The code also applies to all new construction of onsite systems. Pre-existing onsite systems are not subject to this code until they are modified, enlarged, or replaced or when an inspection finds them to be failing.

The basics of the existing code were left in place. Following are some of those requirements.

Under the code, a new onsite system must be constructed on a minimum of 20,000 square feet if it is served by a public water supply and 40,000 square feet if it is served by a private well. It also must have a minimum of 50 feet horizontal separation from any domestic water supply well and 100 feet horizontal separation from any public well.

For a lateral field, a 10,000 square feet reserve is required with a one-inch absorption or greater occurring within five to 60 minutes. The area must have at least four feet of permeable soil above any clay, shale, or rock formation and must have a groundwater elevation of at least 10 feet below the ground surface for standard construction.

Wastewater lagoons must have a minimum horizontal separation of 100 feet from other properties. Drainfields require a minimum horizontal separation of 25 feet from other properties.

Other specifications of the code include the following:

- No onsite system should be constructed within 400 feet of an existing sewer.
- Owners must notify the director of the code enforcement office if they intend to construct or modify an onsite system and apply for a permit to submit a specific design proposal.
- Once a permit is approved and a system is installed, it must be inspected by the director of the code enforcement office.
- If installation does not meet the requirement, corrections are ordered and another inspection will be conducted.
- If a permitted installer covers a system before inspection, an administrative hearing will be held and may result in the suspension or revocation of the installer’s permit.
- If a system fails to be constructed satisfactorily within one year, the application becomes invalid.

The major changes to the code language were to clean out sections that were not pertinent to the sanitary code (such as animal control), to add a licensing requirement for installers, and amend the code to allow the use of advanced technology.

**Alternative Systems**

An alternative or enhanced system is defined in the code as any system that produces a higher-quality effluent than that from a conventional septic tank, specifically all media filter, aerated tanks, and mounds followed by soil absorption, including drip irrigation.

Since the new codes were instituted in October 2002, 55 to 60 alternative system units have been installed. “We have entire subdivisions now where only alternative systems are permitted because of the soil types and shallow groundwater situations,” Wiltse said.

Before any permits are issued for an advanced wastewater system, a restrictive covenant must be completed by the homeowner and filed with the register of deeds.
The covenant states that the homeowner will keep a maintenance contract in place for the life of the system. These systems are also required to operate on an annual operating permit to be renewed January 1 of each year.

Subsurface, pressurized drip irrigation systems are the main type of dispersal currently utilized behind advanced wastewater treatment systems the county now permits.

Cyndra Kastens, Sedgwick County water quality specialist, said, “Of onsites where advanced wastewater treatment is required, only those systems with the NSF Standard 40 class 1 designation are approved. We know those systems are going to provide a better quality effluent than what we were using before.”

Though the county is not at this time planning to perform any site specific effluent testing on the approved systems, both Wiltse and Kastens remain confident that based on the NSF test data, the use of the advanced treatment systems bring a significant improvement in water quality.

Wiltse added that the codes are constantly evolving. Currently, his office is in the process of updating the codes to include specific regulations about installation of drip fields. “Alternative system locations can be site sensitive,” he said. “If you go in and start doing soil work over the whole property, it makes it more difficult to install some of these drip fields. We will be requiring contractors to stake the drip field area off, and then keep the heavy equipment and anything that’s going to compact or disturb the soil off of the area. The contractors are in favor of it.”

Another update will be requiring a little more information from contractors concerning the equipment list to make sure materials from different manufacturers’ products are not being mismatched. “We just want to make sure that what we think they are installing is what the customer is actually getting,” Wiltse said. “It’s the little stuff that can make a big difference at some point.”

Reviewing the code for changes at this time has lead Sedgwick County to investigate the National Onsite Wastewater Recycling Association’s Model Performance Code For Decentralized Wastewater Infrastructure Guidance, currently out in draft form (see www.nowra.org). Wiltse believes the changes will be in line with those recommendations.

In addition to code revisions, the county is also revising the licensing resolution and adding two members to the advisory board for a broader representation.

Maintenance of traditional septic systems and lagoons may be in the offering, but has not been incorporated in the code yet.

**Advice to Others**

“To me, the first thing you do is to go to the industry,” Wiltse said. “Find out what their problems are, what their heartburns are. Sometimes it may be painful to hear what they say, but it’s a lot easier to hear it one-on-one instead of when you’re in front of the governing body and something comes up that you didn’t know about.

Wiltse cautions that industry representatives should be brought into the process early. “You should talk to them before you get too far involved,” he said. “Let them have an involvement in it from start to finish, and you’re going to get considerably more out of that code than if you try to do it all yourself.”

The advisory board is another important component, according to Wiltse.

Kastens echoed Wiltse’s advice, “It is important to maintain some type of involvement with the different state and national organizations as well. You’ve really got to be able to stay up with the industry and the latest research and technology, not only for the regulatory staff, but also for the local installers who are out there in the trenches every day. You have to provide opportunities for education for them. It is a changing industry. We’ve got to make every effort to stay on top of it.”

For more information, contact Wiltse or Kastens at (316) 383-7951 or visit the Sedgwick County website at www.sedgwickcounty.org.
All you have to do is ask.

The National Environmental Services Center (NESC) exists to assist small and rural communities with their drinking water, wastewater, environmental training, solid waste, infrastructure security, and utility management needs and to help them find solutions to problems they face.

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In recent years, much effort has been focused on improving the security of the nation’s water infrastructure. Now that the deadlines for the federal Bioterrorism Act requirements have come and gone, what’s next on the horizon for water and wastewater systems? We interviewed U.S. Environmental Protection Agency (EPA) officials and other experts to learn about the status of national water and wastewater infrastructure security and emergency response planning (ERP), the resources available to small communities and trainers, and what the future may hold for small system security and ERP.

**Bioterrorism Act Requirements and Compliance**

The first major step toward improving water sector security nationwide was taken June 12, 2002, when the Public Health Security and Bioterrorism Preparedness and Response Act (better known as the Bioterrorism Act) was signed into law. Title IV of the Bioterrorism Act included specific requirements for community drinking water systems serving more than 3,300 people. First, these systems were required to prepare and submit vulnerability assessments (VAs) to the EPA. The deadline for systems serving from 3,301 to 49,999 residents was June 30, 2004. According to Andrew Bielanski, an environmental engineer and small systems expert with EPA’s Water Security Division, 95 percent of the approximately 7,900 water systems this size have completed the VA requirement, and 95 percent have sent VA certifications to EPA.

Most of the nation’s water systems have also met the second phase of the Bioterrorism Act requirements by submitting emergency response plan certifications due in December 2004. “Eighty-six percent of systems in the 3,301 to 49,999 category have sent their ERP certifications to EPA,” says Bielanski. “EPA is working to achieve 100 percent compliance from these systems.”

With these security and emergency preparedness requirements mostly satisfied, will EPA be giving guidance to drinking water systems serving 3,300 or fewer? And will anything be required of wastewater systems?

**New Security Measures To Be Voluntary**

According to Bielanski, the only mandatory federal requirements are those set forth in the Bioterrorism Act that apply to community drinking water systems serving more than 3,300 people. Other water sector security measures are voluntary and are likely to stay that way for the foreseeable future. Right now, there are no similar requirements for smaller drinking water systems or for wastewater utilities.

“EPA’s goal is to provide the water sector with the tools, training, and information it needs to prevent, prepare, and respond to different kinds of threats,” says Bielanski. “Unless Congress passes legislation that’s enacted into law, water security efforts will continue to be voluntary at the federal level.”
Voluntary Guidance Coming for Smallest Drinking Water Systems

The Bioterrorism Act does require that EPA produce a security guidance document for community drinking water systems serving populations of 3,300 or fewer. Bielanski expects the document to be published in August or September 2005.

“The guidance will incorporate what we have learned so far in water security and won’t differ greatly from what was asked of larger systems,” says Bielanski. “However, the information presented in the guidance will be in a simple and straightforward format that is more in tune with the needs of smaller communities.”

Bielanski emphasized again that the recommendations in the guidance are voluntary, pointing out that there are no federal requirements for these smaller water systems. When completed, the guidance’s availability will be announced in the National Environmental Services Center’s (NESC) publications and on its Web site at www.nesc.wvu.edu.

EPA, Water Groups, Utilities Collaborate

EPA and other groups have been working together to evaluate national water sector security and to develop additional voluntary recommendations for both drinking water and wastewater utilities. The National Drinking Water Advisory Council’s (NDWAC) Water Security Working Group, whose members represent water and wastewater utilities, public health officials, and groups such as the Rural Community Assistance Partnership, was formed to provide expert advice to EPA on best security practices and policies for the water sector.

Among the working group’s challenges was to decide what constitutes an “active and effective” security program and identify incentives and other ways to overcome obstacles to implementing voluntary programs. The group also examined the problem of how to evaluate and track the effectiveness of security programs on a national level as well as within individual utilities. After completing a series of public and private meetings around the country, the group presented its findings to the NDWAC. The report will be available to the public in the fall from EPA’s Web site at www.epa.gov/safewater/ndwac/council.html.

Another series of meetings, the Water Sector Security Workshops, hosted by the Water Environment Federation (WEF), EPA’s Water Security Division, EPA’s Homeland Security Research Center, and eight partner organizations including NESC, was completed in July. WEF and EPA will issue a final report of these findings to the water sector. James Sullivan, WEF general counsel, says the purpose of the workshops was to identify trends and needs for water sector security.

NESC To Publish Top 10 Wastewater Security List

The National Environmental Services Center (NESC) is developing a new security resource for small wastewater systems. This top 10 list of security and emergency preparedness actions is funded by the U.S. Environmental Protection Agency (EPA).

“The overall goal of this project is to foster improved emergency preparedness and security among the nation’s smaller wastewater systems,” says John Hoornbeek, Ph.D., NESC’s director of training. The vast majority of wastewater systems in the U.S. are small systems.

“This top 10 list will be a supplement to existing wastewater resources, and one that may be particularly useful in reaching those small wastewater systems that have been reluctant to conduct full vulnerability assessments,” notes Hoornbeek.

The list will identify 10 actions that apply to systems across the country, significantly improve emergency preparedness and security among these systems, and are practical for implementation by smaller wastewater systems.

NESC is spearheading the effort in coordination with a panel of wastewater security experts from around the country.

The top 10 list will be available in the fall and will be announced in NESC’s publications and on its Web site.
“The workshops looked at what has happened in water sector security since the VAs and ERPs have been completed, current security needs, and what still needs to be done,” says Sullivan. “Although the Water Sector Security Workshops were different from the NDWAC Water Security Working Group meetings, they were complementary efforts. So when the joint WEF/EPA final report is issued, it will reference the recommendations of that group and draw parallels between the two efforts where appropriate.”

Reports from the first two Water Sector Security Workshops held in Phoenix, Arizona, and Philadelphia, Pennsylvania, are available via the WaterISAC’s Water Security Channel (WaterSC) located at www.watersc.org. To learn more about the Water Sector Security Workshops, including information about the partner organizations involved and the meeting agendas, visit www.watersecurity-workshops.com.

**Wastewater Security Materials Available**

Securing drinking water systems is a national priority, but protecting the nation’s 16,000 plus wastewater treatment plants and associated collection systems is also vital to safeguarding public health, the environment, and the economy. According to Jim Wheeler, an environmental engineer with EPA’s Office of Wastewater Management, although there does not appear to be any move toward developing security regulations or requirements for wastewater systems, there has been a lot of work focused on providing information and voluntary guidance.

“EPA has developed several documents on vulnerability, emergency response planning, and a security products guide for wastewater systems,” says Wheeler. Links to the documents and other information can be accessed at EPA’s Water Security Web site located at http://cfpub.epa.gov/safewater/watersecurity/index.cfm.

Among the products Wheeler references is the guidance document, Protecting Your Community’s Assets: A Guide for Small Wastewater Systems, which was developed by NESC. The guide includes a set of checklists and planning tools to help wastewater operators and managers identify and reduce their system’s vulnerability to external and internal threats, such as natural disasters, terrorism, vandalism, or a disgruntled employee. The guide also can be downloaded online at no charge from NESC’s Web site located at www.nesc.wvu.edu/netscsc/netscsc_index.htm.

WEF has announced the release of a new publication, Wastewater Threat Document, on the Water Security Channel (WaterSC) located at www.watersc.org. Dan Rees of Scientech, LLC, project manager for the development of the document for WEF, says it was designed to help managers and operators of wastewater systems better understand and address potential vulnerabilities and threats to their facilities. “The document provides communities with a process for identifying security vulnerabilities and threats to wastewater system assets,” says Rees. “Risk managers can base their vulnerability assessments on the information gathered.”

**Designing Secure Water and Wastewater Facilities**

Now that security has become a national priority rather than an afterthought, it makes sense that new water and wastewater systems begin service with as many security and emergency preparedness features built in as possible. The American Society of Civil Engineers (ASCE) in cooperation with EPA, WEF, and the American Water Works Association (AWWA) has formed a committee to develop voluntary security design standards for wastewater, drinking water, and stormwater systems.

According to EPA’s Wheeler, the document, tentatively titled Voluntary Design Standards for Security Enhancement of Water and Wastewater Systems, will be developed in phases over the next three years. However, the partnership created the following three preliminary documents, which are available for download from WEF at www.wef.org/watersecurity/:

- Interim Voluntary Security Guidance for Wastewater/Stormwater Utilities,
- Interim Voluntary Security Guidance for Water Utilities, and
- Interim Voluntary Guidelines for Designing an Online Contaminant Monitoring System.

In the absence of the final, comprehensive design standards, these publications outline some voluntary security measures that com-
munities can implement when building new facilities or retrofitting old ones. The status of the multi-phase voluntary system design guidance project can be followed at ASCE’s Web site at www.asce.org/static/1-wise.cfm.

**EPA: Training is Key to Success**

Although there are many resources available to communities who want to improve system security and emergency preparedness, simply providing access to information is not enough. Small communities, especially, need help sorting through and adapting the myriad of information available.

“Training truly made a difference and is the key to success,” says EPA’s Bielanski. “Training plays a critical role in getting the proper information out to systems and helping them understand the purpose and requirements of what they are to learn or accomplish. Without training, I don’t believe we would have had the high compliance rates in meeting the Bioterrorism Act requirements.”

Bielanski says the most important thing that trainers working with water and wastewater systems should be aware of is that security is here to stay.

“People must change their attitudes and perspectives to water security,” he says. “It also shouldn’t be an overwhelming or single issue—it can be incorporated with other aspects of system operation training.”

For example, Bielanski suggests that security issues can often be incorporated into operator and board member training. He points out that preparation for emergency response is not limited to intentional acts—the training is also applicable to natural disasters. Trainers should be aware of the links that can be drawn between security and normal system operation.

“Smaller community systems may not have the resources to fully understand these tools and guidance,” Bielanski says. “So training and trainers will keep playing a vital role in getting the proper information to systems.”

A different version of this article was first printed in the Summer 2005 issue of the NESC newsletter E-Train.

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**NESC offers security training module for local officials**

The National Environmental Services Center (NESC) has developed a resource for trainers working with small community decision-makers and local officials. Due Diligence—Small Water System Security is the latest addition to Managing a Small Drinking Water System: A Short Course for Local Officials training package. This module addresses security and emergency response from the local official’s perspective and outlines five key guidelines for securing the community water system:

1. Recognize and understand the threats to your water system.
2. Comply with local, state, and federal requirements.
3. Assess vulnerabilities and secure the water system.
4. Be prepared to respond and recover from emergencies.
5. Know your responsibilities and provide leadership.

The module also includes key vulnerability assessment, security, and emergency response tools that a local official can provide to system personnel for addressing these issues and for developing a culture of security at the water system.

The module can be used as a stand-alone training resource, for self-study, or as part of the complete 11-module package of resources designed for training local officials. For more information or to order, contact NESC at (800) 624-8301 or (304) 293-4191, and request Item #TRPMCD62. Cost is $32.00, plus shipping and handling charges.
Abstract:
If daily hydraulic loading rates exceed the hydraulic capacity of the subsurface beneath cluster and high-density wastewater soil-absorption systems, groundwater mounding may occur and negatively impact treatment system performance. Mounding can occur as perched water on low hydraulic conductivity lenses or as excessive elevation of the water table. Mounding may alter flow directions, result in effluent seeps at the surface, and/or cause lateral movement of water, affecting nearby water supplies or water bodies. Most critical is evaluating the potential for reduction of the vadose zone thickness, which could result in inadequate conditions for treatment of wastewater pollutants. This paper presents a flow chart and decision-support tool that establishes the strategy level for site investigation and evaluation based on the potential for groundwater mounding and the consequences should it occur. The strategy level indicates the appropriate characterization activities and modeling approaches.

In the past, system designers and regulators have not generally considered the potential implications of excessive mounding of water below wastewater soil-absorption systems (WSAS) because most systems were small and isolated. However, cluster and high-density WSAS (typically defined as those receiving more than 2,000 gallons of wastewater per day [gpd]) are increasingly being used to serve residential and commercial developments. Insufficient hydraulic capacity of the subsurface at these larger WSAS sites may result in
• significant groundwater mounding on low hydraulic conductivity lenses or excessive elevation of the water table (which may alter saturated flow direction or reach the surface), and/or
• and/or lateral movement of water, which may affect nearby water supplies or water bodies, or may cause effluent breakout on slopes in the vicinity of the WSAS (Figure 1).

This article addresses design with respect to groundwater mounding and presents a methodology that addresses
• the evaluation of site-condition and system-design influences on the potential for groundwater mounding and lateral spreading, and selection of investigation techniques and modeling approaches based on site conditions, system parameters, and
• the severity of the consequences of excessive mounding.
• evaluation of the potential for groundwater mounding and break-out on the surface or side slopes requires different levels of effort depending on the characteristics of the subsurface and the consequences of excessive mounding on system performance.

Methodology
Design of cluster WSAS with respect to hydraulic mounding involves consideration of the loading rate, number, and sizing of multiple onsite systems. The first consideration in design of a large WSAS is to specify an overall size of the infiltration area that, when coupled with the anticipated volumetric loading rate, results in an infiltration rate that is less than the vertical hydraulic conductivity of the infiltration zone after a wastewater-induced biozone has developed to prevent the development of excessive ponding of wastewater over the infiltration area. That is Q/A < Kv, for consistent dimensional units of volume, length, and time.

Next, recognizing spatial constraints of the site and reasonable dimensions for construction of a network of subsurface infiltration trenches, the designer strives to elongate the infiltration area in the direction perpendicular to groundwater flow beneath the site, which should minimize mounding compared to other orientations of...
the trench network relative to the groundwater flow direction. After establishing a reasonable design, consideration is given to the potential for perching and mounding of water on low hydraulic conductivity layers in the vadose zone and, ultimately, the rise of the water table required to carry the treated wastewater that percolates to the groundwater away from the site. A phased approach indicates more investigation as the risk of mounding increases and the consequences associated with excessive mounding become more severe. A flowchart (Figure 2) guides preliminary assessment and indicates subsequent steps based on preliminary site investigation that determines soil types and depth to groundwater. A decision-support tool extends the method, following the philosophy of investigating the potential for groundwater mounding below WSAS.

**FIGURE 1**
Potential groundwater mounding below WSAS

**FIGURE 2**
Flowchart for preliminary assessment of the potential for groundwater mounding guides subsequent steps of the assessment process
that the degree of characterization and associated cost should be considered in light of the potential for mounding and the consequences for WSAS performance (Tables 1 to 5). The decision-support tool utilizes additional qualitative information as well as site-specific quantitative data from field investigations to determine the strategy level for site assessment. The strategy level provides a guide to the magnitude and intensity of field investigation and the sophistication of implementing the design (e.g., simple equations versus more complicated mathematical modeling).

**Design Approach**

The flowchart (Figure 2) is a technical aid that does not consider local regulatory requirements; rather it describes the basic evaluation requirements and may establish that no further action is required with respect to design related to mounding of groundwater. (Further evaluation may be necessary for treatment consideration, but this article only addresses design issues related to groundwater mounding.)

For example, a coarse-grained soil with relatively high hydraulic conductivity with no low-permeability layers and an unsaturated zone with a thickness of more than 40 feet would not require further evaluation. Alternatively, a fine-grained soil with a shallow water table and potential for low hydraulic conductivity layers may require an extensive investigation as guided through use of the tables that constitute the decision-support tool, depending on the design specifications (e.g. loading rate, infiltration area). For economic reasons, when a design results in unacceptable conditions given the available data, then redesign to reach a clearly acceptable situation should be considered prior to undertaking extensive field investigations or numerical modeling to further evaluate the original design.

The decision-support tool (Tables 1 to 5) utilizes qualitative information beyond that collected in the preliminary investigation, as gleaned from existing information, additional site visits, and subsurface investigations, to determine the strategy-level for site assessment.

First, the potential for water perching, mounding of the water table, and/or breakout on slopes is estimated by “quantified” subjective site ratings entered in Table 1. Weighting factors based on experience with similar sites can be considered when making these qualitative judgments. The weights must add to one and are site specific. For example if the bedrock is far below the ground surface, then its hydraulic conductivity is not important. Hydraulic conductivity of the material directly below the infiltration area is generally the most important factor. However, if the water table is very shallow, then depth to

---

**Table 1**

Methodology for subjective evaluation of the potential for perching of water, water table mounding, or breakout on slopes.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>LOW</th>
<th>HIGH</th>
<th>Rank</th>
<th>Weight</th>
<th>SITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loading Rate</td>
<td>low (e.g., &lt;1 cm/day)</td>
<td>high (e.g., &gt;6 cm/day)</td>
<td>1</td>
<td>10</td>
<td>WT</td>
</tr>
<tr>
<td>Soil Type</td>
<td>sands/clay-loams</td>
<td>fine-sand, heavy-clay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil Sorting</td>
<td>poor</td>
<td>well</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil Structure</td>
<td>granular/blocky</td>
<td>platy/prismatic/massive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil Heterogeneity</td>
<td>uniform</td>
<td>variable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drainage</td>
<td>moderate to well</td>
<td>poor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth to Water</td>
<td>large</td>
<td>small</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Table/Low K layer</td>
<td>far</td>
<td>near</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bedrock character</td>
<td>homo, high k</td>
<td>hetero, low k</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Characteristic curve for K&lt;sub&gt;u&lt;/sub&gt;</td>
<td>flat</td>
<td>steep</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal Hydraulic Conductivity</td>
<td>high</td>
<td>low</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proximity to Wetlands</td>
<td>far</td>
<td>near</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prone to intense storms</td>
<td>no</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sum of Weighted Ratings</th>
<th>Ws Sum to 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>RATING</td>
<td></td>
</tr>
</tbody>
</table>

1 Low and High denote importance of parameter condition to contributing to mounding.  
2 Weighting is site specific so as to include or exclude a given parameter from consideration based on conditions (see examples in the discussion). Weights are to sum to one to maintain a measure of their relative significance and produce a summed weight between 1 and 10.

**Table 2**

Methodology for subjective evaluation of the consequences of excessive mounding, which affects the performance of the WSAS.

<table>
<thead>
<tr>
<th>CONSEQUENCE OF EXCESSIVE MOUNDING</th>
<th>MILD</th>
<th>SERIOUS</th>
<th>SITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative infiltration area locations</td>
<td>numerous</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Timing relative to full construction</td>
<td>early</td>
<td>late</td>
<td></td>
</tr>
<tr>
<td>Proximity to shallow water supply</td>
<td>far</td>
<td>close</td>
<td></td>
</tr>
<tr>
<td>Proximity to surface water &amp; sensitive habitats</td>
<td>far</td>
<td>close</td>
<td></td>
</tr>
<tr>
<td>Local population density</td>
<td>low</td>
<td>high</td>
<td></td>
</tr>
</tbody>
</table>

| AVERAGE | |
|---------|
water becomes more important, and that weighting factor is increased. The procedure is intended as a guide. If the guide suggests a problem, then the final design decision should be based on a more rigorous analysis.

Next, the severity of consequences of excessive mounding on the performance of a WSAS is evaluated by considering “quantified”, subjective evaluation of consequences based on experience and judgment (Table 2). Using the combined estimate of mounding potential (Table 1) on the vertical axis of Table 3 and consequence of performance deficiency rankings (Table 2) on the horizontal axis of Table 3, the investigation strategy level is read from their intersection in the body of Table 3. The strategy level read from Table 3 provides a guide to the

CONTINUED ON NEXT PAGE
magnitude and intensity of field investigation and modeling by viewing the column associated with that strategy level in Tables 4 and 5. The term investigation has two levels. The first level of investigation involves estimates of parameter values based on existing or inexpensively obtained information. The second level involves site-specific observations and measurements.

Site Investigations

The flowchart (Figure 2) is used for preliminary site investigations. Preliminary investigation includes the following:

- acquiring proposed development plans, including site layout, waste loading, and pretreatment of wastewater, if any;
- construction plans, including location of structures, open areas, and timing of the WSAS construction relative to the entire facility development;
- the storm-drainage plan, including how run-off from impermeable surfaces is handled; and
- hydraulic data (if possible, site-specific data, but if such data are not available, data from nearby sites can be used), including maps (topographic, geologic, and soil), drillers’ well logs archived by the state or county, public well water-level information, aerial photos, water supply wells in the vicinity, hydrographs from wells, values for hydraulic conductivity or data from tests designed to determine hydraulic conductivity, and climate information from nearby weather stations to estimate recharge rate and the potential for water table fluctuation.

The preliminary investigation also includes a visit to the site to identify potential areas for the WSAS and to select the specific site most likely to perform well based on such factors as topography, soil type, depth to bedrock, character of bedrock, proximity to wells, water supply, location of wetlands, and proximity to breaks in slope. Potential alternative locations for the WSAS than the location in the site plan should be identified.

The area of investigation extends beyond the site to the system boundaries (horizontal and vertical) to encompass the zone where wastewater is assimilated into the environment and is not detectable or will not influence system operation. For example, a surface water discharge point (e.g., lake, pond, or stream), a change in slope, clay layers, perched zones, the regional water table, or points of convergent flow, such as wells, constitute boundaries.

Evaluation of landscape conditions, including vegetation, surface waters, slopes, and landforms may locate areas likely to have mounding problems, such as steep slopes, low permeability soils, shallow water table, and nearby wetlands. Such areas may only be suitable for high capacity WSAS using specialized installations (e.g., advanced treatment with disinfection followed by shallow drip dispersal) (Hantzsch and Fishman, 1982; Converse and Tyler, 1985, Uebler et al., 1985; Goff et al, 2001; and Siegrist et al., 2001). Locations underlain by highly fractured rock are less likely to have mounding problems in contrast to locations underlain by sound rock or low hydraulic conductivity sediments, such as clay lenses.

Evaluation of seasonally variable weather conditions is important because areas with high seasonal infiltration may result in seasonal fluctuation of the water table, which may exacerbate mounding and cause temporary system overload. Full-year groundwater level monitoring data is sometimes available from local water districts or planning agencies. Seasonal high water levels are particularly problematic when coupled with shallow, continuous, low hydraulic conductivity layers.

For example, Uebler et al. (1985) found a failure rate of 20.5 percent for WSAS installed on Leon hardpan soils compared to 7.5 percent for systems in other types of soils. They installed drains to lower the high seasonal water tables at sites where the overall soil would be classified as moderate to moderately high hydraulic conductivity. However, while water tables declined at sites with discontinuous, poorly cemented layers after drain installation, water tables remained high at sites with more continuous, better cemented, layers. These small, but critical differences would not be revealed by soil type determined from maps, nor soil profiles based on limited core data. Areas with seasonal high water levels may require specialized installations (Hantzsch and Fishman, 1982; Converse and Tyler, 1985; Uebler et al., 1985; and Goff et al, 2001) or lower application rates during wet periods.

The most significant factor for evaluation of mounding is hydraulic conductivity (K) of the soil and aquifer media. It is difficult to measure K accurately because its value varies substantially over short distances due to heterogeneity. Therefore, careful attention must be given to this important parameter. Hydraulic conductivity cannot be accurately estimated from simply knowing the soil type because K of any particular soil type may vary by orders of magnitude. Thus, it is important to obtain reliable measurements of K when performing engineering analysis for cluster or high-density WSAS. Suggested methods for measurement of K in unsaturated and saturated soil are outlined and references are provided in Porter et al. (2005).

Variations in K on the order of a factor of 10 across a potential site are not unusual, even when site-specific measurements are collected. Analyzing the statistics of several measurements provides insight on the uncertainty associated with K measurements, and therefore, the potential error that might be propagated when using a single K value in an equation or model. If the designer has not collected detailed measurements of K, but, rather, has obtained a reasonable estimate based on soil classification or a few measurements, then the site should be evaluated using a range of K, including the expected value and a factor of 10 above and, most importantly, a factor of 10 below the expected value when estimating mound height. Several states require these detailed, on-the-ground, direct-observation
soil/site investigations in their on-site sewage regulations.

The percolation test is the most widely used evaluation technique to capture the character of soil hydraulic conductivity. There are major problems with this test including a high degree of variability in results, lack of measurement of a fundamental soil property, and regulatory requirements that may limit testing to the wet-weather season (Hantzsche et al., 1982). Moreover, this method does not actually provide a measure of K for most hydraulic conditions, but rather an infiltration rate that is valid for the particular conditions of the test. Familiarity with cautions regarding percolation test procedures and alternative methods is important (Gross et al., 1998; Jenssen and Siegrist, 1991; and Siegrist et al., 1985).

A widely accepted alternative method for hydraulic conductivity estimation is soil characterization information derived from U.S. Department of Agriculture (USDA) Soil Survey maps (Hantzsche et al., 1982; and Plews and DeWalle, 1985). This has been used to select the type of WSAS installation (Engelbreton and Tyler, 1998) and determine design infiltration rates (Bouma, 1975). In general, hydraulic conductivity decreases as the distribution of sizes increases (poorly-sorted or well-graded sediments) and the percentage of fine grains increase (more silt and clay). However, the shape, arrangement, and packing of grains also influence hydraulic conductivity, so it cannot be determined solely from grain size information. Soil-survey maps provide general information on a coarse scale, but are limited to surface material, while the materials of interest are soil layers below the bottom of the trenches that may not be related to surface soils. The soil survey method is comparable with percolation test results, but can be conducted in any season (Hantzsche et al., 1982) and, when coupled with knowledge of the plasticity of the fine-grained material, provides more reproducible estimates than percolation tests (Gross et al., 1992).

Even if soil survey data are used in conjunction with percolation tests, they are not sufficient to describe the natural variability at most sites (Siegrist et al., 1985). Large cluster and high-density WSAS generally require a large area, and heterogeneity is often substantial. Thus, variability of the site needs to be evaluated via direct observations of layering with description of soil types and lateral extent of layers, soil profile indicators of seasonal saturation, zones of potential lateral spreading of effluent, as well as seeps and water tables in boreholes and test pits. One borehole at each corner of the proposed infiltration area, drilled to the base of the unconfined aquifer (if it is thin), provides a useful characterization of saturated thickness, as well as soil character and depth to water.

If the aquifer base is not detected, a minimum design thickness is determined as water-table elevation minus maximum borehole depth. About one test pit per 1,000 m² (about 10,000 ft²) provides reasonable indication of lateral heterogeneity and continuity of units. If the strategy level for the site warrants testing, the low hydraulic conductivity layers (tight, fine-grained, poorly sorted materials) will be the targets of future testing.

Advanced investigation (e.g., Section 2.7 of Poeter et al., 2005) is required for sites where potential for mounding is high and consequences of excessive mounding are severe. A number of states include these activities as a standard part of the permitting and design process for individual as well as “community” absorption fields. Designers are encouraged to search for such guidance for their locale.

**Modeling Considerations**

Given that most WSAS investigations involve relatively low-cost site characterization activities, the uncertainty associated with parameter values is likely large relative to the errors resulting from approximations made in model development. Nevertheless, it is important to understand the errors that can arise from model selection and setup.

Analytical models generally assume hydraulic properties are homogeneous and isotropic, while geometry and boundary conditions are simple and constant. Some analytical solutions assume the aquifer is infinite, which has both benefits and disadvantages in evaluating mounding. Relative to an assumed infinite aquifer, a no-flow boundary (such as a low-permeability unit) or a high-head boundary in a nearby water body, will cause the mound to be higher than predicted by the model. On the other hand, a low-head boundary in a nearby water body will result in less mounding in the field than predicted by the model.

Often, analytical models for mounding consider only one or two dimensions. Generally, limiting dimensionality yields conservative results. That is, higher mounding will be predicted than will occur in the field, because mound dissipation generally occurs in three dimensions, not just the dimensions assumed by the analytical model. The often-used assumption for analytical models that would make this effect unimportant is that the unused physical dimension in the model is very long compared to the remaining model dimensions. However, this condition is not always met in practice.

Complex problems may require numerical modeling. This approach is useful when site-specific data are available and the designer is familiar with numerical modeling. Unlike analytical models, numerical models cannot extend to infinity. Every boundary of the model is at a specified location and must be assigned a flow or head condition. It is desirable to terminate models at natural geohydrologic boundaries, such as water bodies or units of low hydraulic conductivity, but sometimes the locations of boundaries are not known. In other cases, the extent of the model needs to be limited in order to maintain the desired level of detail while maintaining reasonable computer execution time. Consequently, models may have artificial boundaries. For example, heads may be fixed at known water-table elevations at a county line (even if the
true heads are not known at that location). A flow line, or groundwater divide, may be set as a no-flow boundary. Use of artificial boundaries is acceptable as long as the boundary has a minimal effect on the result. The impact can be evaluated by noting the difference in hydraulic behavior at the boundary with and without the WSAS in the model.

Cluster and high-density WSAS require more landscape area (larger footprint) than individual WSAS. Use of one large bed for the infiltration area should be avoided due to construction problems, distribution problems, and potential for anaerobic conditions to develop in the vadose zone (Siegrist et al., 1985 and 2001). Consequently, preferable designs have infiltration areas composed of subunits with a number of subunits, n, with dimensions \( l_s \) and \( w_s \), a given fractional area of \( f_s \) of trenches where effluent is introduced, and a separation between subunits of \( S_p \) (Figure 3). Optimal wastewater distribution is generally achieved by designing a long narrow infiltration area with its long axis perpendicular to regional groundwater flow (or in cases where vadose zone flow dominates a sloped setting, perpendicular to the landscape fall-line), because this maximizes the area for lateral flow of effluent, and thus decreases the gradient required to carry water from the site, resulting in less mounding.

When predicting groundwater mounding from WSAS, two potential mounding scenarios should be considered:
- perching of percolating water on a low K layer in the vadose zone (this evaluation can be bypassed if site characterization data give no indication of layering in the vadose zone), and
- mounding of the ambient groundwater table (this evaluation needs to be conducted even if water perches in the vadose zone because, at steady state, the seepage will continue to the water table, although it may be spread over a larger area).

Water may mound on a low K layer in the vadose zone and rise to the overlying ground surface or move laterally on that layer to breakout on a slope. Alternatively, it may move uninhibited to the water table and flow away from the site with the regional flow of groundwater. Some combination of these scenarios may occur (Figure 1). Barring breakout at the surface or transpiration, the perched water will spread on the low K layer, and, ultimately, the total volume of infiltration water will pass through to the water table. As long as the perching allows sufficient exposure of the wastewater to the vadose zone either above or below the perching layer, then this case may be advantageous, because it prolongs treatment time and decreases the recharge rate per unit area to the water table and, thus, is equivalent to a larger infiltration area.

Given the focus of this design procedure on mounding in the natural system below the infiltration area, and not on conditions in the infiltration trenches, both cases assume the infiltration water enters the system uniformly over the entire infiltration area (not just the fractional area occupied by the system trenches) at the long-term acceptance rate specified in the design. For example, if the design infiltration rate is 5 cm/day (2 inches/day), in a system of equally spaced, one-meter-wide trenches with one meter spacing between trenches, then the effective infiltration rate is 2.5 cm/day (1 inch/day). This assumption is reasonable for a large network of infiltration trenches and is practically necessary given the exhaustive number of combinations of trench width, number of trenches, and spacing for any given infiltrative area.

Given the long-term, relatively constant infiltration from a mature WSAS, evaluation of groundwater mounding for steady-state conditions is sufficient. Transient solutions can be used to evaluate steady-state conditions if they are evaluated for substantial time. Given boundary conditions at WSAS field sites, steady conditions likely prevail in less than three years. However, to obtain a conservative estimate from an unbounded transient analytical solution, 10 years is considered a reasonable time for evaluation. This can be confirmed by noting the mound height is not changing significantly with time after 10 years for the site parameters. In addition, for particular circumstances, it may be useful to evaluate short-term or particular transient events, such as 100-year storms or infrequent, but likely large, loadings (seasonally used dwellings, for example). However, we focus on steady-state conditions,
which are most common, for this work. It is also useful to note that, in fine-grained soils, dry conditions can result in very high water-acceptance rates initially due to capillarity. However, these high rates are not representative of the long-term acceptance rates achieved once the soil is highly saturated from wastewater infiltration.

The infiltration rate \( q' \), where \( q' \) is the total daily hydraulic loading rate to the system divided by the total system area (the area of the infiltration trenches and the area between the trenches), must be less than the saturated \( K \) of the receiving soil to avoid breakout of wastewater at land surface and ponding at steady state. The rate of percolation is the product of the hydraulic gradient and conductivity. In the direction of flow, the gradient is the difference in hydraulic heads divided by the distance between the points where the heads are measured. The maximum vertical gradient without ponding is one (i.e., a unit hydraulic gradient) as controlled by free drainage conditions (i.e. the hydraulic head equals the elevation, so the difference in head equals the difference in elevation and their quotient is one). Thus, the maximum velocity of infiltration is the saturated vertical hydraulic conductivity, \( K_v \). Consequently, the infiltration area design needs to be adjusted to yield:

\[
q' < \text{saturated } K_v
\]  

Once this is achieved, the saturated \( K_v \) of low \( K \) lenses in the unsaturated zone must be considered. If the \( K_v \) of these lenses is less than \( q' \), mounding will occur as perched water areas in the unsaturated zone, and this should be considered the more pressing design problem. In this case, the low \( K \) layer can allow infiltration at a rate higher than its saturated \( K \), because the perched water above the layer causes a gradient greater than one through the low \( K \) layer. The gradient will equal the difference between the top of the mound and the bottom of the low \( K \) layer divided by the thickness of the layer. As noted above, investigating the validity of the most important assumptions associated with this solution.

The conceptual model (Figure 4) applies to a two-dimensional vertical cross-section of an infiltration area with width \( W \). For mathematical convenience, a symmetrical geometry is assumed, and thus the half-width (\( w = 0.5W \)) is shown in Figure 4 (representing the right-half of a full system). Note that the report by Poeter et al. (2005) contains an error in the section on vadose-zone mounding. In that report, the figure and equations mistakenly use the full width \( W \) in place of the half-width, \( w \), which should have been used. The vadose-zone layer examples in the report that demonstrate calculation and use of a maximum infiltration-area width, actually represent a maximum half width for a given \( H_{\text{max}} \). The methodology example in the report is still correct, however. The full width \( W \) was and should be used for design calculations. The terminology and equations for the saturated zone mounding in the report are not affected by this correction.

The analytical solution assumes that the half-width (\( w \)) is much smaller than the length of the infiltration area (the dimension into the page) so that the 2-dimensional approximation is valid.
If this assumption does not hold, then the solution provides a conservative estimate for design, because the height and lateral extent of the mound would be less than those given by the solution. It is also assumed that the water table is deep; thus, the low K layer in the vadose zone is the sole cause of mounding. The solution is based on the hydraulic conductivity of two layers (i.e., the soil below the infiltration area and the low K layer) that are homogeneous and isotropic, but can have different values of saturated K. The K for the upper layer (below the infiltration area and above the perching layer) is annotated as K1 and is a horizontal conductivity, while the K for the underlying perching layer (which causes the mounding) is given by K2, and is the vertical conductivity. The model is only applicable when K1 > K2.

Before describing the solution, it is important to point out some fundamental concepts related to infiltration in the unsaturated zone. First, if the infiltration rate, q', is greater than the saturated K of the soil or infiltrative surface, then ponding will eventually develop. Some ponding is normal in infiltration systems, but the analytical solution does not consider this case. Rather, a constant infiltration rate is assumed. Fortunately, WSAS infiltration rates are relatively constant within a range of 1 to 5 cm/day. In addition, mounding will not occur on a layer if the infiltration rate is less than K2 (i.e., not valid when q' < K2), so it is not reasonable to make these calculations in that case.

The maximum height of the mound, Hmax, occurs at the center of the infiltration area, and is:

\[ H_{\text{max}} = W \left( \frac{q'}{K_1 \left( \frac{q'}{K_2} - 1 \right)} \right)^{1/2} \]  

where

- \( w \) = one-half width of overall infiltration area,
- \( q' \) = the effective wastewater infiltration rate,
- \( K_1 \) = the horizontal K of the upper layer, and
- \( K_2 \) = the vertical K of the lower layer.

The value for q' is obtained by dividing the daily hydraulic loading rate to be applied by the initial design area (including the space between trenches) as described earlier. When choosing the initial design area, the practitioner should keep in mind that long-term infiltration rates within a trench are likely to be limited to values less than 6 cm/day because of biomat development in the trench (Siegrist, 1987; Siegrist and Boyle, 1987; and Van Cuyk et al., 2005). If the mound height is unacceptable based on initial design parameters and equation 2, then the width could be decreased (and the length increased), to achieve an acceptable Hmax.

The lateral extent (L) of the mound, which is relevant for designing a system to prevent or minimize the possibility of partially treated wastewater breakout on nearby side slopes, is given by the following simple expression:

\[ L = \frac{w \cdot q'}{K_2} \]  

For design purposes, it is useful to rearrange Equations 2 and 3 to solve for the maximum acceptable half-width (wmax) of an infiltration area for a desired design wastewater infiltration rate, q', starting with a fixed total infiltration area.

The first case to examine is the one for ground surface breakout. An acceptable Hmax would be less than the maximum height above the top of the low K layer that would still allow the desired thickness of unsaturated soil for treatment of wastewater. Using that Hmax, the maximum width, W, is calculated from Wmax = 2 wmax, where wmax is

\[ w_{\text{max}} = H_{\text{max}} \left[ \frac{q'}{K_1 \left( \frac{q'}{K_2} - 1 \right)} \right]^{-1/2} \]  

Once wmax and Wmax are calculated, then the length of the trenches is adjusted to achieve the desired design infiltration area. Of course, in practice, a particular dimension (e.g., length) may be limiting. For these cases, if Wmax is less than the design W required to achieve the desired wastewater loading for the fixed length, then either the wastewater loading must be reduced, or the design width of the infiltration area should be increased. This would lower the q', and a new Wmax would need to be calculated. Thus, the process is iterative.

The next case to consider is the one where side slope surface breakout is of concern. The simplest case, where the land slope extends down to the same elevation as the top of the low K layer, is given by

\[ w_{\text{max}} = L_S \frac{K_2}{q'} \]  

Here, Ls is the distance from the center of the infiltration area to the slope where breakout is anticipated. It is useful to note this is independent of the conductivity of the top layer, depending only on the distance to the side slope, and on the ratio of the value of K2 to the wastewater infiltration rate, q'. Also note this is not valid for q' < K2, but this is not a concern because, as stated earlier, mounding will not occur due to the layer effect under this condition. However, mounding of the underlying water table may occur and should be evaluated using the approach presented later in this article.

In most cases, it is likely that the slope of concern will not extend to the same elevation as the top of the low K layer. In such a case,

\[ w_{\text{min}} = K_2 \left[ H_S \left( \frac{K_1}{K_2} \right)^{1/2} \right] + X_S \]  

where

- \( X_S \) = the horizontal distance to the side slope, and
- \( H_S \) = the depth below the surface to the top of the low K layer at Xs.
In addition, it is possible that the most limiting condition would not occur at the base of the slope, but, rather, might occur at elevations higher than the base. This case is most likely to occur in locations where the slope is close to the infiltration area and is steep compared to the slope of the mound. Under such circumstances, it is prudent to compute the minimum width for several values of \( H_S \) and \( X_S \). If the designer is concerned that this condition might occur, then the height of the mound along the \( X \) axis can be calculated from a more complete form of Equation 2 found in Poeter et al. (2005) and compared to the shape of the slope.

One cannot assume that any one condition is always the limiting condition; thus, all relevant criteria must be evaluated.

**Estimating Mounding of the Ambient Ground Water Table Below a Wastewater Infiltration Area**

Hantush (1967) presented a useful analytical method for estimating water table mounding under a high-density or cluster WSAS. Finnemore and Hantzsche (1983) suggested some simplifications, which were reasonable approximations, but the more exact calculation, valid for \( a^2 + b^2 < 0.04 \) (\( a \) and \( b \) are defined with Equation 7) is used here because the reasonable range of parameters, and the need to estimate long-term mounding, satisfy this criterion.

Hantush offered solutions for rectangular (Figure 6) and circular infiltration areas, but the rectangular source solution is most relevant to larger WSAS analysis. The aquifer is assumed homogeneous, isotropic, bounded by a horizontal water table overlying a horizontal impermeable base, and not bounded in the lateral direction. The infiltration water is assumed to move vertically to the water table such that flux to the water table occurs directly below and over the same area as the infiltration area (i.e., no lateral spreading in the vadose zone). If such spreading were to occur, the water table mounding would be...
less than predicted by this analytical model. If extent of a perched zone is determined as discussed in the previous section, the source zone for this analysis could be assigned the dimensions of the perched mound. However, it should be noted that the seepage will not be uniform throughout the mound (seepage will be greater at the center) and this will underestimate the maximum height of water table mounding at the center of the seepage area. If the regional flow field has a significant slope, mounding may be offset and increased. The analytical solution assumes the K is isotropic. Consequently, if the vertical hydraulic conductivity, Kv, is less than the horizontal hydraulic conductivity, Kh, and the Kh value is used as the homogeneous K in the analytical solution, then mounding will be under-predicted. If, in the same case, the Kv value is used in the analytical solution, then mounding will be over-predicted. Numerical models are used to investigate conditions, such as a sloping regional water table and anisotropy, which are not considered by this analytical solution. These are discussed by Poeter et al. (2005).

For a horizontal impermeable base and initially horizontal water table, the maximum head rise, $z_{max}$, occurs at the center of the infiltration area ($x=0, y=0$) and is calculated using equation 7. The equation is complex so, it is not easily rearranged to solve for W. Consequently it is reasonable to set up a convenient system for inputting the values describing the design and system properties, note the mounding, and adjust the input values until an acceptable design is found. A spreadsheet for this procedure is available from NDWRCDP (2005).

The parameters $x$ and $y$ are defined as $x_1$ and $y_1$ in Figure 6 for the orthogonal and the askew cases. If the slope contours and elevation of the impermeable base are highly irregular, the designer needs to assess the most vulnerable location (the lowest, closest point to the infiltration area) and determine ($x_1, y_1$) for that location. If the most vulnerable location is not obvious, evaluations should be made for all the potentially vulnerable locations.

\[
 z_{max} = \sqrt{h_i^2 + \frac{q'h_{avg}t}{2S_y}} \left( \frac{1}{4K_h h_{avg}t} \left[ \frac{w}{S_y} - \frac{1}{4K_h h_{avg}t} \right] \right) - h_i
\]

where

\[
 z_{max} = h_{avg} - h_i \\
 q' = \text{effective wastewater infiltration rate per unit area of the infiltration zone} \\
 h_i = \text{initial saturated thickness} \\
 h_{avg} = \text{iterated head at location and time of interest: } 0.5(h_i(0)+h(t)) \\
 K_h = \text{horizontal hydraulic conductivity} \\
 l = 1/2 \text{ overall infiltration area (all subunits combined) length, } 1/2 \text{ L, (Figure 5)} \\
 w = 1/2 \text{ overall infiltration area width (all subunits combined), } 1/2 \text{ W, (Figure 5)} \\
 S_y = \text{specific yield (use 0.001 to obtain conservative long-term solution)} \\
 t = \text{time since infiltration began (use 10 years to obtain conservative long-term solution)}
\]

The spreadsheet uses the following approximation for $S^*$ and is accurate for $\alpha^2 + \beta^2 < 0.04$:
When considering breakout on a slope, the allowable water table rise is the entire depth to water, less an increment of safety ($Dx_1 - \text{Increment-of-Safety}$). The goal, in this case, is to prevent breakout, not to allow sufficient vadose zone thickness to treat the wastewater, because the wastewater arrives at this location via lateral flow in the saturated zone. If mounding is above the surface at $x_1$, the WSAS can be moved further from the slope and the orientation, dimensions, or the loading can be adjusted to decrease mounding at the slope.

For evaluations of water table rise, the estimated height of mounding is added to the seasonal high water table to determine if the design will be acceptable.

Additional discussion of this approach is provided by Poeter et al. (2005) along with step-by-step design procedures, an outline of limitations, and numerical modeling examples of cases that are not appropriate for the analytical solution.

### Model Acquisition and Implementation

Analytical models are available in the literature. Many of the analytical models can be applied with a calculator (e.g., the Khan model for perching of water in the vadose zone). Some of the analytical solutions are more involved but are readily solved using a spreadsheet (e.g., the Hantush solution for evaluating mounding of the water table). Spreadsheets for that solution are available on-line at the National Decentralized Water Resources Capacity Development Project web site (NDWRCDP, 2005). The spreadsheets are set up such that a designer can enter design specifications and hydraulic property values appropriate for their site and adjust the design until the maximum water table rise at selected distances is acceptable.

For saturated zone numerical modeling, the U.S. Geological Survey (USGS) MODFLOW code is recommended and can be downloaded from the USGS at no charge at [http://water.usgs.gov/software/ground_water.html](http://water.usgs.gov/software/ground_water.html). Most users prefer to manage MODFLOW modeling using a graphical user interface (GUI). The most commonly used GUIs are Groundwater Modeling System (GMS), Visual MODFLOW (VM), and Groundwater Vistas (GWV). Numerous outlets are available and can be found by entering the name of the software package in an Internet search.

For unsaturated zone numerical modeling, a number of codes are available as summarized in Poeter et al. (2005). HYDRUS2D (a two-dimensional finite element numerical model based on the Richards equation for unsaturated flow) was used to present the work in that report. Other similar models are available at lower cost but without a graphical-user interface. A disadvantage for numerical models such as HYDRUS is the relatively long execution time that results from solving the nonlinear Richards equation, which requires iterative techniques. A significant advantage of the finite-element numerical model is the ability to simulate irregular meshes (e.g., soil mounds, hill slopes, valleys, stream banks).

Implementation of analytical models requires understanding of the groundwater hydraulics and basic computational, calculator, and spreadsheet skills. For designers to conduct their own numerical modeling studies, they should have a theoretical knowledge of the underlying hydraulic processes (e.g., saturated and unsaturated groundwater flow) and knowledge of basic modeling concepts. Modeling courses are offered by many companies and organizations and can be found by searching the Internet with a Web browser, using key words along the lines of “short course groundwater modeling.” Alternatively, a consultant can be hired to conduct the modeling work, but the designer should be informed about modeling in order to reasonably assess the benefits and limitations of the consultant’s work.

Modeling efforts and costs for WSAS projects vary considerably. The site may be low risk and a few analytical calculations may suffice. In this case, the effort may take only a day. If limited numerical modeling is required, the project may take a week. For a complex site, with high risk and a wealth of data, the project may require one or more months. If commercial software is used the software costs may range from a few hundreds to a few thousands of dollars. Labor costs for modeling a WSAS project can range from a few hundred dollars for the simplest project, to thousands of dollars for a moderate project and tens-of-thousands for complex, high-risk projects. In such situations, the modeling work may support regulatory procedures associated with permitting the site. In addition, employees may require training before conducting the modeling work.

### Conclusions

Groundwater mounding in the subsurface below larger WSAS can occur if the daily hydraulic loading rates applied to the infiltration area exceed the hydraulic capacity of the subsurface to assimilate the added water. If excessive mounding occurs—as perching of water on a low K layer and/or elevation of an ambient groundwater table—it can result in reduced purification of wastewater pollutants and pathogens before groundwater recharge under the site or seepage of partially treated wastewater to the ground surface. Site investigation techniques and modeling methods can be used to effectively assess the potential for groundwater mounding under different design scenarios and site conditions. Such an analysis can be accomplished to aid development of an appropriate WSAS design for a given site so that groundwater mounding is controlled within an acceptable level.

### Acknowledgements

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Papers are now being accepted for the juried article section of the Small Flows Quarterly, the only magazine/journal devoted to onsite and small community wastewater issues (i.e., communities with populations less than 10,000 or communities handling fewer than one million gallons of wastewater flows per day).

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The National Environmental Services Center Offers Two Demonstration Videos Free for Three Months (October 2004–December 31, 2005). Be sure to place your order—all orders will be accepted on a first-come, first-served basis.

Community Onsite Options: Wastewater Management in the New Millennium (Item #DPVTMG07)
National Onsite Demonstration Program
Filmed on location across America, highlighting several communities each effectively operating unique onsite/decentralized management systems (OMS), this video is a must for community, environmental, and public health professionals. Community Onsite Options is an excellent resource for all audiences and is worthwhile including on the agendas of community leadership forums, public information meetings, and professional conferences addressing onsite/decentralized wastewater management issues.

Approaches to Onsite Management: Community Perspectives (Item #DPVTMG09)
National Onsite Demonstration Program
This video shares insights from selected community onsite management systems (OMS’s). Local leaders, public officials, program managers, and national experts discuss the concepts for community onsite/decentralized wastewater management and the types of responsible management entities (RME’s) providing oversight, services, and support for communities nationwide.

For ordering information see page 53.
Planning for an Onsite System
Keeping your Property System Safe

I am going to build a house on a piece of property I just purchased, and I want to include a septic system. Is there anything I should know about that before I build the house?

Demographics are shifting. Many people are moving from the cities to the country, away from the hustle and bustle, and most often, away from centralized wastewater treatment, city water, and basic cable and electrical utilities. With current market values and lower interest rates, the housing industry is booming. Unfortunately, what often happens is that when the perfect piece of property is found, basic utilities are not readily available. The question is, how many people really think about their wastewater treatment options when purchasing a lot and building their dream home?

For example, a beautiful piece of land is available, large enough to fit your dream home perfectly. But, is there enough land to fit an onsite wastewater system, too? What about the drinking water source or well? Unfortunately, in many cases, this is somewhat of an afterthought. Many states require not only enough area for your onsite system, but also a reserve area in case the system needs to be repaired or replaced. Though the land, when purchased, would have easily accommodated a conventional onsite wastewater system, construction and building practices may sometimes change this condition. Another complication that often occurs is that the original location for the onsite system is preserved during construction, but the reserve area is compromised during construction of the home.

When these situations occur, the homeowner and installer are faced with difficult and often expensive choices. There are generally onsite treatment solutions available for these conditions, but the price of these options is much greater than that of a conventional system. In many states, these systems are considered “engineered systems,” meaning that there is some mechanical component to the system. Whether it’s a home aerobic treatment unit, a filtration system, a pressurized distribution system, or a combination of all of the above, the fix will not be cheap. Their mechanical components can make these systems quite expensive, and a licensed professional is required to design and install most of the systems.

Many changes to the site’s soil condition can occur during the building process. The natural soil is removed by excavation, compacted by heavy equipment, or covered over with rocks, brush, and extra soil from the area where the home’s foundation is to be, and it then becomes inaccessible. The undisturbed soil profile is essential, because the soil structure and naturally occurring bacteria remove nutrients and other constituents in the wastewater effluent. When the natural soil structure is disturbed or damaged, these naturally occurring bacteria are either unable to do their job, or simply not present.

Let’s look at this through an actual scenario of what should happen when purchasing property in a rural setting. Property buyer Kaleigh finds the parcel of land she has been looking for to build her dream home. She knows there are no utilities, such as electricity, drinking water, or wastewater services. What does she need to do? Electricity is usually the first thing buyers think about. Available electricity is usually determined by the power company, and they will be able to let her know the extent of running the line, setting up utility poles,
and the costs for these tasks. But, before she begins the task of getting basic services, she must first contact the local health department or regulatory agency to see if the site is indeed fit for use. The health department will either perform a site evaluation or recommend a builder, installer, or contractor to perform the evaluation in order to determine the site’s ability to provide these basic services.

Usually, this site evaluation will look at other properties in the area for drinking water well information, such as depth and location for the drilling to be performed. Notably, the location of the drinking water well will have an impact on the location of the wastewater treatment system. Each state has a minimum separation distance for the wastewater treatment system from the drinking water source. This information can be obtained from the local health department or from the state regulatory authority. In most cases, when it comes to wastewater treatment, the installer or health official will perform a percolation test or a soil evaluation to determine which area of the property is best suited for the system.

Now that Kaleigh knows where her well will be located and the area for her wastewater system and reserve area is sited, it is important for her to make sure the builder is made aware of their location, too. The area designated for her onsite system should be identified and marked so that heavy equipment or excavation practices do not have a chance to create a costly situation.

The builder is now ready to begin construction of Kaleigh’s dream home. With these areas marked and identified, no one should have to worry about those potentially costly mistakes that are preventable with planning.

A section of property that is covered over with rocks and extra soil during home construction becomes inaccessible for use as a drainfield.
New Orleans, Louisiana 9/4/05 — Aerial view of houses swamped by floodwaters after Hurricane Katrina. New Orleans is being evacuated as a result of floods caused by Hurricane Katrina.

Photo by Liz Roll/Federal Emergency Management Agency (FEMA).
In light of the recent disaster befalling the states of Louisiana, Alabama, and Mississippi, emergency preparedness is at the forefront of all our minds. Being prepared to deal with water contamination and its health effects on our citizens is now a reality. To aid in this effort, the following list of resources may be beneficial.

**National Small Flows Clearinghouse:**
- SFPLNL30 How to keep your Water “well”
- SFPLNL06 Wastewater treatment protects small community
- GNBKGN12 Community-Based environmental protection-A Resource
  Book for Protecting Ecosystems and Communities
- SFPLNL11 Basic wastewater characteristics
- WWCDTR09 Emergency Response Tabletop Exercises for Drinking Water
  and Wastewater Systems

**National Environmental Training Center for Small Communities:**
- TRBLGN25 Emergency Response Planning Resources for Small Water and Wastewater Utilities
- TRBLGN26 Emergency Response Plan Guidance for Small and Medium Community Systems
- TRPMCD62 Due Dilligence-Small Water System Security
- TRPMCD56 Preparing for the Unexpected: Security for Small Water Systems
- TRBKMG03 Protecting Your Community’s Assets: A Guide for Small Wastewater Systems
- TRCDMG05 (CD-Rom Version)

**National Drinking Water Clearinghouse:**
- DWFSPE57 Emergency Disinfection of Water Supplies
- DWFSPE204 Water for Emergency Use
- DWBLMG69 Response protocol toolbox: Planning and responding to drinking water contamination
  threats and incidents, Module 5, Public Health
- DWPKOM59 Emergency Response Planning Pack (ERPP)
- DWBLPE58 Water Testing
- DWBLPE97 Water Testing Scams
- DWFSPE140 Bacteriological Contamination of Drinking Water
- DWBLPE183 Mycobacteria: Drinking Water Fact Sheet
- DWBLPE112 Interpreting Drinking Water Quality Analysis: What do the numbers mean?
- DWBLOM05 Shock Chlorination of Wells and Springs

To order any of these publication, please fill out the order form on page 53. If you need additional assistance, or have unanswered questions, please contact us by calling (800) 624-8301. Technical staff are available to assist you with your water and wastewater needs.

Gulfport, Mississippi, 9/4/05 — Fire and Environmental Research
Applications Team (FERA) urban search and rescue vehicles being
decontaminated. Working with local and out-of-state teams, search
and rescue continues. All vehicles must be decontaminated upon
returning to base, since floodwater carries disease and toxins.
Photo by Leif Skoogfors/FEMA.
Decentralized Systems Technology Fact Sheet: Septic Tank Polishing
Office of Water, U.S. Environmental Protection Agency
Polishing systems are used to improve the quality of septic tank effluent. Effluent polishing may be necessary due to site constraints, regulations, or other limiting factors. One of the most common technologies used to polish septic tank effluent is the sand filter. This fact sheet gives the design criteria of the three types of sand filters typically used for effluent polishing. It also includes advantages and disadvantages, performance, operation and maintenance, costs, and references to more information on sand filters. The cost is $0.80. Request item #WWFSGN234.

When is a septic system regulated as a Class V well?
Office of Ground Water and Drinking Water, U.S. Environmental Protection Agency
A septic system is required to meet Underground Injection Control Program requirements and is considered a Class V well if the system receives any amount of industrial or commercial wastewater or the system receives solely sanitary waste from multiple-family residences or a non-residential establishment and has the capacity to serve 20 or more persons per day. This fact sheet discusses minimum federal requirements for Class V wells and additional requirements that apply when a system receives motor vehicle waste. Locations of where one might find Class V wells are also listed. This fact sheet is free of cost. Ask for Item WWFSOM70.

Septic Tank and Drainfield Operation and Maintenance
Vogel, Michael P.; Rupp, Gretchen I.; Montana State University Extension Service
This fact sheet provides information about the operation and maintenance of a conventional gravity-flow septic system. Tips for using a septic system are also provided, as well as some answers to frequently asked questions about when to pump the tank, why systems fail, and if additives are the right choice for your septic system. The fact sheet is free of cost. Ask for Item #WWFSOM53.

Septic Tank Inspection and Troubleshooting
Vogel, Michael P.; Montana State University Extension Service
Evaluating a septic tank prior to sale or purchase of property protects both the buyer and seller. A properly functioning system can also be a good selling point and enhance the value of the house. This fact sheet discusses what is involved with an evaluation, why a system fails, and information on when to pump the septic tank. Troubleshooting septic system problems is also discussed in a symptom/cause relationship. The fact sheet is free of cost. Ask for Item #WWFSOM54.

Cluster Wastewater Systems Planning Manual
Pio Lombardo; Lombardo Associates, Inc.
This manual has two objectives. First, it outlines a comprehensive wastewater management planning process that allows communities to assess where and how cluster systems are appropriate, and thereby enabling the development of an optimized, decentralized wastewater management plan. Second, it provides technical and planning information to assist land use planners, engineers, developers, and other stakeholders in developing and implementing cluster wastewater systems. This CD-ROM is free. Request item #WWCDMG33.

Case Studies of Economic Analysis and Community Decision Making for Decentralized Wastewater Systems
Richard Pinkham; Hamilton, Booz A.; Magliaro, J.; Kinsley, M.; Rocky Mountain Institute
This report examines how communities consider and value the benefits and costs of onsite,
Small Flows Quarterly, Fall 2005, Volume 7, Number 4

cluster, and centralized options in monetary or other terms, and examines the driving issues, motivations, thought processes, and decision-making methods of stakeholders relative to choices of wastewater system scale. Case studies conducted in eight communities examine how each community evaluated various topics in the wastewater facility decision-making process. Also included is an analysis for a hypothetical community on the financial benefits of incremental capacity expansion using decentralized systems compared to periodic large-scale investments in centralized capacity. This CD-ROM is free. Request item #WWCDMG27.

Iowa Handbook for Enabling Legal Mechanisms for Wastewater Management
National Onsite Demonstration Program

This CD-ROM is free. Request item #WWCDMG27.

Creative Community Design and Wastewater Management

Joubert, Lorraine; Flinker, Peter; Loomis, George; Dow, David; Gold, Art; Brennan, Diana, and Jobin, Justine; University of Rhode Island Cooperative Extension Coastal Institute in Kingston, Washington University, St. Louis, MO

This manual demonstrates how advanced decentralized wastewater treatment systems can be used to support more compact land use patterns that would otherwise be infeasible with conventional wastewater treatment systems. The manual also informs how decentralized technologies can be powerful tools in directing sustainable community development while protecting local water resources. Developers, wastewater treatment system designers and installers, and homeowners will also find ideas on fitting septic systems into landscapes in a way that retains natural features and unique architectural elements of a community and adds value to property. This CD-ROM is free. Ask for item #WWCDMG27.

New Mexico Handbook for Enabling Legal Mechanisms for Wastewater Management
National Onsite Demonstration Program

New Mexico relies heavily on groundwater as a source of drinking water. As a result, the prevention of groundwater pollution from wastewater discharge is important. New Mexico has many avenues for both incorporated and unincorporated communities to pursue wastewater funding. This handbook discusses the financing options for wastewater treatment and the potential organization structures available to manage community wastewater treatment systems. This 31-page booklet is free. Request item #DPBLMG37.

2004 Guidelines for Water Reuse
Office of Wastewater; U.S. Environmental Protection Agency

The purpose of this CD is to present and summarize water reuse guidelines, with supporting information, for the benefit of utilities and regulatory agencies, particularly in the U.S. Guidelines cover water reclamation for nonpotable urban, industrial, and agricultural reuse, as well as augmentation of potable water supplies through indirect reuse. Direct potable reuse is covered briefly. This guide is also available in a book format (WW-BKGN259). The CD is free. Ask for item #WW-CDGN260.
West Virginia Handbook for Enabling Legal Mechanisms for Wastewater Management

National Onsite Demonstration Program

With a substantial rural population and rugged terrain, West Virginia makes extensive use of onsite sewage disposal. Forty percent of West Virginia's housing units use septic tanks, while 55 percent use public sewers. The last five percent use other methods of sewage disposal. West Virginia has state laws and rules governing the use of onsite treatment systems. These laws and rules are discussed, as well as financial options and public and private management of wastewater. This 30-page booklet is free of cost. Request item #DPBLMG35.

A Homeowner's Guide to Septic Systems

Office of Water; U.S. Environmental Protection Agency

This guide explains how a septic system works and what steps a homeowner can take to ensure the system works properly. Topics covered include inspections, water conservation practices, and signs of system failure. Also included is a checklist to keep track of septic system maintenance. This 18-page booklet is free of charge. Ask for item #WWBLPE95.


National Small Flows Clearinghouse

This interactive CD provides the user with a look at the presentations from the 2004 State Onsite Wastewater Regulators and Captains of Industry Conferences held in Orlando, Florida. A discussion about the future of onsite wastewater treatment opened the conference, followed by presentations about the effects infiltrative surface architecture have on effluent infiltration, soil treatment principles, state certification programs, training needs of state regulators, and onsite data management projects and case studies. The cost of this CD-ROM is $10.00. Request item #WWCDRG71.


National Small Flows Clearinghouse

This interactive CD documents the 2003 State Onsite Regulators and Captains of Industry Conferences. The agenda covered topics such as onsite wastewater funding, the role of soils in onsite wastewater treatment, conducting scientific investigations, and status reports of several states onsite programs. The cost of this CD-ROM is $10.00. Request item #WWCDRG71.

Septic Systems, Soils, and Groundwater Protection

Dennis P Swaney and John H Martin Jr; Cornell Cooperative Extension

This 16-page booklet discusses basic background information about septic systems and their environmental effects. The characteristics of raw sewage and septic tank effluent are discussed in detail along with potential public or environmental health concerns. The cost of this booklet is $2.45. Ask for item #WWBLGNZ61.

Antibacterial Products in Septic Systems

Farrell-Poe, Kitt; The University of Arizona, College of Agriculture and Life Sciences, Cooperative Extension

To attain proper treatment, a septic system is very dependent on millions of naturally occurring bacteria throughout the system. The use of antibacterial products, such as bleach and hand soaps, can upset the bacterial balance if used in excess. In this fact sheet, types of bacteria and their function are discussed, as well as tips on proper cleansers to improve septic system performance. The cost is $0.60 Request item #WWFSPE86.
Products List

Item Number Breakdown

First two characters of item number: (Major Product Category)
WW Wastewater
FM Finance and Management
GN General Information
SF Small Flows
DP Demonstration Program

Second two characters of item number: (Document Type)
BK Book, greater than 50 pages
BL Booklet, less than 50 pages
BR Brochure
CD Computer Disk/ROM
DV Digital Video/DVD
FS Fact Sheet
PC Customized Search
PL Pipeline
PK Packet
PS Poster
QU Quarterly
SW Software
VT Video Tape

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The NESC’s Products Catalog provides abstracts of many products. The guide may be downloaded via the NESC’s Web site at www.nesc.wvu.edu/nsfc_productscatalog.htm.

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DPBLGN04 A demonstration of innovative treatment and disposal technologies in environmentally sensitive karst terrain near Rock Bridge Memorial State Park, Missouri .............................$1.95

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WWBLPE46 Living on Karst: A Reference Guide for Landowners in Limestone Regions ......................$0.00
GNBRPE51 Polluted ..................................................................................................................................$0.00
WWBRPE53 How Wastewater Treatment Works … The Basics ..................................................................$0.00
WWBRPE62 Fat-Free Sewers: How to Prevent Fats, Oils, and Greases from Damaging Your Home and the Environment .........................................................................................................................$0.30
WWPSPE65 Wastewater Collection and Treatment Systems for Small Communities .........................$1.25
WWFSPE68 Selecting an Onsite Wastewater or Septic System ...................................................................$0.75
WWFSPE69 A Quick Guide to Small Community Wastewater Treatment Decisions ..............................................$1.30
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WWBRPE72 Landscaping Your Septic Tank .................................................................................................$0.40
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WWBLPE75 Septic Systems for Waste Water Disposal .................................................................................$0.65
WWCDPGE76 Everything You Always Wanted To Know About Septic Systems … But Didn’t Know Who to Ask! HomeOwner Version 1.0 ..............................................................................................................$6.50
WWFSPE77 Managing Your Household Septic System .................................................................................$0.20
WWFSPE79 Understanding Your Household Septic System ............................................................................$0.00
WWFSPE80 Inspecting Your Household Septic System .................................................................................$0.00
WWFSPE81 Maintaining Your Septic Tank .................................................................................................$0.00
WWBLPE82 What Do You Mean My House Has a Septic Tank? .................................................................$8.45

WWBLPE83 Solutions to Nonpoint Source Pollution: A Riparian Homeowner’s Guide to Nonpoint Source Pollution Prevention .................................................................$0.00
WWBRPE85 Operation and Maintenance Tips for Your Septic System .......................................................$0.00
WWFSPE86 Antibacterial Products in Septic Systems .................................................................................$0.60
WWBRPE87 Mound Systems: Alternative On-site Wastewater Treatment ...................................................$0.00
WWWBLPE88 Constructed Wetlands: Advanced Septic Treatment for Single Family Homes .......................$0.00
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WWWCFPE93 Wastewater Treatment Education Materials .................................................................$10.00
WWWFSPE94 Help us Protect Our Septic System and Keep Our Groundwater Clean .................................$1.00
WWWBLPE95 A Homeowners Guide to Septic Systems ...........................................................................$3.60

Regulations/Legal Mechanisms

In addition to the regulatory products listed below, access our Regulations Database at www.nesc.wvu.edu/nsfc/nsfc_regulations.htm. If you do not have Internet access, contact the wastewater technical assistance unit at the NESC using the phone numbers below to request additional information.

DPBLMG35 West Virginia Handbook for Enabling Legal Mechanisms for Wastewater Management .................................................................$0.00
DPBLMG36 Iowa Handbook for Enabling Legal Mechanisms for Wastewater Management .................................................................$0.00
DPBLMG37 New Mexico Handbook for Enabling Legal Mechanisms for Wastewater Management .................................................................$0.00
WWWBRG30 Control of Pathogens and Vector Attraction in Sewage Sludge (Revised July 2003) .........$0.00
WWWBLR34 State Onsite Wastewater Regulatory Contacts List, January 2003 .............................................$0.00
WWWBRG35 Standards for the Use and Disposal of Sewage Sludge, 40 CFR, Part 503 ..............................................$0.00
WWWBRG36 Domestic Septage Regulatory Guidance: A Guide to the EPA 503 Rule ..............................................$0.00
WWWBRG38 Plain English Guide to the EPA Part 503 Biosolids Rule .................................................................$0.00
WWWBLR42 NPDES and Sewage Sludge Program Authority: A Handbook for Federally Recognized Indian Tribes .........................................................................................................................$0.00
WWWBRG43 Land Application of Sewage Sludge: A Guide for Land Applicators on the Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge, 40 CFR, Part 503 ..............................................$0.00
WWWBRG44 Preparing Sewage Sludge for Land Application or Surface Disposal ..............................................$11.00
WWWBLR45 Surface Disposal of Sewage Sludge ....................................................................................$9.40
WWWFSRG5 Class V Injection Wells ...........................................................................................................$0.70
WWWBRG66 Guide to the Biosolids Risk Assessments for the EPA Part 503 Rule ..............................................$0.00
GNFSRG67 USEPA’s Program to Regulate the Placement of Waste Water and other Fluids Underground .................................................................$0.00
WWCDRG69 A Brief History of Onsite Sewage Treatment in California and the Progression Toward Statewide Standards .........................................................................................................................$0.00
WWWFSRG70 When is a septic system regulated as a class V well? .................................................................$0.00

State Onsite Wastewater Regulators and Captains of Industry Conference Proceedings

WWWCDRG68 Interactive CD ROM (2002) .................................................................................................$10.00
WWWCDRG71 Interactive CD ROM (2003) .................................................................................................$10.00
WWWCDRG72 Interactive CD ROM (2004) .................................................................................................$10.00

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### Products List

#### Research

- **WWBLRE14** Methodology to Predict Nitrogen Loading from Conventional Gravity On-Site Wastewater Treatment Systems ...........................................$5.00
- **WWBKRE16** Preliminary Risk Assessment for Viruses in Municipal Sewage Sludge Applied to Land ..................................................$0.00
- **WWBKRE21** Potential Effects of Water Softener Use on Septic Tank Soil Absorption On-Site Waste Water Systems ...........................................$12.20
- **WWBKRE25** The Expanding Dairy Industry: Impact on Ground Water Quality and Quantity with Emphasis on Waste Management System Evaluation for Open Lot Dairies ...........................................$11.70
- **WWBLRE28** Household Water Reduction and Design Flow Alliances for On-Site Wastewater Management and Supplement ..........................................$4.00
- **WBLRE30** Linear Regression for Nonpoint Source Pollution Analyses .................................................................................................................................$0.00
- **WWBKRE32** Assessment of Single-Stage Trickling Filter Nitrification .................................................................................................................................$0.00
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- **WWBKRE36** Subsurface Flow Constructed Wetlands for Wastewater Treatment .................................................................................................$21.25
- **WWBKRE38** Literature Review for Septic Siting Study: A Means of Interpreting Past Research on Septic Systems ..............................................$30.25
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- **WWCDRE43** Septic Tank Nutrient Removal Project: Advanced Onsite Sewage Disposal System Demonstration (Book on CD-ROM) ...$10.00
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- **WWBLRE47** Performance of an Aerobic Treatment Unit and Drip Dispersal System for the Treatment of Domestic Wastewater at the Northeast Regional Correction Center .................$3.00
- **WWBLRE48** Performance of a Textile Filter, Polishing Sand Filter & Shallow Trench System for the Treatment of Domestic Wastewater at the Northeast Regional Correction Center .................$3.00
- **WWBLRE49** Performance of Pre-engineered Modular Peat Filters for the Treatment of Domestic Wastewater at the Northeast Regional Correction Center .................$3.00
- **WWBKRE50** The Class V Underground Injection Control Study .................................................................................................................................$7.00
- **WWBKRE51** The Class V Underground Injection Control Study .................................................................................................................................$7.00

#### Training Materials

- **DPCDMG03** Community Self Assessment .................................................................................................................................$10.00
- **DPCDMG04** Envisioning Your Community’s Future .................................................................................................................................$10.00
- **DPCDMG05** Enabling Mechanisms: Options for Community onsite management .................................................................................................................................$10.00
- **DPCDMG06** Community Redness Indicators .................................................................................................................................$10.00
- **WWCDTR08** Model Decentralized Wastewater Practitioner Curriculum .................................................................................................................................$0.00
- **WWCDTR09** Emergency Response Tabletop Exercises for Drinking Water and Wastewater Systems .................................................................................................................................$0.00
- **WWPKTR10** Decentralized Wastewater Curriculum .................................................................................................................................$105.00

**NPDES Compliance Monitoring Inspector Training**

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- **WWVTDM100** Low Pressure Pipe Sewage Disposal System .................................................................................................................................$13.00
- **FMVTMG01** Wastewater Management in Unsewered Areas .................................................................................................................................$10.00
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- **WWVTGN10** Morrilton, Arkansas, Land Application of Wastewater .................................................................................................................................$10.00
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- **WWVTPF50** Problem with Shallow Disposal Systems .................................................................................................................................$0.00
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- **WWVTPF63** Next Generation of Sewage Treatment: “Flushing in the New Millennium” .................................................................................................................................$30.00
- **WWVTPF64** Mound/Pressure Distribution On-Site Sewage Disposal System .................................................................................................................................$15.00
- **WWVTPF67** Down the Drain: Septic System Sense .................................................................................................................................$16.00
- **WWVTPF74** Uncovering the Mystery in your Backyard: A Homeowner’s Guide to Septic Systems .................................................................................................................................$0.00
- **WWVTPF78** Septic Systems 1-2-3 (VHS) .................................................................................................................................$10.00
- **WWDWVPE91** (DVD) .................................................................................................................................................................................................$10.00
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  Business hours are 8 a.m. to 5 p.m. Eastern Time

**E-mail:** info@mail.nesc.wvu.edu

**Fax:** (304) 293-8651

**Mail:**
- National Environmental Services Center
- West Virginia University
- P.O. Box 6064
- Morgantown, WV 26506-6064

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If you would like to receive news about NESC products or services, subscribe to our electronic mailing list. This notification service gives subscribers the opportunity to learn of NESC activities and other information about sewage treatment options for homes and small community developments.

Information is sent to subscribers via e-mail. Please note that this listserv is for notification only, and cannot be used for posting messages.

To subscribe to the NESC News Listserv, either:
- send an e-mail to subnsfcnews@mail.nesc.wvu.edu *(no additional text is required)* or
- log onto [www.nesc.wvu.edu/nsfc/nsfc_listserv.htm](http://www.nesc.wvu.edu/nsfc/nsfc_listserv.htm)
Many state and local health departments do not have the resources to develop or purchase software to effectively inventory and manage small wastewater treatment systems in their jurisdictions. The U.S. Environmental Protection Agency (EPA) is developing an off-the-shelf, user-friendly management tool formatted in Microsoft Access that features Web-style buttons, point-and-click data entry, and intuitive use features.

There are approximately 23 million onsite and clustered wastewater treatment systems in the U.S. These facilities are designed and permitted mostly by local health departments, which typically track site evaluation, system type, and other information via paper filing systems. Some states and localities have electronic data systems for logging general information, such as owner name and address, permit number, fee paid, etc., but few maintain electronic systems capable of storing even the most basic information regarding system type, design flow, inspection reports, etc.

About a half-dozen data management systems have been developed over the past few years to track information on permits, service calls, inventory data, and site attributes. But none of the management information systems reviewed incorporate the full set of data elements needed to generate inventories, map system locations, provide information on system design flows and types, and track inspections or services rendered.

**Need for a Locally Based Management Information System**

There is a national need for a publicly available, freely circulated computer-based management information system that can be used by state and local governments, federal facilities, and others who must manage information on large numbers of decentralized wastewater systems (e.g., private residential communities, resorts, etc.).

Important elements of such a system have been developed and tested by various public and private entities. For example, the Buzzards Bay National Estuary Program distributes a privately produced inventory and management system tied to Massachusetts’ Title V wastewater program, and other vendors have developed systems to track inventory or service information.

EPA is developing this management information system to aid in identifying and capturing important system inventory and service information, and to help standardize management information so data can be easily transferred to other systems. The system will help answer key questions for public health and water resource program managers, such as:

- How many systems near drinking water sources have not been maintained?
- Are there systems older than 35 years sited less than 50 feet from the lakeshore?
- Which systems require inspection within the next year?
- How many systems of similar types have malfunctioned over the last three years?

**Proposed Management Information System**

EPA is developing a comprehensive management information system with a Microsoft Access database for managing system information. The system will accommodate a wide variety of queries, list reports, and mapping applications if users provide relevant data. The system software and training/user information will be placed on a Web site for free download by state and local governments.

Key data elements will be grouped under the following headlines: General Site Information, Permit Information, Facility Served, Site Evaluation Information, Treatment System, and Service Reports. The final version is scheduled for release in the fall of 2005.

For more information, contact Rod Frederick at (202) 566-1197 or Frederick.rod@epa.gov.
West Virginia University seeks expressions of interest and names of nominees in anticipation of a search to be undertaken for the position of Executive Director of the National Environmental Services Center (NESC). The Executive Director will oversee programs such as the National Small Flows Clearinghouse, the National Environmental Training Center for Small Communities, and the National Drinking Water Clearinghouse.

The NESC is a division of the National Research Center for Coal and Energy (NRCCE) at West Virginia University, an organization dedicated to advancing innovations for energy and the environment. This position reports to the NRCCE Director.

An official announcement and call for applications, when available, will be posted at:

http://www.nrccwvu/employment_opportunities

For more information about this anticipated job opening, contact Lynnette Loud, Assistant to the Director, National Research Center for Coal and Energy at (304) 293-2867 extension 5407.

West Virginia University is an Equal Opportunity Employer. Minorities, persons with disabilities, females, and other protected class members are encouraged to apply.

The editor of the Small Flows Quarterly wants your opinion, and not just as a “letter to the editor.” Our “Forum” column is a place where readers can share ideas that they feel will be of value to people involved in the treatment of wastewater, both onsite and small centralized systems. Please send your opinions (for the Forum column, 750 to 1,000 words) to the Small Flows Quarterly editor at:

Editor, Small Flows Quarterly
National Environmental Services Center
West Virginia University
P.O. Box 6064
Morgantown, WV 26506-6064
or call (800) 624-8301 or (304) 293-4191.

Got an Opinion?

Reducing Costs Through Water Conservation
Wastewater Planning As an Integral Part of Smart Growth
Drainfield Rehabilitation
Wastewater Reuse
Bacterial Source Tracking
Through funding from the U.S. Environmental Protection Agency, NESC assists small communities (those with populations less than 10,000) with their wastewater-related needs. A nonprofit organization, we offer a wide variety of free and low-cost resources on such topics as:

- septic systems and alternative onsite and community wastewater treatment technologies,
- regulations,
- operation and maintenance,
- design and monitoring,
- strategies for managing small wastewater systems, and
- public education.

NESC helps homeowners, local and state government officials, renters, realtors, citizens’ groups, regulators, research scientists, educators, consultants, manufacturers, operators, contractors, and the general public. We produce two quarterly publications about wastewater treatment in small communities, the *Small Flows Quarterly* and *Pipeline*, which are free by request to U.S. residents. Our Web site at [www.nesc.wvu.edu/nsfc/bnsfc_index.htm](http://www.nesc.wvu.edu/nsfc/bnsfc_index.htm) hosts discussion groups on wastewater issues and provides information about conferences and events across the country.

In addition, NESC operates a toll-free technical assistance hotline available Monday through Friday, 8 a.m. to 5 p.m. Eastern Time. NESC provides outreach services through workshops, seminars, and conference participation. We have an inventory of more than 430 free and low-cost educational products about wastewater. NESC also offers information and assistance to small communities about drinking water and environmental training. Contact us today at (800) 624-8301/(304) 293-4191 for a free information packet.