SMALL FLOWS QUARTERLY

SF

Helping America's Small Communities Meet Their Wastewater Needs
Fall 2004 Volume 5, Number 4

JURIED ARTICLE

Cost and Affordability of Phosphorus Removal at Small Wastewater Treatment Plants

Homeowner Cost Cutter: Build Your Own Constructed Wetland

Published by the National Environmental Services Center

National Environmental Services Center

NESC *Assistance. Solutions. Knowledge.*

Timothy Suhrer, Editor

From the Editor

This past spring, the National Environmental Services Center (NESC) held it's annual joint State Onsite Wastewater Regulators and Captains of Industry conference in Orlando, Florida (pg. 13). Thirty-eight states sent representatives—that's not enough; we need all 50. And I know there are more than 21 manufacturers in the onsite industry. This conference is the only one of its kind in the entire water industry, and I'd like to tell you why it's so valuable.

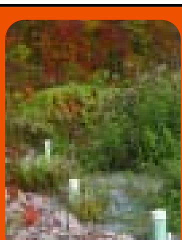
It's the only time when regulators from all the states can come together and discuss the issues they all are dealing with—face to face, no e-mail, no phone bills, for five days. They can talk with EPA regional coordinators eye to eye, with no one getting in the way—no chains of command to negotiate through. Both of these groups are hearing the same presentations on timely and crucially important topics that both need to deal with. During networking sessions, they can find out who thinks what about the issue that was presented. You learn a lot more about people from watching them talk to you than just hearing their voices or reading their words. To further cement these relationships, regulators form into groups according to shared interests from among the topics presented and plan joint white papers to be written about those subjects after the conference. Those position papers are sent to the EPA coordinators who attended the conference. That won't happen anywhere else.

Any company in the onsite industry can send representatives who will have the opportunity not only to network with each other, but also with these same state regulators and EPA regional coordinators. They hear the same presentations as the other two groups and go into the same networking sessions. The conference also includes facilitated joint forums.

These three groups are going to be the prime movers behind any progress that is going to occur in the onsite industry. Our environmental health hangs on what they do. This conference holds the promise of jump-starting that progress.

On pages 4 and 5, we have presented the companies who have contributed funds for these conferences. Along with encouraging greater attendance of the conferences, I would also like to invite any company that sees the value of these conferences and wishes to support them to become a recognized sponsor. For information about how to do that, call Sherry Summers at (800) 624-8301.

Timothy Suhrer



On the Cover

This subsurface constructed wetland is being monitored by NESC to study wastewater characteristics. Call Clement Solomon at NESC for information about the project. Photo by Chris Metzgar.

Helping America's Small Communities Meet Their Wastewater Needs

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FALL 2004

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American Decentralized Wastewater Association

ADWA, a national organization, represents companies that manufacture and market wastewater treatment devices certified by ANSI/NSF Standard 40. Our mission is to nurture the onsite wastewater treatment industry by working with industry leaders and regulators to promote the technology through rules, standards, training, and related activities consistent with contemporary public health and environmental protection standards.

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Bord na Mona

Bord na Mona Environmental Products U.S. Inc., Greensboro, N.C., manufacturers the Puraflo® peat fibre biofilter. Bord na Mona, established in 1946 to develop Ireland's peat resources, developed the biofiltration system Puraflo® in 1984. Puraflo® uses a special fibrous peat as a filter media to treat onsite wastewater. Puraflo® is a simple, low-maintenance system that optimizes natural passive biofiltration technology to produce a high-quality effluent. Puraflo® is available in over 28 states and four foreign countries.

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Greensboro, NC 27407
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National Decentralized Water Resources Capacity

The National Decentralized Water Resources Capacity Development Project is a USEPA-funded training, research, and development program focusing on issues concerning decentralized water resources. To date, the program has supported more than 30 projects, primarily aimed at improving our understanding and strengthening the foundations of training and practice in the field of decentralized wastewater treatment.

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Project Coordinator
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Web site: www.ndwrcdp.org

Infiltrator Systems, Inc.

Infiltrator Systems believes that research is critical to advancing the reliability of onsite wastewater treatment systems. ISI utilizes studies such as Dr. Robert Siegrist's "Wastewater Infiltration into Soil and the Effect of Infiltrative Surface Architecture" to design high-performance products that protect the public and the environment. To read this study, visit www.infiltratorsystems.com or www.nesc.wvu.edu.

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Web site: www.infiltratorsystems.com

NSF International

NSF is the leading provider of independent, third-party testing and certification services for products that impact public health, safety, and the environment. In support of these services, NSF also develops and maintains American National Standards. Today, NSF certifies onsite wastewater treatment systems, effluent filters, disinfection devices, compost toilets, and more.

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Web site: www.nsf.org

Ring Industrial Group

Ring Industrial Group's EZflow Drainage System is the leading geosynthetic aggregate pipe system for use in septic leachfields. EZflow's patented design affords consumers maximum system life and performance, lower system costs, and an environmentally friendly alternative.

Headquartered in Oakland, TN, Ring Industrial Group, LP is a wholly owned subsidiary of Ring Corporation.

Innovative Drainage Technology for Today's Environment

Contact Information:

Dennis Koerner
65 Industrial Park
Oakland, TN 38060
Phone: (800) 649-0253 or (901) 465-6333
Fax: (901) 465-1181
E-mail: inforequest@ringindustrial.com
Web site: www.ezflowlp.com

Sta-Rite Industries

Sta-Rite manufactures pumps, water systems, filters and accessories that move and improve water for a number of applications, including residential, agricultural, and industrial use. The company makes a complete line of pool and spa products including pumps and filters, cleaners, heaters, lights, fittings, and accessories. Sta-Rites products are sold in the U.S. and more than 100 countries.

Contact Information:

293 Wright Street
Delavan, WI 53115
Phone: 800-472-0884
Fax: 800-390-5351
www.starite.com

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Small communities make up 10 percent of the total U.S. wastewater demand. Bio-Microbics works with these communities across the U.S. to provide innovative environmental solutions that enable smart growth and sustainable development. Decentralized technologies are now considered permanent infrastructure that provide cost-effective, long-term options to protect public health and the environment.

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Shawnee, KS 66227
Phone: (800) 753-FAST (3278) or (913) 422-0707
Fax: (913) 422-0808
E-mail: onsite@biomicrobics.com
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Fax: (570) 326-6426
E-mail: mailinfo@cromaglass.com
Web site: www.cromaglass.com

FRALO Plastech
FRALO Plastech is the industry leader in innovative blow-mold technology. FRALO manufactures polyethylene septic, holding, and potable water tanks, risers, and other onsite products. FRALO is the owner of the world's largest blow-mold machine that utilizes a patented multi-layer co-extrusion process, resulting in superior quality products. Blow-mold technology offers superior design characteristics, performance, and longevity for our products.

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Fax: (315) 475-0200
E-mail: info@fraloplastech.com
Web site: www.fraloplastech.com

F. R. Mahony & Associates Inc.
F. R. Mahony & Associates is a manufacturer's representative for water and wastewater treatment systems and stocking distributor for E/One Sewer Systems. Manufacturer of the Amphidrome, Process—the next generation in nitrogen removal for small wastewater systems.

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Fax: (781) 982-1056
E-mail: info@frmahony.com
Web site: www.frmahony.com

Geoflow Inc.
Geoflow developed the WASTEFLOW® dripline for onsite wastewater dispersal. The effluent is placed slowly and uniformly below ground, through the root zone, and can often be used on difficult sites. WASTEFLOW® is built to last with ROOTGUARD® inhibitor molded into each emitter and UltrFresh protection against slime build-up along the dripline wall.

Contact Information:
Karen Ferguson
500 Tamal Plaza #506
Corte Madera, CA 94925
Phone: (800) 828-3388
Fax: (415) 927-0120
E-mail: krf@geoflow.com
Web site: www.geoflow.com

Hancor, Inc.
Hancor, Inc., is one of the nation's leading suppliers of onsite wastewater products, including polyethylene septic tanks, distribution boxes, leachfield products (including gravelless and corrugated polyethylene pipe), and our EnviroChamber‰ units. Widely accepted, the EnviroChamber units afford the user tremendous cost savings, eliminating gravel backfill material.

Contact Information:
Shawn Luton
401 Olive Street
Finlay, OH 45840
Phone: (419) 424-8335
Fax: (206) 600-6033
E-mail: sluton@hancor.com
Web site: www.hancor.com

MicroSepTec
MicroSepTec is a California-based company that manufactures the EnviroServer. The EnviroServer, ES is an advanced onsite wastewater treatment system for residential and light commercial applications. The system is pre-engineered, cost effective, and environmentally friendly. The EnviroServer, meets the needs of the homeowners, installers, architects, engineers, and county health departments.

Contact Information:
Tina Edvardsson, PE or Darika Vana
360 Forbestown Road
Oroville, CA 95966
Phone: (877) 473-7842 or (530) 589-9929
Fax: 530) 589-9179
E-mail: microseptec@microseptec.com
Web site: www.microseptec.com

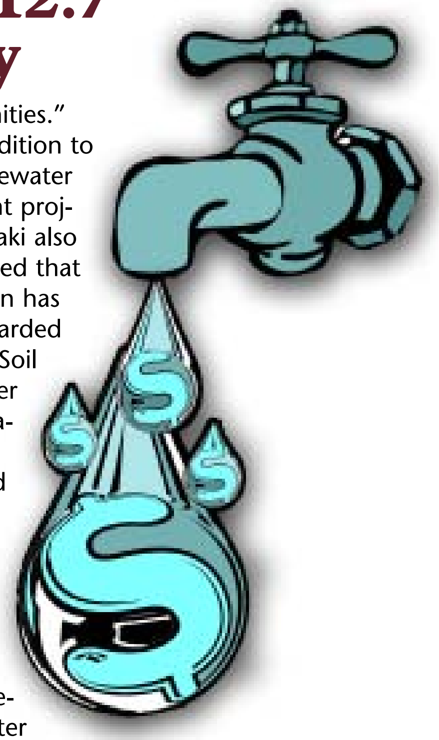
Orenco Systems® Inc.
Orenco Systems® designs and manufactures leading-edge equipment for onsite and decentralized wastewater systems. Products include watertight tanks, pumping and filtration systems, secondary treatment systems (including AdvanTex® filters), community collection systems, and both standard and custom controls. Founded in 1981, Orenco employs nearly 250 people and sells throughout the world.

Contact Information:
Sam Carter or Gail Elber
Orenco Systems, Inc.
814 Airway Avenue
Sutherlin, OR 97479
Phone: (800) 348-9843 or (541) 459-4449
Fax: (541) 459-2884
E-mail: scarter@orenco.com
Web site: www.orenco.com

Premier Tech Environment
Since 1986, Premier Tech Environment has devoted considerable energy to the research, development and innovation of leading-edge onsite wastewater treatment technologies. A recognized leader in this field thanks to its innovative technologies, Premier Tech Environment offers its customers simple, efficient and economical technologies that require minimum operation and maintenance.

Contact Information:
Chantale Coulombe
Phone: (877) 295-5763
E-mail: ecoflo@premiertech.com
Web site: www.premiertech.com

New York Governor Announces $12.7 Million To Improve Water Quality



Governor George E. Pataki announced in July more than $12.7 million in grants for 43 water quality improvement projects to help reduce pollution and runoff entering New York's lakes, rivers, and streams.

"From Long Island Sound to the Great Lakes, our treasured waterways across New York provide historic, cultural, and environmental lifelines for the communities along their banks," Pataki said. "By offering these communities the assistance they need to improve the capacity and performance of their wastewater treatment plants and to reduce runoff, we are improving water quality and safeguarding these priceless resources for future generations."

Of the funding, $9.7 million will be used to assist municipalities in reducing water pollution through wastewater treatment improvements. Ten new wastewater treatment plants in upstate municipalities will be constructed and six will be upgraded. The projects address environmental priorities, including the elimination of raw discharges and failing onsite systems in hardship communities and improving aging treatment and collection systems.

Funding for these projects was coordinated through Governor Pataki's Water and Sewer Co-Funding Initiative, a cooperative effort between several New York State agencies and one federal government agency to coordinate funding for water and sewer projects in communities throughout the state. The Initiative provides a streamlined process that makes it easier and quicker for communities to obtain optimal funding for their projects and helps ensure that available funds are used as effectively as possible.

Through the Co-funding Initiative, 15 of the 16 wastewater treatment improvement projects are also receiving more than $64 million in state co-funding from Governor Pataki's 1996 Clean Water/Clean Air Bond Act; New York's Clean Water State Revolving Fund, administered by the Environmental Facilities Corporation and DEC; the Community Development Block Grant Program, administered by the Governor's Office for Small Cities; and the Appalachian Regional Commission Development Program, administered by the Department of State. In addition, the Water and Wastewater Disposal Loan and Grant Program, administered by the U.S. Department of Agriculture's (USDA) Rural Development program, has provided these projects with $3.36 million in funding and has an additional $5.5 million in funding for which they are eligible.

Patrick Brennan, Director of the USDA Rural Development, said that the Co-Funding Initiative "is a model of intergovernmental cooperation that maximizes public resources and keeps drinking water and wastewater treatment affordable for rural communities."

In addition to the wastewater treatment projects, Pataki also announced that $3 million has been awarded to assist Soil and Water Conservation Districts and municipalities with implementation of 27 projects to reduce water pollution from runoff sources other than agriculture as part of the statewide Nonagricultural Nonpoint Source Pollution Abatement and Control Program. This runoff carries soil, animal waste, automotive fluids, and other contaminants into waterways and is a major source of water pollution in New York. These projects will focus on urban stormwater management, aquatic habitat restoration, stream bank restoration, road bank stabilization, and improved road salt storage.

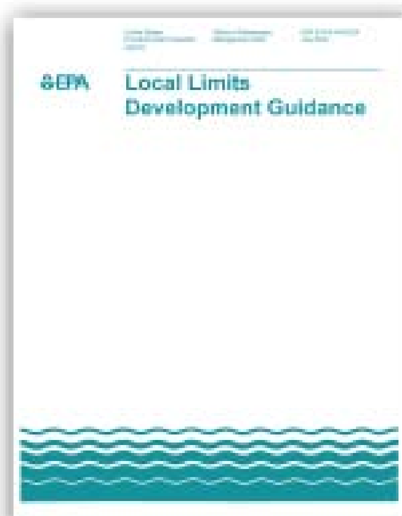
A list of projects receiving the funding can be found on the Web at **www.state.ny.us/governor/**.

Local Limits Development Guidance is Available

EPA has released the final *Technically Based Local Limits Guidance* manual for municipalities that operate pretreatment programs. The manual provides guidance to municipalities on the development and implementation of local controls for discharges of industrial or commercial wastes to sewage treatment facilities, with specific information on:

- determining pollutants of concern,
- collecting and analyzing data,
- calculating maximum allowable loadings,
- designating and implementing local limits to protect wastewater treatment and collection systems, and
- performing annual reviews and periodic reevaluations.

The new guidance is available at **www.epa.gov/npdes/pretreatment**.



Calendar of Events

DECEMBER

10th Annual KOWA Conference & Exhibit
Kentucky Onsite Wastewater Association
December 1–3
Louisville, Kentucky
(270) 358-8665
katherinem.peake@ky.gov

2004 Ground Water Expo
National Ground Water Association
December 12–15
Las Vegas, Nevada
(800) 551-7379
www.ngwa.org

Plant Operations Math for Water and Wastewater Operators
Water Environment Federation, New England Water Environment Association Massachusetts Water Pollution Control Association
December 14–15
Boston, Massachusetts
(703) 684-2452
Fax: (703) 684-2492
www.wef.org/conferences/

JANUARY

Inspection World 2005
American Society of Home Inspectors
January 13–15
Austin, Texas
(800) 743-2744
hq@ashi.org
www.inspectionworld.org

15th Annual Nonpoint Source Water Quality Monitoring Results Workshop
Idaho Departments of Environmental Quality, Fish and Game, Lands, and Agriculture, U.S. EPA, U.S. Forest Service, U.S. Bureau of Land Management, U.S. Geological Survey, Agricultural Research Service, Electronic Data Solutions, Eco-Analysts, Inc., and CH2MHill.
January 4–6
Boise, Idaho
(208) 373-0120
bmallard@deq.state.id.us
www.deq.state.id.us/water/nps/nps workshop 2005.htm

16th Annual Alabama On-site Sewage Treatment & Disposal Conference
Alabama Onsite Wastewater Association (AOWA)
January 19–20
Auburn, Alabama
(205) 652-3803
atartt@uwa.edu

AWWA Source Water Protection Symposium
American Water Works Association
January 23–25
Palm Beach Gardens, Florida
(303) 347-6201—Linda Moody
www.awwa.org/conferences/

2nd Annual OWPI Educational Conference and Trade Show
Onsite Wastewater Professionals of Illinois
January 24–26
Collinsville, Illinois
(618) 523-4266
Fax: (618) 523-4751
www.owpi.net

FEBRUARY

2005 Disinfection Conference Sharing Disinfection Technologies: Water, Wastewater, and Biosolids
Environment Federation, American Water Works Association, International Water Association February 6–9
Mesa, Arizona
(703) 684-2452
Fax: (703) 684-2492
www.wef.org/conferences/

National Water Quality Conference
USDA-Cooperative State Research, Education, and Extension Service and the Land Grant Colleges and Universities and North Carolina State University
February 7–9
La Jolla, California
(919) 515-7154—Kathryn Murray
soils_training@ncsu.edu
www.soil.ncsu.edu/swetc/waterconf/main.waterconferenc.htm

2005 Design-Build in Water/Wastewater Conference
Design-Build Institute of America
February 9–11
Orlando, Florida
202) 682-0110
Fax: (202) 682-5877
2005waterprogram@dbia.org
www.dbia.org

2005 Integrated Concepts in Water Recycling International Conference
University of Wollongong
February 14–17
Wollongong, Australia
+61 2 4221 3385
Fax: +61 2 4221 4738
ozaquarec@uow.edu.au
www.uow.edu.au/eng/cme/research/ozaquarec/conferences.html

27th Annual (2005) HWEA Conference
Hawaii Water Environment Association
February 17–18
Honolulu, Hawaii
(808) 531-3017
jstone@oceanit.com
http://hwea.org/conf.htm

2004 Pumper and Cleaner Environmental Expo
Cole Publishing, Inc.
February 23–26
Nashville, Tennessee
(800) 257-7222
www.pumpershow.com

WEF/AWWA 2005 Joint Management Conference
Water Environment Federation and American Water Works Association
February 27–March 2
http://www.awwa.org/conferences/jmc/

MARCH

Crossing Boundaries: GITA 28th Annual Conference
Geospatial Information & Technology Association
March 6–9
Denver, Colorado
(303) 337-0513
info@gita.org
www.gita.org

27th Annual ARWA Conference
Alabama Rural Water Association
March 13–16
Mobile, Alabama
(334) 396-5511
www.alruralwater.com

27th Annual NMRWA Conference
New Mexico Rural Water Association
March 21–24
Albuquerque, New Mexico
(505) 884-1031
Fax: (505) 884-1032
www.nmrwa.org/events.php

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.**

New Guide Assesses Software for Environmental Management System (EMS) Implementation

A new guide prepared by the Global Environment & Technology Foundation (GETF) compares "off-the-shelf" software products specifically designed to support an organization's development, implementation, and subsequent management of its environmental management system (EMS). The assessment focused primarily on managing environmental issues; however, the analysis also considered the software's capability for integrating quality, environment, security, and safety and health into a single management system approach. While the assessment was conducted specifically with ports in mind, the assessment may be useful to other public sector businesses and organizations considering the use of software to support their EMS.

EMS software packages can offer the following key implementation management and EMS maintenance tools:

- better communication between environmental and project staff at multiple installations;
- easy access to routine environmental and EMS documents and records;
- access to regulations and other requirements;
- enhanced management of permits, reporting, and compliance;
- database query, reporting, and updating;
- document repositories;
- enhanced project management;
- e-mail based notification systems with escalation functions;
- calendar and EMS milestone and progress functions;
- EMS report generation tools; and
- information access security controls.

The software assessment entailed collecting factual information via interviews, product demos, message exchanges, and Web research on sixteen EMS-focused software products currently available. Each of the identified products was assessed against specific criteria as deemed critical to implementing a viable computer-based management system. Example criteria included: ISO compliance, platform dependencies/adaptability, e-mail notification capability, template provision, licensing requirements, access controls/security features, training, product support, and price. The products were also assessed for manageability of fundamental EMS elements, including: document control features, procedure writing, sample documentation database, environmental aspect and risk assessment, tracking regulatory compliance, record management, corrective and preventative action, and auditing.

To download the guide, visit **www.peercenter.net/ewebeditpro/items/O73F4044.pdf**.

New Report Examines the Integration of Management Initiatives for Water and Wastewater Utilities

A new report, *Continual Improvement on Utility Management: A Framework for Integration,* examines 15 different management initiatives available to water and wastewater utilities, each designed to help improve performance in areas such as safety, quality, finances, human resources, and environment. Funded by the U.S. Environmental Protection Agency (EPA) and sponsored by the Association of Metropolitan Sewerage Agencies (AMSA), EPA, and the Water Environment Federation (WEF), the guide provides a roadmap showing how the management initiatives interrelate and how a utility can best approach integrating them in the context of a continual improvement management system framework. The 15 management initiatives examined include:

- American Public Works Association's (APWA) management accreditation program;
- asset management;
- American Water Works Association's (AWWA) proposed accreditation program;
- Balanced Scorecard;
- Bid-to-Goal;
- capacity, management, operation, and maintenance programs (CMOM);
- EPA environmental management systems (EMS) initiative for local governments;
- Governmental Accounting Standards Board Statement #34 (GASB-34);
- International Organization for Standardization (ISO) 14001;
- ISO 9001;
- Malcolm Baldrige National Quality Program;
- National Biosolids Partnership's EMS for Biosolids;
- Occupation and Health Administration's (OSHA) Voluntary Protection Program;
- Partnership for Safe Water; and
- QualServe.

The report can be downloaded from the Web at **www.lgean.org/html/whatsnew.cfm?id=762**.

Wastewater on the web...

Sewage World

www.sewage.net

The Sewage World Web site contains links to many different water, wastewater, and utility facilities throughout the U.S. This site also contains links to facilities in Australia, Egypt, China, Sweden, Japan, Israel, and Finland. Users can also access industrial flow charts for some processes.

USA Blue Book

www.waterdesk.com

The USA Blue Book claims to be the first and only complete catalog for water and wastewater operations. The catalog features more than 12,000 items in stock for immediate shipment with full descriptions, prices, tips, and advice. The entire catalog can be accessed on the USA Blue Book Website. By using the product search, users can look for specific products or look under product specials to access new products and special deals. Users can choose to request a catalog to be mailed to them. Users can also receive quotes for catalog and non-stock special requests and technical support.

Water Online

www.wateronline.com

Water Online provides information relevant to the water and wastewater industry. On this site, users can find products and suppliers, read current headlines, and keep up with the latest information through newsletters, trade publications, and market research reports. This site also has information on jobs and services available for individuals in the water and wastewater industry.

Water Environment Federation (WEF)

www.wef.org

The WEF is dedicated to the preservation and enhancement of the global water environment. The WEF's mission is to deliver high-quality products and services to members and stakeholders, promote and advance the water quality industry, and benefit society through protection and enhancement of the global water environment. This Web site features a technical discussion group, wastewater certification and training information, a wastewater operations glossary, and a product listing.

Water/Wastewater Links Page

www.members.aol.com/ronwater1/index.htm

The Water/Wastewater Links Page is designed and written for individuals involved with the operations and maintenance of water and wastewater treatment plants. This site is designed for the new Internet user with links to information on how the Internet got started, how to search for information on the Internet, how to access mailing list home pages, and Web discussion groups for operational problems.

The Groundwater Foundation

www.groundwater.org

The Groundwater Foundation, a nonprofit organization formed in 1985, is dedicated to informing the public about groundwater through various programs and publications. Not only does this site feature information about groundwater, but it also includes information about the Groundwater Foundation's various programs and events, youth programs, press releases, and an online catalog.

Water Environment Research Foundation (WERF)

www.werf.org

WERF is the largest organization in the U.S. that provides wastewater and water quality research. WERF research has included topics as diverse as fate and transport of toxic compounds, ecological risk assessment, optimization of treatment system operations and management, comparative effectiveness of disinfections processes, wet weather flows, and biosolids management. The WERF Web site provides information about watersheds, ecosystems, stormwater, human health, the latest news and events, products, and funding opportunities.

The Louisiana Rural Water Association

www.lrwa.org

The Louisiana Rural Water Association (LRWA) is a nonprofit organization that was established in 1978 to aid small water and wastewater systems through training and onsite technical assistance. The LRWA also promotes water conservation and protection through public awareness campaigns. This site features information about training, conferences, water, employment opportunities, and governmental links.

EMS Resource Centers Available to Assist Local Governments

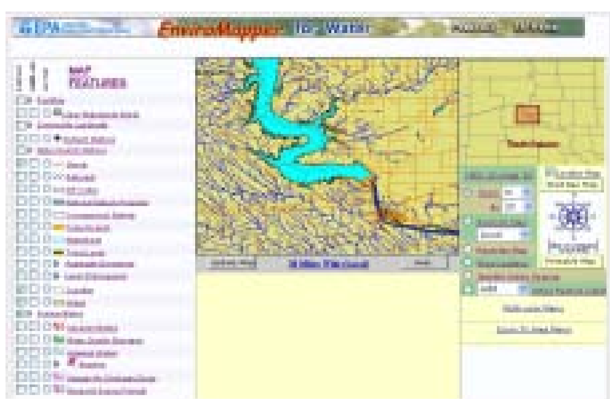
The U.S. Environmental Protection Agency (EPA) has designated seven organizations around the country to become environmental management systems (EMS) local resource centers. These centers will help local agencies adopt EMSs to improve their overall environmental performance and compliance and meet environmental goals. The announcement supports EPA's overall policy of actively promoting adoption of EMSs that help improve environmental performance and compliance.

EMSs, used extensively in private industry, are now being adopted by a growing number of local governments, through work led by the Office of Water in collaboration with other EPA offices. EMSs provide organizations with a structured process for identifying and then reducing a broad range of environmental impacts from their operations and meeting key environmental goals. The designated EMS local resource centers are located in existing academic or other nonprofit institutions that have a proven track record of providing high quality environmental assistance in their respective areas. The organizations selected as EMS resource centers include the following:

- Georgia Institute of Technology—Economic Development Institute; Contact: Tim Israel, (404) 894-0968, **tim.israel@edi.gatech.edu**.
- Purdue University – Center for Clean Manufacturing Technology and Safe Materials (CMTI); Contact: Lynn Corson, (765) 463-4749, **corson@purdue.edu**.
- Texas Commission on Environmental Quality; Contact: Ken Zarker, (512) 239-3145, **kzarker@tceq.state.tx.us**.
- University of Florida—Center for Training, Research, and Education for Environmental Occupations (TREEO); Contact: William Engel, (352) 392-9570 **bengel@treeo.doce.ufl.edu**.
- University of Massachusetts at Lowell—EMS Service Program; Contact: Matthew Donahue, (978) 934-4741, **matthew_donahue@uml.edu**.
- Virginia Polytechnic Institute & State University—Center for Organizational and Technological Advancement (COTA); Contact: Robert Herbert, (540) 853-8276, **bherbert@vt.edu**.
- The Zero Waste Alliance in Portland, Oregon; Contact: Larry Chalfan, (503) 279-9383, **lchalfan@zerowaste.org**.

EPA will work with the centers to help them better serve the needs of local and state agencies that wish to learn more about EMSs and adopt them for their operations. Each center will also share information on their activities through an online national clearinghouse of EMS information for public agencies, available at **www.peercenter.net**. Additional information about the local resource centers can be found at **www.peercenter.net/resourcecenters/**.

A New Version of EnviroMapper is Now Available



EPA's Office of Water has just released a new version of EnviroMapper for Water **(www.epa.gov/waters/enviromapper/)**. EnviroMapper for Water provides a Web-based mapping connection to a wealth of water data. You can use it to view and map data, such as the uses assigned to local waters by your state (fishing, swimming, etc), waters that are impaired and do not support their assigned uses, the reasons why waters are impaired, water quality monitoring information, closures of swimming beaches, and the location of dischargers. Maps can be viewed at the national, regional, state, or local levels. This latest release of EnviroMapper for Water (Version 3.0) features several new layers of water data including EPA's national water quality database STORET, National Estuary Program study areas, and the location of nonpoint source projects. Other enhancements make it easier to locate and view these data, and instructions are included describing how to incorporate the resulting map into your own Web page. For more information, contact Tommy Dewald at **dewald.tommy@epa.gov** or (202) 566-1178.

Seattle's Stormwater Program Wins Innovations in American Government Award

The Innovations in American Government Awards

Seattle, Washington's stormwater initiative has won an esteemed Innovations in American Government Award. Seattle's Natural Drainage Systems Program uses plants, trees, and soil to purify and transport the city's stormwater runoff. The goals of the program are to infiltrate and slow stormwater flow, filter and bioremediate pollutants by soils and plants, reduce impervious surface, increase vegetation, and improve the pedestrian experience.

Impervious surfaces such as rooftops, streets, and parking lots do not allow rainwater to seep into the soil. Consequently, the water flows quickly and in great volumes to Seattle's creeks—a significant part of the city's drainage system. Pollutants generated by urban activities, such as landscaping, transportation, and business, are carried through creeks into lakes and Puget Sound, impacting the food chain that supports native marine fish populations. Projects under the Natural Drainage Systems Program use natural features—open, vegetated swales, stormwater cascades, and small wetland ponds—to mimic the functions of nature lost to urbanization. New technologies like porous pavement are also being employed and tested.

For 17 years, the Innovations in American Government Award has recognized quality and responsiveness at all levels of government, honored government efforts that are creative, effective, and address significant problems, and has fostered the replication of innovative approaches to the challenges facing government. The award is a program of the Ash Institute for Democratic Governance and Innovation at Harvard University's John F. Kennedy School of Government and is administered in partnership with the Council for Excellence in Government. Referred to as the Oscars of good government, the award includes a grant of $100,000 to help expand the program.

For more information about Seattle's Natural Drainage Systems Program, go to Seattle's Web site at **www.seattle.gov/util/About_SPU/Drainage_&_Sewer_System/Natural_Drainage_Systems/index.asp**. For more information about the Innovations in American Government Awards, click on **www.excelgov.org/displayContent.asp?Keyword=aiHomePage**.

Revised EPA Policy Provides Incentives for Small Local Governments to Seek Compliance Assistance

The U.S. Environmental Protection Agency (EPA) has issued the Small Local Governments Compliance Assistance Policy, which revises and supercedes EPA's Policy on Flexible State Enforcement Responses to Small Community Violations. EPA issued the revised policy to clarify who are the intended recipients of state penalty mitigation benefits under the prior policy, and to make those benefits available, in defined circumstances, to local governments with larger resident populations and in response to a wider variety of environmental compliance activities.

By establishing parameters within which EPA will generally defer to a state's decision to reduce or waive the normal noncompliance penalty of a unit of small, general-purpose local government, the revised policy provides an incentive for small local governments to seek compliance assistance from their states and take the actions necessary to achieve and sustain comprehensive environmental compliance.

The revised policy became effective on June 2, 2004. To view a copy of the policy, go to the Web at **www.lgean.org/html/whatsnew. cfm?id=763**. For more information, contact Kenneth Harmon at (202) 564-7049 or **harmon.kenneth@epa.gov**.

New Web Site Keeps Water Quality Testing Standards Current and Accessible

For the first time, water professionals can access up-to-the-minute developments in water quality testing standards and consult with other experts through a new site on the World Wide Web.

Three prominent water and public health organizations, the American Public Health Association, the American Water Works Association, and the Water Environment Federation, have launched an online, subscription-based service of the popular *Standard Methods for the Examination of Water and Wastewater* at **www.StandardMethods.org**. Print versions of *Standard Methods* have served as the industry guide for water quality testing for 99 years, providing more than 350 separate methods of water quality measurements used by industry scientists, analysts and engineers.

Standard Methods Online will add the following services:

- new, revised, and U.S. Environmental Protection Agency approved methods will be continuously updated and available for download 24 hours a day, seven days a week;
- subscribers will receive e-mail notification of additions, updates, and approvals as they happen;
- fully searchable text;
- e-newsletter highlighting the latest issues and trends; and
- access to a community of experts through online discussion forums.

"In addition to enabling quicker dissemination of new and revised methods, adding Standard Methods Online will create a constant energy for new methods to be produced," said Lenore Clesceri, chair of the Standards Methods Joint Editorial Board.

Older methods that could not be included in revised printed editions due to space constraints will also be retained online, pending review and approval by the Standard Methods Committee.

New Web Site Showcases International Innovative Environmental Solutions

The U.S. Environmental Protection Agency (EPA) has a new Web site offering environmental policies and best practices from countries around the world. The online global library provides links to journals, databases, guidelines, programs, and case studies involving innovations in air, toxics, waste, and water issues, as well as multi-media approaches, such as environmental management systems (EMS), sustainable transport, smart growth, and industrial ecology. It provides examples of state and local partnerships with other countries and regions that have resulted in creative environmental solutions in the U.S., such as

- constructed wetlands to treat wastewater;
- green buildings and renewable energy to address climate and air pollution;
- industrial ecology to support pollution prevention and brownfields revitalization;
- a list of fellowships for group and individual exchanges; and
- a number of resources on evaluating international initiatives.

The library will help state and local governments, federal agencies, nongovernmental organizations, as well as other countries learn from these experiments. For more information, visit the Web site at **www.epa.gov/innovation/international**.

EPA Launches New Water Program Web Site

The U.S. Environmental Protection Agency (EPA) Office of Water has announced the opening of a new Web site providing in one place access to a range of key information about the water program strategic plan and supporting materials. The site is a convenient, one-stop access point to:

- the new EPA Strategic Plan;
- the draft national water program guidance document;
- Water Sub-objective Implementation Plans; and
- Regional Plans from each EPA region.

The Web site is located at **www.epa.gov/water/waterplan**.

State Regulators and Industry Representatives Meet in Joint Conferences

NESC ENGINEERING SCIENTIST
Andrew Lake

The National Environmental Services Center (NESC) has been holding an annual joint conference for the past 4 years—bringing together the State Onsite Wastewater Regulators and Captains of Industry conferences. These conferences have provided regulators from each state a time and place to share ideas and discuss issues surrounding onsite/decentralized wastewater needs and to interact with members of the wastewater industry.

The joint conference is structured for those members of state government who deal directly with onsite/decentralized wastewater regulations, as well as enforcement and development. The stated purpose of these conferences has been to facilitate a cooperative effort among regulators and members of industry to create "issue papers" and share ideas to generate a better understanding of each state's individual onsite wastewater program and to promote interaction with manufacturers of onsite/decentralized technologies.

The 6th Annual State Onsite Regulators and the 4th Annual Captains of Industry conferences held this spring (February 23–27) in Orlando, Florida, featured presentations and discussions from the nation's leading researchers in the wastewater industry. NESC Executive Director John Mori, Ph.D., kicked off the conferences by welcoming the largest delegation of states ever to attend (38 states) and 21 representatives of the Captains of Industry.

The agenda for this year's conference was geared specifically toward technology, research, and the future of the onsite wastewater industry.

The keynote address was delivered by George Tchobanoglous, Ph.D., Professor Emeritus of the University of California at Davis. The presentation provided a synopsis of where the onsite industry has been and the future that it plays in our day-to-day lives. Tchobanoglous discussed three key elements as defining the future of wastewater treatment: effective reuse of water, reducing the demand for water, and developing an approach for long-term environmental sustainability.

The keynote address set the tone for the remainder of the conference, with presentations highlighting ongoing research and how these key elements are being addressed.

Keynote speaker George Tchobanoglous, Ph.D., Professor Emeritus of the University of California at Davis.

The remainder of the first day focused on current research being conducted at several leading universities. Robert Seigrist, Ph.D., Colorado School of Mines (CSM), presented the "Highlights and Findings of the CSM Small Flows Program with a Focused Discussion of Effluent Infiltration as Affected by Infiltrative Surface Architecture." Jerry Tyler, Ph.D., University of Wisconsin, Madison, provided a two-part presentation on "Soil Treatment Principles: What do we know? What do we need to know?" as well as, "Soil Treatment in regards to the Na-

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Above and Below Right: Conference attendees toured the Florida Onsite Wastewater Association's training center in Lake Alfred.

tional Model Code Initiative." Mark Gross, Ph.D., University of Arkansas, presented on "Low-Pressure Pipe Systems: Practical Considerations." The final presentation for the day focused on "Test Center Data vs. Real World Data—a Capacity Development Project," presented by Tom Groves, New England Interstate Pollution Control Commission. This was the most technologically and research-oriented day for the state regulators and Captains of Industry and gave them a feel for the current state of the wastewater industry.

The second day featured presentations from Tom Bruursema of National Sanitation Foundation, International (NSF), regarding "The Status of NSF Standard 40 and What's Needed for the Future" and Don Canada from the American Decentralized Waste Water Association, speaking on "Aerobic Treatment Unit Maintenance."

Following these presentations, a new opportunity was provided to this year's attendees—a field trip to Lake Alfred, Florida, to visit the Florida Onsite Wastewater Association training center. The visit was hosted by Kevin Sherman, director of the training center. The attendees were able to hear presentations on the different types of onsite systems, their uses, and operation and maintenance issues for each. This field trip provided a valuable and practical hands-on experience for the attendees to view varying treatment options.

The conference resumed the next day by covering one of the hottest developing topics in the wastewater industry—certification. The discussion began with a presentation from Christl Pokorney, National Environmental Health Association (NEHA), and Tony Smithson, NEHA Onsite Wastewater Technical Section Chair. The presentation and discussion covered plans for NEHA to develop a National Onsite Wastewater Installers Credentialing Program.

NEHA was looking to members of the State Regulatory forum to aid in developing protocol for such a national program. In an effort to further facilitate this request, NESC staff will be developing a discussion listserv for those members who are interesting in supporting NEHA in this endeavor.

Two states that have existing certification programs in place presented case studies. Those presentations were given by Ken Graber, Texas Commission on Environmental Quality and Sonia Cruz, Florida Department of Health.

During these presentations and discussions, the Captains of Industry representatives were holding a separate session to develop issue papers and discussion topics for the state regulators to address. This session produced a desire from industry representatives to develop a separate listserv-type discussion forum for greater interaction with the state onsite regulatory community. NESC staff will be developing this service to facilitate this request.

The remaining days of the conference dealt with training needs for state regulators, with the discussion facilitated by Bruce Lesikar, Ph.D., Texas A&M University and Doug Ebelherr of Chase Environmental Services, Inc. Following that discussion, Robert Pickney of Onsite Systems, Inc., provided case studies from the State of Tennessee on "Applying Technology to Assist Small Communities in Meeting Their Wastewater Needs."

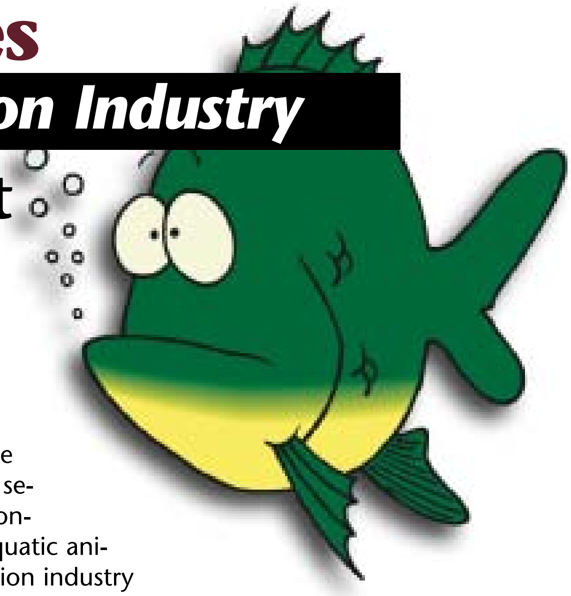
Both of these sessions introduced a need and willingness to develop working relationships among fellow regulators and those individuals working in private industry in managing onsite systems and assisting small communities. The direction of the conference turned to looking more toward the future by forging working relationships with state legislatures, developing data management/inventory tools, and looking to what the National Decentralized Water Capacity Development Project is doing to support the state onsite regulatory community's needs.

The 6th Annual State Onsite Regulators and 4th Annual Captains of Industry conferences provided a positive experience in both understanding the current status of the wastewater world and gaining insight into what the future may hold, as well as identifying some tools and ideas that could move the industry forward by forging new partnerships and working relationships.

Currently, NESC is working with Chase Environmental Services, Inc., to develop the agenda for next year's joint conference, which will be held in New Orleans, Louisiana in March. An interactive CD has been created by Chase Environmental Services, Inc. and is currently being reviewed by NESC staff. It should be available to the public soon.

Any inquiries regarding the State Onsite Regulators and Captains of Industry conferences can be directed to the NESC. Call (800) 624-8301 or (304) 293-3161.

Effluent Guidelines
Aquatic Animal Production Industry
Final Rule—Fact Sheet



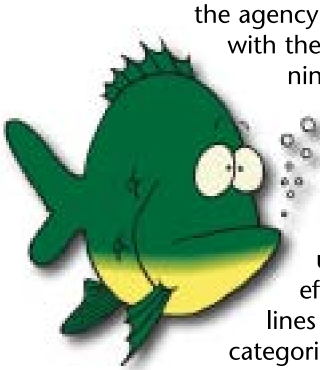
Summary

The U.S. Environmental Protection Agency (EPA) is setting standards for the discharge of wastewater from concentrated aquatic animal production facilities (known as fish farms). This rule establishes effluent limitation guidelines and new source performance standards for specific types of commercial and noncommercial operations that produce aquatic animals for food, recreation and restoration of wild populations, pet trade, and other commercial products. Rather than setting numeric limits, the EPA is requiring best management practices to control the discharge of pollutants in the wastewater from these facilities. EPA found that it is not necessary to establish pretreatment standards for existing or new facilities.

Background

On June 30, 2004, EPA's acting deputy administrator signed a final rule to establish wastewater controls for concentrated aquatic animal production facilities (fish farms). The regulation applies to about 245 facilities that generate wastewater from their operations and discharge that wastewater directly to U.S. waters. When these requirements are applied in National Pollutant Discharge Elimination System (NPDES) permits, they will help reduce discharges of conventional pollutants (mainly total suspended solids), nonconventional pollutants (such as nutrients, drugs, and chemicals) and, to a lesser extent, toxic pollutants (metals and PCBs).

In October 1989, the Natural Resources Defense Council and others sued EPA, claiming the agency had failed to comply with the Section 304(m) planning process required by the Clean Water Act. In January 1992, plaintiffs and EPA agreed to a settlement that established a schedule for EPA to promulgate effluent limitation guidelines for 11 specific industrial categories and for eight other categories to be determined by the agency. EPA selected the concentrated aquatic animal production industry as one of those 11 categories. The revised consent decree required EPA to sign a proposed rule by August 14, 2002, and to take final action by June 30, 2004. This rule is the last of the 19 categorical rules to be issued and completes EPA's obligation under the 1992 consent decree.



To which facilities does this rule apply?

The final rule applies to direct discharges of wastewater from these existing and new facilities:

- facilities that produce at least 100,000 pounds a year in flow-through and recirculating systems that discharge wastewater at least 30 days a year (used primarily to raise trout, salmon, hybrid striped bass and tilapia), and
- facilities that produce at least 100,000 pounds a year in net pens or submerged cage systems (used primarily to raise salmon).

What are the impacts of the regulation?

EPA expects that, when the rule is implemented through NPDES permits, the discharge of total suspended solids will be reduced by more than 500,000 pounds per year, and biochemical oxygen demand and nutrients will be reduced by about 300,000 pounds per year. The resulting improvements in water quality will create more opportunities for swimming and fishing and reduce stress on ecosystems in those waters. EPA estimates it will cost about $1.4 million a year for the facilities to comply with this rule, an amount that EPA analyses indicate is affordable.

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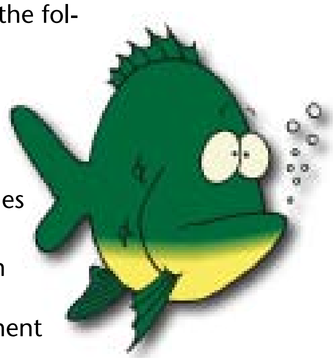
What does the rule require?

The rule requires that all applicable facilities do the following:



- Prevent discharge of drugs and pesticides that have been spilled and minimize discharges of excess feed.
- Regularly maintain production and wastewater treatment systems.
- Keep records on numbers and weights of animals, amounts of feed, and frequency of cleaning, inspections, maintenance, and repairs.
- Train staff to prevent and respond to spills and to properly operate and maintain production and wastewater treatment systems.
- Report the use of experimental animal drugs or drugs that are not used in accordance with label requirements.
- Report failure of or damage to a containment system.
- Develop, maintain, and certify a best management practice plan that describes how the facility will meet the requirements.

The rule requires flow through and recirculating discharge facilities to minimize the discharge of solids such as uneaten feed, settled solids, and animal carcasses.

The rule requires open water system facilities to do the following:

- Use active feed monitoring and management strategies to allow only the least possible uneaten feed to accumulate beneath the nets.
- Properly dispose of feed bags, packaging materials, waste rope, and netting.
- Limit as much as possible wastewater discharges resulting from the transport or harvest of the animals.
- Prevent the discharge of dead animals in the wastewater.

How can I get copies of the rule or additional information?

For a copy of the final rule, contact the Office of Water Resource center at (202) 566-1729 or **center.water-resource@epa.gov**. You can also write or call the National Service Center for Environmental Publications (NSCEP), U.S. EPA/NSCEP, P.O. Box 42419, Cincinnati, Ohio 45242-2419, (800) 490-9198, **www.epa.gov/ncepihom/**. Electronic copies of the preamble, rule, and major supporting documents are available at **www.epa.gov/guide/aquaculture** or in E-Docket at **www.epa.gov/edocket/**. Once in the E-Docket system, select "search," then key in the docket identification number (OW-2002-0026). For additional information, contact Ms. Marta Jordan at (202) 566-1049 or **jordan.marta@epa.gov**.

New Rule to Protect Nation's Beaches

As part of the Clean Beaches Plan, the U.S. Environmental Protection Agency (EPA) has issued a proposed regulation to improve standards for water quality monitoring at our nation's beaches. EPA acted to ensure that more protective health-based standards are in place in all states and territories bordering Great Lakes or ocean waters.

"We are working as partners with the states and territories to promote scientifically strong, defensible standards for coastal and Great Lakes recreational waters," said EPA Acting Assistant Administrator Ben Grumbles. "States have made good progress over the last several months. We expect this to continue, but in the meantime, we are ensuring that the public is protected by having federal standards in place."

Of the 35 states and territories that have coastal or Great Lakes recreational waters, ten have already adopted EPA's recommended criteria for all their coastal recreational waters, and 17 states are in the process of adopting these criteria. Other states have adopted the criteria for portions of their waters, while a small number have yet to take action. EPA will exclude from the final federal regulation any state or territory that adopts these more protective health-based criteria. The proposal has a 30-day comment period, and EPA will issue a final standard in early fall.

The Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000 required coastal states and states bordering the Great Lakes to adopt EPA's most current bacteria criteria by April 10, 2004 to better protect beach goers from harmful pathogens. The Act requires EPA to propose federal standards for the state's coastal or Great Lakes waters for states that have failed to meet the deadline. Specifically, for these states, EPA is proposing *E. coli* and *enterococci* criteria for their coastal recreational waters. These bacteria do not directly cause illness, but are good indicators of harmful pathogens in waterbodies.

The Administration's Clean Beaches Plan includes grant funding to all BEACH Act states and territories to ensure continued monitoring of the nation's beaches and public notification of beach closures and advisories. These funds are designed to ensure the protection of public health and to improve information on the quality of waters at the nation's beaches. EPA estimates that Americans take a total of 910 million trips to coastal areas each year and spend about $44 billion at those beach locations.

Information about the beach criteria proposal, a list of states and their status as of July 1, 2004, and the EPA's Clean Beaches Plan is available at: **www.epa.gov/beaches/**.

Think septics are always bad? Then you don't know sewage

CONTRIBUTING WRITER
Jim Cummins

I am encouraged by the recent debates over Maryland's proposed "flush tax" because additional funds are needed if we are going to clean up the Chesapeake Bay.

But the ingrained view that septic systems (septics) are worse than wastewater treatment systems (sewers) is unfair. I am not defending the current state of septics; I heartily agree that they need to be better inspected and maintained, but the same applies to sewers.

Septic systems treat the waste of about 4 million people, or 25 percent of the Bay's population. Septics are typically regarded as bad and needing to be replaced by sewers. Septics are old-fashioned, almost a second cousin, to outhouses. Sewers are high tech and good.

> "It makes more sense to upgrade septic systems than to replace them with sewers."

Take a closer look, though. Using data from the Chesapeake Bay Program, the big-picture assessment is the other way around. Per person, septics contribute only 60 percent of the nitrogen that typical sewers do (3.7 pounds/year versus 6.0 lbs/year) from plants when both systems lack nitrogen removal technology. This is the opposite of what most people think.

In addition, septics contribute no phosphorus while sewers contribute 0.36 pounds per person per year—each year, Baywide, that is 0.0 pounds of phosphorus from septics compared with about 4.3 million pounds from sewers.

Upgrading plants with advanced nitrogen removal technology would substantially reduce nitrogen contributions from sewers to 1.6 pounds per person. However, if septics were upgraded, their nitrogen contribution would be 0.9 lbs/person, again, almost half that of sewers.

It makes more sense to upgrade septic systems than to replace them with sewers.

Experts argue that it would be costly to fully upgrade septic systems and difficult to regulate because they are privately owned and individuals must bear the upgrade costs. But sewers are far from cheap, are financed with large amounts of federal and state dollars (thus, septic users have been paying for sewer upgrades for a long time), and are far from easy to regulate.

The debate doesn't end with nutrients. Sewers, even new ones, leak. Was any of the 418 million gallons of sewage reported spilled in Maryland between 1996 and 2001 or the 241 million gallons spilled in Northern Virginia between 1997 and 2001 some of yours? What about any of the approximately 3 billion gallons of combined sewer overflow spilled annually in the District of Columbia through pipes carrying waste to the Blue Plains treatment facility?

These reported spills are of much greater volume than if all of 1.3 million septic tanks in the watershed cracked and spilled everything. Faith that the contents of a toilet attached to a sewer system make it to a treatment plant needs more reflection.

In addition, the usual pathways for sewers are streams, which are torn up with long-term damage as the outfalls dramatically change the hydrology of the receiving waterway.

Increased runoff from associated development causes erosion, which contributes much of the Bay's worst pollutant, sediment, and exposes once-buried lines to breaks and blocks fish migrations.

Septics, by contrast, recharge groundwater while also maintaining local hydrology. We should change our attitudes and policies about septic systems and, with equal vigor, upgrade them.

Understand that relying solely on the expertise of the homeowner is the wrong approach. We don't do that with our furnaces, we hire experts.

Upgrades in sewer treatment plants, which used to discharge practically untreated waste, have been the most important factor in the remarkable improvements of the Potomac River.

Sewers are the best technology for meeting dense population demands. But we must also install them with the best of care, especially in regard to sewer pipes, and have rigorous inspections of the whole system, not just the plant. It doesn't matter if the treatment plant is 100 percent efficient if the stuff never makes it there.

Put the right technology where it works best. Sewers are the best mechanism for keeping growth well-planned and connected to bigger themes like major highways, service infrastructures, city identity and schools. However, any wastewater treatment technology, when poorly sited, maintained and inspected, is bad. Use septics when the soil conditions are right and where long runs of sewer pipelines are risky.

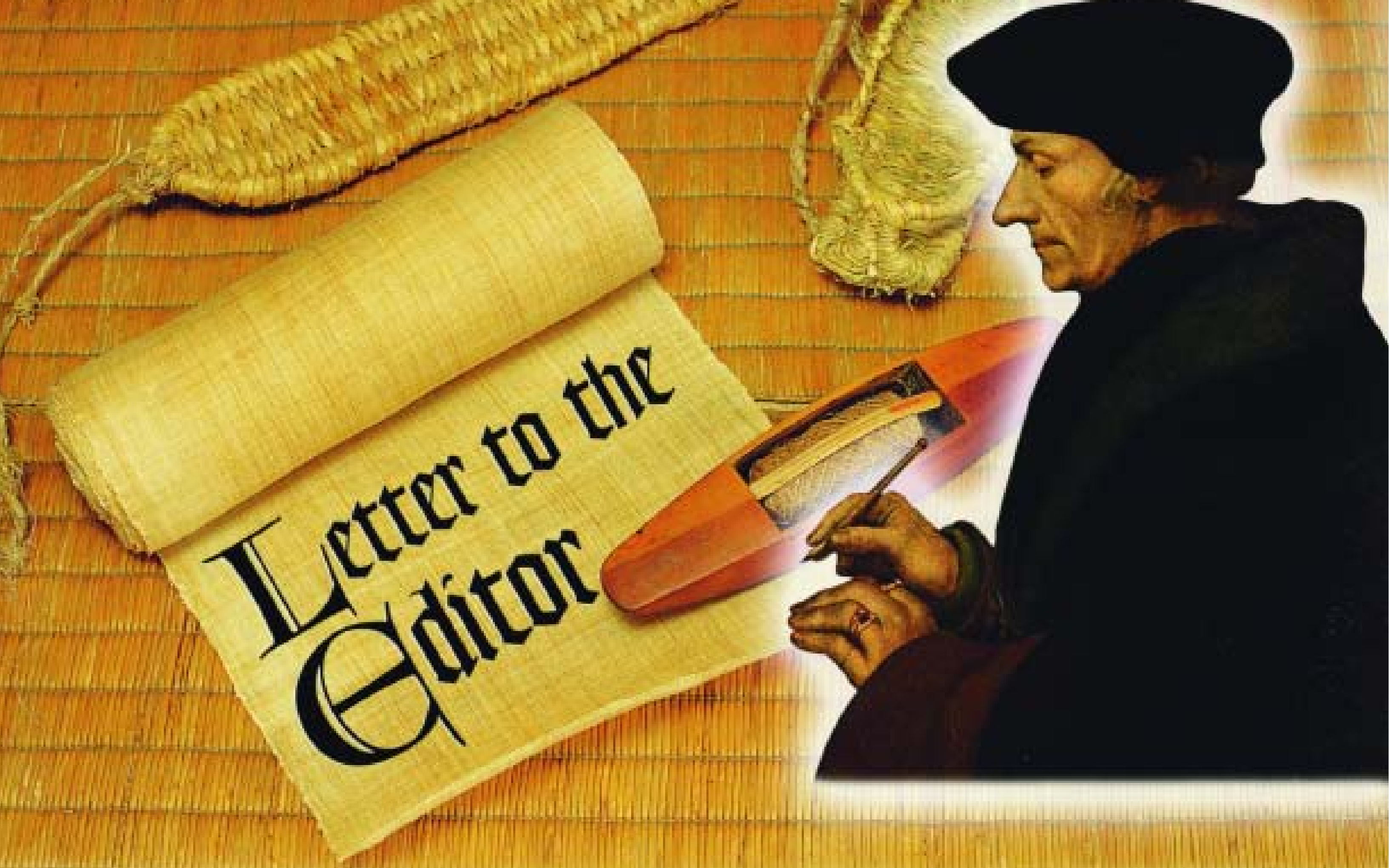
Both systems work. Both need improvements in technology, installation, maintenance, and inspection. It is not a question of which is better, because each has its place. But septic, sewer, and let us not forget waterless technologies, should be used correctly, evaluated fairly, and improved at every opportunity.

The Potomac River has become a national showcase for successful programs to restore highly polluted waters. This turnaround has created economic benefits. Shorelines once considered practically worthless because of the odor and appearance of the river are now considered prime real estate.

Our continued investments in all forms of wastewater treatment and other nutrient reductions will return benefits in the form of new jobs, increased property values and tax revenues, reduced water treatment and health care costs, improved wildlife and inland fisheries and importantly, in our ability to enjoy them.

Jim Cummins is the associate director of living resources for the Interstate Commission on the Potomac River Basin.

This forum is reprinted from the May 2004 issue of the Bay Journal *with permission from the Alliance for the Chesapeake Bay.*



Letter I

Dear Editor:

As I watch the wheels of government turn, I sense a dangerous and costly grinding. It comes from the management of septic waste from homes in our shoreline towns.

Here in Connecticut, our registered sanitarians are monitored by their town health directors. They follow the rules of the Public Health Code of the State Department of Public Health. The system has been in place for years. They supervise septic installations.

For new installations of conventional septic tanks and leach fields, this system of management works. Our septic waste is safely and economically recycled into wholesome water and harmless gases. Make no mistake; both the process and its administration are proven. For repairs of failed systems that erupt to the surface, again the sanitarians can and do promptly enforce and supervise repair. The recently enacted law sponsored by State Representative Marilyn Giuliano will help permit correction of many failed systems.

A problem arises when a failure underground does not come to the surface. Here, the existing law does not permit a sanitarian to enter upon a person's property to investigate. A test well on public land nearby might suggest a failure or an illegal subsurface hooking of a sewer pipe from a home to a town storm drain. According to present law, however, the town sanitarian cannot come upon the private property to conduct a harmless but colorful dye test to find the source of the contamination. At the same time, the state Department of Environmental Protection (DEP) can, and sometimes does, declare an area to be polluted, but the sanitarian is still not permitted to search out the source in order to have it corrected.

One might ask how does this come to pass? I believe it is because the Connecticut State DEP does not want the town sanitarians to succeed in doing their jobs. The DEP wants those failures, which they will then try to correct by building still more structural sewage treatment plants. These plants are part of the DEP empire and job security.

Unfortunately, these sewage treatment plants are expensive to build and maintain, and they are often unreliable. Also, they discard a valuable resource—water. Worse, they discard less-than-pure water into our rivers. The rivers are thus polluted as they are loaded with impure or chlorinated water.

Marvin Roberts
Old Lyme, Connecticut

Letter II

Dear Editor:

Your recent Q&A [Spring 2004] about onsite wastewater treatment systems was chock full of useful information for the consumer. However, the Water Quality Association must take exception to your statement, "Don't allow backwash from home water softeners to enter the septic system."

The negative reaction of onsite systems to softener brine has become an "urban legend" (or in this case, "rural") that has no scientific basis. The overwhelming majority of technical and scientific research papers demonstrate that softener brine does not pose a hindrance or hazard to onsite systems.

Upon review of the literature, in fact, four states recently withdrew restrictions or bans on softener brine discharge through the administrative or legislative process. These included New Jersey, Kentucky, Montana, and Texas.

In addition, the U.S. Environmental Protection Agency re-issued its guidance document, "Onsite Wastewater Treatment Systems Special Issues Fact Sheet 3—Water Softeners," on the softener/onsite system issue last year. It, too, found no reason to restrict flow from water softeners into septic systems.

If your writers reviewed the reason for onsite system failures in any given state, he or she will seldom, if ever, see failure attributed to softeners. And in fact, tens of thousands of onsite system owners throughout the U.S. use softeners without any biological or mechanical failure.

With more home growth occurring outside municipal waste treatment systems, the onsite market is expanding to meet the need. But many of these new homes are also built in water with high hardness levels. Today's consumers want to have a working waste treatment system *and* water of a quality that won't ruin their pipes, cut the operational efficiency of water heaters or add more wear and tear to their water-using appliances, clothing, and linens.

It is not fair to these consumers—or to the home water treatment professionals who serve them—for such authoritative sources as the National Small Flows Clearinghouse to continue repeating an unproven "rural legend."

Carlyn A. Meyer
Government Relations
Water Quality Association

Letter III

Dear Sir:

The Technical Overview on Alternating Drainfields in the Spring 2004 issue of the Small Flows Quarterly neglected to mention an important cause of the failure of septic systems, one that can affect alternating systems as well as conventional ones. I am referring to the waste products of anaerobic processes that occur in the soil when it is saturated.

The alternating drainfield system takes advantage of the fact that the biomat that forms as aerobic organisms digest the wastes in the liquids entering the drainfield dies off when that part of the system is not in use. The waste products of aerobic decomposition are largely carbon dioxide and water, which do not affect the soil's permeability. But anytime a system is in use, and the soil is completely saturated for any length of time, anaerobic decomposition of our wastes occurs. The by-products of these processes are insoluble compounds of iron and sulfur that accumulate in the pores of the soil, reducing its permeability. This "sludge" does not die off when the system is not in use, and over time, increases to the point that the septic system malfunctions.

Proper water maintenance can reduce the growth of these insoluble compounds, but we cannot prevent it completely because we cannot control the weather. In temperate climates, spring rains often cause the ground to be saturated for several days. And the melting of snow in late winter does the same. So the liquid wastes we produce will be subjected to anaerobic decomposition for a substantial portion of some part of every year. Except perhaps in arid regions, over time, every drainfield will eventually malfunction because of the by-products of anaerobic decomposition.

Sincerely,
Pascal de Caprariis
Professor Emeritus
Department of Geology
Indiana University-
Purdue University, Indianapolis

Legal views

CONTRIBUTING WRITER
Elizabeth Dietzmann, J.D.

When Systems Fail

That's it. Enough is enough. If one more person at one more conference talks about septic system failures, or failure rates or failure studies, I will scream. The term "failure" is routinely bandied about with impunity, yet no one seems to be able to agree on a definition or even agree whether or not "failure" is significant. I have danced around this issue in previous columns, but I can't ignore it any longer. Be warned—abandon hope all ye who enter here. I have no answers—just a series of perplexing questions. By way of illustration, I would like to share the following article I stumbled across recently. It is a typical example of the way in which "failure" is used to describe absolutely nothing, but great weight is given to the pronouncement that systems have "failed."

York Dispatch

York Township septic systems failing
Commissioners consider expanding public sewers

By HEIDI BERNHARD-BUBB
For The York Dispatch

Monday, June 14, 2004—Septic systems are failing in several York Township neighborhoods, leading the board of commissioners to consider a major expansion of the public sewer system.

Township manager Mark Derr said only a few systems have failed in the two main areas. One is off Leaders Heights Road at Skylark Drive and Wren Terrace; the other includes Reynolds Mill Road from Whispering Pines Trail past Shenandoah Drive, as well as homes along Kresta, Lentzlyn and Amad drives.

Because of the age of the developments, Derr said, it's only a matter of time until many of systems start to fail.

Pre-dated regulations: Many of the homes were built before new Pennsylvania Department of Environmental Protection regulations that require lots to be large enough to test for a septic system in two places so that a second system can be built if the first one fails.

The township water and sewer authority has begun working with York-based C.S. Davidson to design the sewer project, and a timetable for planning and building the system is being developed.

The water and sewer authority will plan the expansion and then make a recommendation to the board of commissioners, who will have final approval.

But for now, officials are uncertain whether the commissioners will approve the project, who will pay for the system if approved, and how many homes will be included.

System design: Public works director Scott DePoe said the township would spend the rest of the year designing a system and negotiating rights of way for the project with the Pennsylvania Department of Transportation. The number of homes included will depend on its final design, he said.

DePoe said he expects the final design to go before the board of commissioners in January, with bids going out in April and work starting August 2005.

A major concern is who will pay for the project.

Derr said the township expects to see preliminary cost projections this summer, and the commissioners will debate several funding options.

The project may be paid for by raising sewer rates for the entire township, assessing individual homes that will receive sewer service, or a combination of the two options, Derr said.

So let's look at some of the confusing ways in which "failure" is used. Hey, and rest assured—this reporter is no more or less guilty of using the term in a confusing manner than most of the professionals I listen to at conferences.

"Septic systems are failing in several York Township neighborhoods, leading the board of commissioners to consider a major expansion of the public sewer system."

Well, right off the bat this illustrates the decentralized versus big pipe mentalitly. Apparently public sewer systems don't fail. We don't know what caused the county to decide that these septic systems were "failing" (could have been intermittent effluent ponding over the drainfield), but apparently a major expansion of the public sewer system is the only possible solution. Why is the answer so often the construction of multimillion-dollar gravity sewer systems (which are designed to have infiltration and inflow—I/I and therefore must also have exfiltration and outflow—E/O, right?)? The leaking gravity sewers flow into a wastewater treatment plant that also may have "unplanned discharge events," blending, and other divergences from its design and permitted effluent quality limits. When the digressions occur, they are not particularly considered failures, but are simply events when the discharge limits are unmet, and partially-treated sewage from ALL of the homes, not just a few with "failing" septic systems, flows into the receiving stream at one point, out of one pipe. So the solution to a few dispersed possibly surfacing systems isn't to treat the wastewater from those homes locally and discharge or reuse the treated water locally, but is to collect the wastewater from ALL of the homes that can be gathered into the financing package, and transport all of that sewage to a point discharge of a significantly larger volume than the one or two homes with "failed" septic systems.

So it is accepted that the fact that public sewer systems are specifically designed to work only during periods of normal flow, and expected to overflow during storm events, and this does not count as "failure." See the photo above of a pressure relief valve, aka manhole, that routinely overflows after every big rain, yet has not "failed" enough to warrant installation of a drainfield to treat the overflowing sewage. By the way, this sewage is pouring into the receiving stream downstream of the wastewater treatment plant. (Note the emergency generator in the photo. This way, if the power fails, the generator can run pumps that still can't keep up with the flow.)

"Township manager Mark Derr said only a few systems have failed in the two main areas . . .. Because of the age of the developments, Derr said, it's only a matter of time until many of the systems start to fail."

Well, as good wastewater sleuths, I bet we can guess what is going on. A few homes have some sort of effluent or other liquid surfacing in the drainfields. This is borne out by the next sentence.

"Many of the homes were built before new Pennsylvania Department of Environmental Protection regulations that require lots to be large enough to test for a septic system in two places so that a second system can be built if the first one fails." I am sure that this is a slight misstatement of the regulations. The regulations probably require that an alternate drainfield be built in the event of "failure," not a whole new septic system, but it is still interesting to note that the regulatory structure does not allow "failure" in onsite systems, while "failure" is accepted as part of the normal operations of public sewer systems. On we go. It appears that the focus is on the drainfields and that "failure" in this context has something to do with ponding effluent. But how was this determination of ponding even made in the first place? Is it "failure" if effluent ponds over the drainfield for only part of the year, or only after a heavy rainfall (just like "real" sewers)? If the soil absorption system handles the effluent most of the time, is that "intermittent failure"? Or is it, to use the big-pipe terminology, merely an "unplanned discharge" or simply an "overflow event?"

Most of the time, "failure" does seem to be defined as water or partially treated wastewater standing (ponded) over the soil absorption system. Certainly that was the main indicator used by local health departments to identify "failure" in the recent California study of septic systems. But would it still be "failure" if one of these new-fangled soil/air injectors could be used to rejuvenate the drainfield? Is that still "failure"? Did the septic system "fail" if some sort of advanced treatment was installed and the existing drainfield was able to accept the treated effluent? Does "failure" denote some sort of permanent condition? Does "failure" have to be permanent? Does "failure" mean that the system can never, ever work no matter what? Is it like the permanent, fatal error message I get when I enter an incorrect e-mail address?

Obviously, we would consider it "failure" if the septic tank needed to be pumped and sewage backed up into the basement of a home. Certainly the family holding their daughter's wedding in the back yard would consider that a catastrophic failure! But once the tank is pumped and the toilets flush, the system would function again, so it would not be "failing" any more. Nonetheless, with traditional systems, the primary emphasis is placed on the soil absorption system. As long as there is no water standing over the drainfield, the system is working. But how do we know the system isn't "failing" in other ways? Our regulatory structure is based on the idea that as long as the drainfield is accepting the wastewater (i.e. no ponding) then (somehow) the soil is treating the wastewater. But isn't it "failure" if the drainfield accepts effluent but treatment is not occurring? How do we even know what really happens in the soil without monitoring, and how do you really monitor these processes when one root hole or fracture in the soil can divert the effluent plume away from a lysimeter or monitoring well? If you can't really assess the treatment that is occurring in a soil absorption sys-

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tem, then how can you possibly determine whether or not "failure" is occurring?

When you throw advanced treatment (AT) systems into the mix, it becomes even more confusing. It seems at first glance that you could define "failure" pretty easily. AT systems are designed to meet certain effluent limits. A sample can be taken at the pipe leading from the tank to the drainfield. Specific water quality parameters such as five-day biochemical oxygen demand, total suspended solids, organic carbon, pH, coliform bacteria count, nitrogen species, phosphorus, etc., can be measured and the effectiveness of the AT system can be evaluated. Unfortunately, the final step is discharge into the soil. So is it "failure" if an AT system produces effluent that meets design or permit standards, but the effluent surfaces in the drainfield? What if the nearby surface water (that is, surface water that is upslope of the "failing" system) has more *E. coli* than the effluent that is surfacing? Is that "failure"? As a thought, where is the "failure" anyway if the treated effluent is cleaner than the surrounding surface water? If the water standing over the drainfield is cleaner than background water ponded in the lawn after a rain, was there a "failure" and whose was it? Can we prosecute and collect fines from Mother Nature when the background water is not as clean as the treated effluent? What if the AT system does not produce effluent that meets the design standards, but there is no ponding? Is that "failure"? Is it really only "failure" if the effluent quality is poor and there is ponding? Does an AT system "fail" if some mechanical component breaks, but it can be replaced? What if the system no longer produces effluent after the expiration of its design life? Isn't that really "failure"? Maybe you have to compare performance "failure" to hydraulic "failure," and component "failure" to system "failure." Maybe "failure" is an incredibly vague concept that should never be used to describe the performance of any type of wastewater system, unless it is used with great specificity. If I tried to argue the meaning of failure in front of a judge based on its common usage in the wastewater field, I would probably be held in contempt of court. I think it is easier to define "pornography" than "failure." I am reminded of Justice Stewart's comment concerning pornography, when he said that that he couldn't define pornography, but he knew it when he saw it. Well, half the time you can't even see the "failure"! Maybe we are taking the wrong approach—maybe we need to take a more spiritual approach and think about "failure" the way the Inuit think about snow. I read in Smilla's Sense of Snow that they have over two hundred words for snow, because there are that many kinds of snow.

So there you have it. No answers, just more questions. As someone once said, "I fear that I have not fully answered any of your questions, but have merely succeeded in raising more questions. I feel that now we are as confused as ever, however we are now confused at a higher level and about more important things."

Elizabeth Dietzmann, J.D., is a consultant in the planning, development, and management of decentralized wastewater systems. As an attorney, she focuses on coordinating the legal, political, and financial aspects of using decentralized technology as an alternative to central sewer systems. Although she consults with clients across the country, Elizabeth is happy to live in a small town in Missouri, with her dogs, cats, and horses. She can be reached at **edietzmann@earthlink.net.**

Related Products

For ordering information, see page 55.

A Manual for Managing Septic Systems (Item #WWBKOM41)

The Greeley-Polhemus Group, Inc.

This 179-page manual explains how a septic system works and why a management program is needed. Based on experiences in Sussex County, New Jersey, this manual describes what a homeowner should or shouldn't do in the daily operation of a septic system. The manual also provides guidance to local entities for periodic inspections and discusses potential institutional and financing arrangements. Although this manual targets New Jersey, it can serve as a guide for other states in the U.S. The price of this manual is $28.35

Maintaining Your Septic System: A Guide for Homeowners (Item #SFPLNL03)

National Small Flows Clearinghouse

The Fall 1995 *Pipeline* focuses on educating homeowners about proper septic system operation and maintenance. Topics include groundwater pollution, system inspections, and the use of additives and cleaners. The newsletter includes a handy list of important septic system do's and don'ts. The cost of this 8-page newsletter is 40 cents.

Why Do Septic Systems Malfunction? (Item #WWFSGN205)

K. Mancl, B. Slater; The Ohio State University Extension

This two-page fact sheet discusses not only the signs of septic system malfunction, but also why a system malfunctions, and how the malfunction can be avoided. A distinction is made between system malfunction and system failure, that is, when a system cannot be fixed to bring it back into compliance. Three reasons for system failure are noted along with ways that the property owner can avoid system failure. The information here is easily accessible and could be a good tool for community or public education. The price of this fact sheet is 40 cents.

Onsite System Management Tool Increases Compliance in Wisconsin

NSFC STAFF WRITER
Caigan McKenzie

"Out of sight, out of mind" is no longer a viable excuse for homeowners in Wood County, Wisconsin, to not maintain their holding tanks. Nor can homeowners continue to illegally dump waste under the cloak of night.

Between October 2000 and May 2004, proper maintenance of homeowner holding tanks in Wood County, Wisconsin, skyrocketed from 20 percent to 97.73 percent, and their three-year septic tank maintenance and inspection program is close to 99 percent compliance.

Duane Greuel, environmental specialist with the Wood County Department of Planning and Zoning, credits these phenomenally high compliance rates to an internet-based maintenance reporting system provided through a contract with Carmody Data Systems, DeForest, Wisconsin. "Communicating with my stakeholders is high on my list," Greuel said. "Day in and day out, I work with liquid waste carriers, installers, master plumbers, system maintenance professionals, system designers, and soil testers.

"In addition, I spend a lot of time working with realtors, bankers, developers, utility firms, assessors, and homeowners. Providing accurate, timely information to such diverse entities would be unachievable without this waste management tool."

Prior to the Waste Management System

Before 2000, Wood County's holding tanks were administered nine different ways. "Prior to our system, records of maintenance, pumping, installation, etc, were all kept by different Wisconsin agencies, including the Department of Natural Resources, county health officials, and the Department of Commerce," Scott Carmody, president of Carmody Data Systems, Inc., said.

"Problems arose because there was no cross-referencing of data. When wells became polluted from failing septic systems or land-spread sewage, county regulatory officials were caught in the middle without the proper records to track the problems."

Driving Force behind Waste Management System

Prior to 2000, holding tanks were the predominant sewage system for developments on slowly permeable soils. State and county regulations mandated that these tanks be emptied when the liquid level reached one foot below the inlet invert of the holding tank.

The average holding tank system would need to be pumped every 70 to 80 days for a family of four living in a house plumbed with water-conserving fixtures. Holding tanks for homes without such fixtures would need to be pumped more often.

"Cost for waste removal is approximately $70 for a holding tank system and $150 for an onsite system using a septic tank," Greuel said. "Even though these prices aren't high, many holding tank homeowners chose to discharge waste onto the surface of the ground instead of paying a professional to haul it away."

Research done in 1997 and 1998 by Marshfield Medical Research Foundation in Marshfield, Wisconsin, found that illegal wastewater disposal was the major cause for an unusually high number of viral diarrhea cases in the county. Data showed that for each holding tank added to a 40-acre parcel, there was a 22 percent increase in viral diarrhea cases, especially in children, because of exposure to the untreated wastewater.

In response to this health threat, the Wood County Board of Supervisors approved an ordinance amendment on February 15, 2000, that permitted the Planning and Zoning Department to regulate all holding tanks in the county under a unified reporting system.

Some Waste Management Tool Capabilities

What began as a system to track maintenance of all holding tanks installed after 1985 has expanded into a system to manage and maintain all 12,000 onsite wastewater systems in the county, regardless of their installation date or type. Greuel expects that it will take four people working for three years to develop this data base.

A Carmody Program training session in Wood County, Wisconsin. Photo courtesy of Scott Carmody.

"Because of this system, we have eliminated approximately 15,000 sheets of paperwork just for holding tanks," Greuel said. "It has enabled us to be more efficient with less staff."

Wood County allows stakeholders to log on to the system, enter the secure area, and fill in the pertinent information. Carriers can also register new clients, and licensed installers can enter all service events, creating a maintenance history for each onsite treatment system.

Access to information is based on the type of information the user needs to see. County regulatory officials and state DNR representatives can view the entire database, while stakeholders are limited to information pertinent to their clients and needs.

The system maintains a data log history, so it is easy to identify user entry mistakes. "This has really helped clean up sloppy clerical work," Greuel said.

CONTINUED ON NEXT PAGE

The system can create reports by searching a variety of parameters, for example, systems serviced, systems pending service, disposal locations sorted by territory or provider, and permits issued by property owner and address.

Homeowners who have exceeded their required service threshold are flagged and listed, providing a useful regulatory tool. The report shows all systems by type that need to be serviced. (See graphic below.)

The user can view permits and can list the schedule for inspecting each component of a system. For example, a FAST® (Fixed Activated Sludge Treatment) system is inspected once a year, and the effluent pump, including floats and switch settings, must be inspected at the same time.

Postcards advising homeowners that it is time to inspect their systems can be electronically generated and automatically printed for any class of onsite systems. Because Wood County has approximately 6,500 conventional, nonpressurized systems, it would overload the industry to service all of these systems during one period and would create an artificial price increase for the homeowner. To prevent this, Greuel designed the program to divide the notices into two groups that are sent at different times.

Reports can also be customized using any parameter in the program. Using an Excel™ format, the report will provide statistics for the parameters selected. For example, you can find all the septage that was spread on a parcel of land and where the waste originated. "That's unheard of," Greuel said.

The program contains the manufacturer's suggested maintenance report for each type of system so that a maintenance provider can verify what needs to be done to maintain the systems. It also lists all active, licensed installers and service providers in the county.

"A feature that has helped us tremendously is finding information we need without using a permit number or legal description," Greuel said. For example, typing a street name allows the system to list everyone on that street. The user can then match the name with the address, or the user can simply enter a street number, and the system will list all the streets with that number.

Data Entry

Greuel used courthouse records, such as tax listings and assessments, to determine which properties in the county had onsite treatment systems. "Generally speaking, if the assessment for a property is over $15,000, we know it contains a dwelling," Greuel said. "Not all existing homes have a permitted onsite system, but it is still valuable to include those lots in the data base."

"It took a lot of investigative work to match up old permits because of inaccurate legal descriptions." Some permits were no longer tied to a dwelling because the dwelling (for instance, a mobile home) had been relocated and not replaced, yet records weren't updated. Existing records also didn't show that dwellings had been abandoned, connected to municipal treatment systems, or removed by new construction (for instance, property purchased for highway right of way). Still other properties had reconnects and multiple permits because of replacement systems.

Collecting information was further complicated by address changes and missing tax parcel numbers. Some properties didn't have tax parcel numbers attached to them because a parcel was split and assigned a new tax identification number.

"Sometimes there wasn't enough information about a property in the courthouse, and someone would need to go to the site to verify a permit," Greuel said. "It took us two years to find, verify, and enter the data, but we are confident that most of our permit data is now accurate."

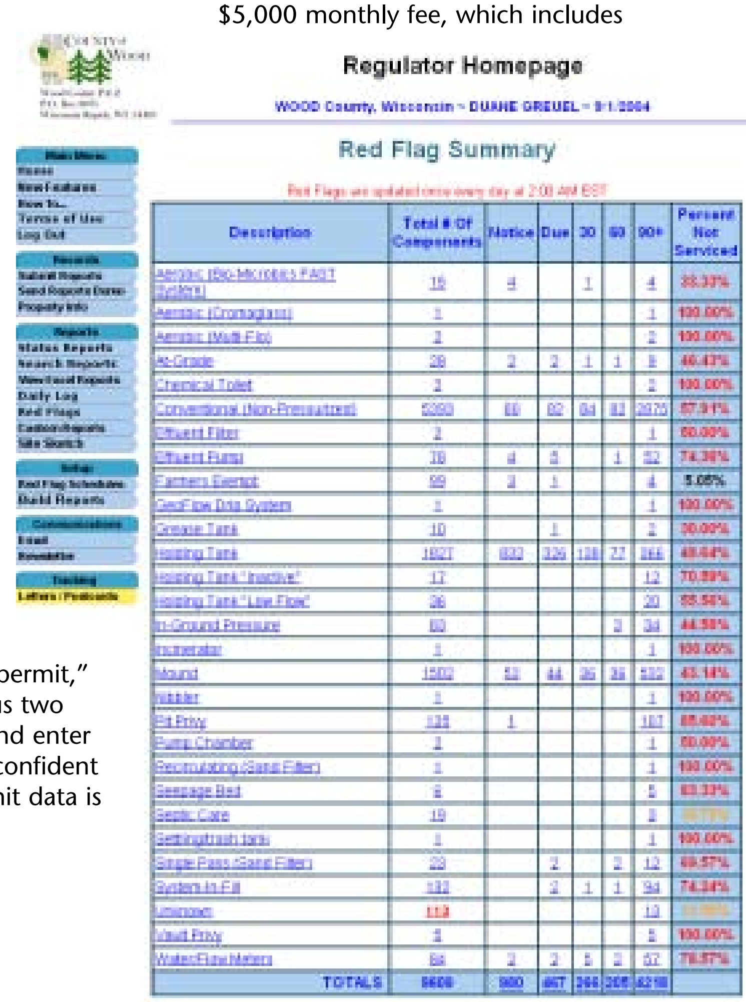
Funding is Major Obstacle

Finding the money to pay for a maintenance system is the major stumbling block across the U.S., according to Greuel. For the first two years of operation, Wood County passed the $3 a month data entry fee onto the holding tank system homeowners as a user fee.

"Wisconsin is a taxed state with very few user fees," Greuel said. "For example, in Arizona you will pay $300 or $400 for car registration but here you pay only $35, and the rest of the cost is supplemented through taxation. "It doesn't take much of a user fee to get the public sector's attention when they are not used to them."

The county billed holding tank owners $36 annually and new holding tank owners an additional $20 during the first two years of the program. Beginning with the program's third year, the county used departmental funds to fully pay for the program since it was expanded to include all onsite system.

"In his initial proposal, Carmody promised that as his numbers went up, our costs would go down, and they have. Currently we pay a flat $5,000 monthly fee, which includes



Regulator Homepage

WOOD County, Wisconsin ~ DUANE GREUEL ~ 9/1/2004

Main Menu: Home, New Features, How To..., Terms of Use, Log Out

Records: Submit Reports, Send Reports Exemp, Property Info

Reports: Status Reports, Search Reports, Wastes Reports, Daily Log, Red Flags, Custom Reports, Site Sketch

Setup: Red Flag Schedules, Build Reports

Communications: Email, Newsletter

Tracking: Letters / Postcards

Red Flag Summary

Description	Total # Of Components	Notice	Due	30	60	90+	Percent Not Serviced
Aerobic (Bio-Microbics FAST System)	15	4		1		4	33.33%
Aerobic (Cromaglass)	1					1	100.00%
Aerobic (Multi-Flo)	2					2	100.00%
At-Grade	28	2	2	1	1	8	46.43%
Chemical Toilet	2					2	100.00%
Conventional (Non-Pressurized)	5360	60	82	84	83	2970	57.91%
Effluent Filter	2					1	50.00%
Effluent Pump	78	4	5		1	52	74.36%
Farmers Exempt	99	3	1			4	5.05%
GeoFlow Drip System	1					1	100.00%
Grease Tank	10		1			2	30.00%
Holding Tank	1827	832	326	138	77	366	48.64%
Holding Tank "Inactive"	17					12	70.59%
Holding Tank "Low Flow"	36					20	55.56%
In-Ground Pressure	80				3	34	46.58%
Incinerator	1					1	100.00%
Mound	1502	53	44	26	26	522	45.14%
Nibbler	1					1	100.00%
Pit Privy	125	1				107	85.60%
Pump Chamber	2					1	50.00%
Recirculating (Sand Filter)	1					1	100.00%
Seepage Bed	6					5	83.33%
Septic Care	19					3	[illegible]
Settling/trash tank	1					1	100.00%
Single Pass (Sand Filter)	23		2		2	12	69.57%
System in Fill	132		2	1	1	94	74.24%
Unknown	113					13	[illegible]
Vault Privy	5					5	100.00%
Water/Flow Meters	68	2	2	5	2	47	78.57%
TOTALS	9608	900	467	266	205	4218	

unlimited program and computer support, but we expect that to go down further," Greuel said. Wisconsin is trying to get legislation passed to make it easier for the county to generate revenue for these programs, but they don't expect it to be introduced into the state legislature until next year.

Intangible Benefits

"It's difficult to quantify all the program's benefits," Greuel said. "Many of the benefits are intangible; for instance, protecting public health and the environment and ensuring systems don't fail, which saves the consumer money."

Information from the program can be used to educate and inform homeowners. Since system information is centralized, Wood County was able to send out letters to owners of holding tanks explaining available new wastewater treatment technology. These letters prompted many homeowners to convert their holding tanks to onsite systems.

It is also a helpful litigation tool, because it is the homeowner's service provider that enters the data into the system—not the county. Reports show maintenance information and the checks and balances the county depends upon to ensure regulations and codes are not violated.

Future Program Expansions

"As we use the program more in-depth, we are finding information that we never dreamed we would be able to find," Greuel said. "For instance, we can identify which effluent pumps are frequently replaced. Reports show that the reason pressurize systems have failed is because the as-built total dynamic heads of the distribution systems were different from their design calculations, causing the mounds to not properly distribute the effluent. Based on this information, we can change installation or code parameters to properly address the problem."

Demographics in Wisconsin are changing, so Greuel is looking at producing reports that will customize pumping schedules based on household size and system type. For example, a tank for a two-person household doesn't have a high enough sludge level to warrant pumping every three years. This household could be placed on a schedule that has longer time between service events.

"Some of our properties have five or six systems on one parcel and under one property owner, like the area's YMCA summer camp," Greuel said. "We have just begun to break all this information down so that a service provider can access information about a particular system simply by requesting property information and cross-referencing that information with detailed systems descriptions to select the appropriate permit. Information can be entered that helps to identify the location of a specific system on a multi-system lot. In addition, the program can include a site sketch that pictorially shows the location of building, wells, and systems.

"The program shows the provider the history for the site, including when it was last serviced, who serviced it, gallons pumped, and the disposal location." (See graphic below.)

Greuel also plans to attach photographs of the onsite treatment system to the permit application.

Overall Rating

"Has the program helped? Yes," Greuel said. "Is it helping the environment? Absolutely. Is it helping us do our job better? Without a doubt. We can concentrate our efforts where they are needed instead of shuffling paper around. Is it saving the county money? Sure, the general public saves a tremendous amount of dollars.

"If you printed out all the program's features, the printed pages would be three feet thick," Greuel said. "Carmody gives us computer support around the clock, seven days a week. That's really important to me because it allows me to pick up the telephone at any time and ask for something to be fixed or for a new feature to be added. The versatility of the program to flex with changes in onsite regulations is arguably the program's best feature.

"It's going to take a number of years for a program like this to really show its impact on the onsite industry, but I think it is going to give us the management tool we need to take maintenance to the next level."

Wisconsin is not the only state using this program. Carmody Data Systems, Inc. currently has similar systems in 13 states, including the Florida Keys and the Chesapeake Bay.

"As we become more of a rural society, I think programs such as this one will become invaluable," Greuel said.

For more information, contact Duane Greuel at (715) 421-8471 or e-mail him at **dgruel@co.wood.wi.us** and Scott Carmody at (800) 485-1723 or e-mail him at **CarmodyInfo@CarmodyData.com**.

Homeowner Cost Cutter: Build Your Own Constructed Wetland

NESC STAFF WRITER
Caigan McKenzie

Constructed wetlands to treat wastewater from single-family residences is a rapidly emerging bioengineered technology that provides low-cost, natural treatment for sites not suited for conventional onsite systems. With some technical assistance from state and local agencies, a homeowner can install the system himself and save some money.

"It's harder to change spark plugs on your car than it is to put in a constructed wetland," Michael Ogden, president, Natural Systems International, Santa Fe, New Mexico, said.

What are constructed wetlands?

Constructed wetlands are an alternative wastewater treatment method that mimics natural processes to cleanse water. Microorganisms that naturally live in water, on rocks, in soil, and on the stems and roots of wetland plants feed on organic materials and nutrients, removing pollutants from the wastewater. Pollutants are reduced by a factor of 16, or more. (Biological Oxygen Demand and suspended solids are reduced by 94 percent and nitrates are almost completely eliminated.)

There are two types of constructed wetlands: surface flow, where wastewater flows on top of the existing soil, and subsurface flow, where wastewater flows through a porous medium, for instance, gravel or tire chips.

Constructed Wetland Components

A constructed wetland system consists of a septic tank; a pump if the wastewater is unable to travel by gravity through the system; wetland cell(s), which are beds lined with an impermeable liner and filled with graded medium and aquatic plants; and a drainfield, polishing lagoon, or wildlife habitat pond for returning the wastewater back to the environment.

"Wetlands are a great addition because they have no moving parts, and since they rely on natural systems (wetlands), they are basically self-maintaining and self-regulating. Even if you need to leave your home for extended periods of time, the plants will survive," Ogden said.

Is your area permitted for constructed wetlands?

Beginning construction without first getting a permit and knowing exactly what the permit requires is asking for trouble. "The problem is not that the homeowner is not capable of putting in a constructed wetland, the problem is the regulatory process," Ogden said.

"If county/state regulations do not permit for constructed wetlands, then the local sanitarian doesn't know what to do. He may think constructed wetlands are a wonderful idea, but he doesn't have a 'recipe' for writing a permit. Check with your local regulators before installing a constructed wetland.

In some cases, permits are for experimental systems, and the permit might have special requirements. For example, two homeowners in Louisiana recently put in constructed wetlands under an experimental permit. "One of the requirements was that the homeowner would pay a certified testing lab to periodically test the influent and effluent of the wetlands for one year to prove that the wetlands were doing the job," Robert Crawford, engineer IV, Department of Environmental Quality, Baton Rouge, Louisiana, said.

"Although the homeowners were able to easily complete construction, they were unable to pay for testing. There weren't any grants or loans available to help them pay for it, so they had to take the systems out and replace them with approved treatment systems."

According to Crawford, most homeowners in Louisiana don't even know that constructed wetlands are an available technology. "We only have data for municipal wetlands, and they haven't done well in Louisiana," Crawford said. "We were a testing ground for the early municipal constructed wetlands. There just wasn't enough research done in the beginning to get the data we needed and to get the design criteria right."

Of the sixty subsurface municipal wetlands Louisiana put in, only four or five operate at their permit levels. "Many have been taken out in the last 10 years because they can't meet their permits," Crawford said.

"Even though we haven't had much luck with municipal constructed wetlands, our chief engineer at the Department of Health and Hospitals, the agency that permits systems, supports residential constructed wetlands to treat wastewater, but he doesn't have the money to pay for the testing either. Unless we get some homeowners who are willing to pay all costs (installation and testing), we won't be able to get the data we need to approve the system."

"Although your particular county may not permit constructed wetlands, there are numerous sources of information—the U.S. Environmental Protection Agency *Onsite Treatment Manual* (see EPA, 2002) and the National Environmental Services Center, for instance," Ogden said. "These two resources will help introduce the technology to the local sanitarian. He may still balk, but often a local registered professional engineer specializing in onsite wastewater treatment systems can help. An experienced engineer will often be able to remove any concerns that the regulatory agency may have. Fortunately, most states have the necessary regulations and guidelines in place."

Skills Needed

Design and planning are done by professionals. Construction, however, can be done by the homeowner. "The only skill you need is the ability to move large amounts of dirt," Bill Grant, administrator, LaGrange County Health Department, LaGrange, Indiana said. "It's not rocket science to put one of these in.

"I helped a resident who didn't have any special engineering or construction skills. Together we choose a design, and I gave him all the technical assistance he needed.

"We've had residential constructed wetlands since 1992 and only two had problems—bad construction."

General Materials Needed

In addition to the design plans and a backhoe, the homeowner will need safety gloves and boots, a septic tank, a dosing pump if effluent doesn't flow to the wetland cell by gravity, an impermeable liner for the wetland cell, plastic pipe (usually PVC), gravel or some other type of approved porous material for the wetland cell, wetland plants, and plant fertilizer if effluent is not immediately available after planting.

Wetland plants are specially adapted to withstand the stressful conditions characteristic of wetlands, for instance, periodic saturation with water, fluctuating water levels, and little available oxygen. Bulrushes, cattails, reeds, rushes, and sedges are common types of vegetation used in constructed wetlands.

It's best to use native wetland vegetation since they are adapted to the local climate and pests. Wetland vegetation can be found at local nurseries in all regions of the country.

Construction Costs

Costs to build a constructed wetland vary with site conditions, the design, and local requirements.

Grant built a constructed wetland in his backyard in 2002. "The total materials for my wetland were $1,498.24 retail," Grant said. "I already had a septic tank, but had I needed one, my costs would have increased approximately $900. Since water from a constructed wetland system is fairly clean, I only needed a 450-square foot absorption field, adding another $1,000 to my final costs. The total cost for my constructed wetland was $2,498.24. Contractors will increase the costs of materials to cover overhead and make a profit.

"My soils are real sandy, so I didn't need as much of an absorption area. If you get into the heavier clay, you will need a larger absorption area and that will increase your costs.

"The most expensive residential constructed wetland we have ever put in was $5,600 and that was because it was a difficult site with clay and high water. It needed a perimeter drain and a large absorption field. For this particular system, the installer said material costs were $2,800. The contractor pointed out that had he needed to install a conventional septic system, he would have had to charge the homeowner $7,500."

In LaGrange County, constructed wetland plans cost $50. The county purchased standard plans from Michael Ogden. "The wetland was sized based upon the number of bedrooms in the home and on how big the disposal field needed to be," Ogden said.

"So, for instance, a homeowner will know exactly the size for his tank and disposal field based on the number of bedrooms in his home and the percolation rate of his soil. The homeowner had everything he needed when he bought the plans; the information is all there. Once the standard set of drawings, specifications, and guidelines are in place, there is no reason for an engineer to get involved. The rest of it is a handholding process that can be readily done by the county sanitarians."

Preconstruction Steps

All utilities must be located and flagged, and temporary fences should be placed around the absorption field to prohibit traffic and avoid compaction.

Where necessary, vegetation should be removed. Any soil that is removed should be kept for later use. Fill soil should be free of all debris.

CONTINUED ON NEXT PAGE

Some Common Wetland Plants

Common reed
Phragmites australis

Lake sedge, Ripgut
Carex lacustris

River bulrush
Scirpus flaviatilis

Broad-leaved cattail
Typhya latifolia

Salt rush, Baltic rush
Juncus balticus

The wetland cell area should be graded and leveled. Fill should be mechanically compacted to required elevations to ensure proper base preparation. Maximum compaction occurs when the soil is moist (Taylor et al., 1998).

Construction

Construction should begin only after all permits are in place. Steps for constructing a wetland vary geographically because of local regulations, but the steps below provide a general outline of the various stages involved in building the wetland (Big 8 RC&D Website, **www.big8rcd.org**, 2004).

1. Excavate with a backhoe for the septic tank (1,000 to 1,500 gallons depending on the number of bedrooms).
2. Level the floor of the excavation.
3. Carefully lower the septic tank and, if needed, the pump tank. (This can generally be accomplished with the crane on the back of the truck that delivers concrete tanks or with a backhoe if HDPE plastic or fiberglass tanks are being used.)
4. Backfill with soil.
5. Excavate the wetland cell.
6. Cover the bottom of the cell with a plastic liner (30 mil PVC and 40 mil HDPE).
7. Dig a ditch for wastewater piping.
8. Lay the inlet pipe to the cell.
9. Pour and evenly spread gravel or tire chips into the cell.
10. Dig a ditch for the drainage line, and insert and connect the pipes.
11. Dig trenches for the drainfield.
12. Connect the pipes.
13. Fill with water and check for leaks.
14. Add wetland plants.

Maintenance

Constructed wetlands are typically low-maintenance systems. As with a conventional system, the septic tank should be pumped every three to five years to prevent the overflow of solids. Also, the water level should be periodically checked to ensure the correct level.

For a subsurface system, the homeowner can install a small observation tube in each cell to monitor the water level, which normally should be two to four inches below a gravel surface to improve treatment and control mosquitoes. Finally, dead plants (not dormant vegetation), weeds, or saplings that have taken root should be periodically removed.

It is important to wear protective waterproof gloves when performing maintenance tasks to minimize exposure to wastewater, and to avoid any contact with the wastewater if you have open wounds or sores.

Getting Your County Involved

When Ogden first started teaching workshops about constructed wetlands, he sometimes taught homeowners. “An interested homeowner would get a group of neighbors together, and we would teach a workshop on a weekend," Ogden said. "We also tried to sell homeowners a set of plans as a self-help project, but this proved to be very time consuming because the homeowner needed help in getting the permit. It required me to spend considerable time on the telephone answering questions from local county health officials."

Ogden no longer teaches constructed wetland workshops for homeowners alone. "It makes more sense to do it on a countywide basis, since the county has the overall responsibility because it issues the permits," Ogden said.

This way, Ogden has available to him all the information he needs about what a particular county allows for onsite systems. The best audience, according to Ogden, is a combination of sanitarians, contractors, and homeowners.

For More Information

For more information on constructed wetlands to treat residential wastewater, contact your local and state health agencies; the National Environmental Services Center at (800) 624-8301 for technical information and free and low-cost information materials; Purdue University, West Lafayette, Indiana, (765) 494-4773, for a copy of Constructed Wetland Design Manual for Individual Residences; Michael Ogden, Natural Systems International, (505) 988-7453; Bob Crawford, Louisiana Department of Environmental Quality, (225) 219-3465; and Bill Grant, LaGrange County, Indiana, Health Department, (260) 499-6341.

References

Big 8 Conservation and Development (RC &D) Web Site. Accessed 2004. Programs section: Constructed wetlands for wastewater treatment. **www.big8rcd.org**.

Taylor, Catherine, Don Jones, Joe Yahner, Michael Ogden, and Alan Dunn. 1998. Individual residence wastewater wetland construction in Indiana. A joint publication of Purdue University and the Indiana State Department of Health as part of the onsite wastewater disposal project. Purdue University, West Lafayette, Indiana.

U.S. Environmental Protection Agency (EPA). 2002. *Onsite wastewater treatment systems manual*. Office of Research and Development. Office of Water. (Available from NESC on CD-ROM. NESC Item #**WWBKDM99**. [800] 624-8301.)

Constructed Wetlands Survey Project

In 2002, the Water Environment Research Foundation (WERF) funded a project to research and establish the feasibility, design criteria, and operations and management requirements for small-scale constructed wetland wastewater treatment systems.

"We set up a Web site and encouraged people to register their wetlands," said Scott Wallace, P.E., a principal for the research project and vice president, North American Wetland Engineering P.A., Forest Lake, Minnesota. "We gathered information from 19 countries on 1,789 small-scale wetlands. The final report will be published fall, 2004."

The original subsurface flow wetland technology was developed in Germany in the early 1960s, according to Wallace. At that time, many small, rural villages there didn't have conventional septic systems. Instead, homeowners just straight piped their wastewater into the ditch. The first full-scale wetland systems in Germany went online in 1974.

Wetland technology was brought into the U.S in the early 1970s, but it was used for large systems. In the early 1990s, when constructed wetland technology was adopted by Denmark and the United Kingdom, members of the Tennessee Valley Authority (TVA) went to Europe to investigate the technology. In 1993, the Tennessee Valley Authority published a book on design of single-home, subsurface-flow wetland systems, titled *Constructed Wetlands Wastewater Treatment Systems for Small Users Including Individual Residences*. This book was the first major document published in the U.S. that focused on single-home wetland systems.

"The TVA publication accelerated the use of wetlands in the U.S.," Wallace said. "Our published report will be the first to address small-scale wetlands since TVA's publication.

"Constructed wetlands are popular with the Amish because they don't use electricity and modern equipment, which is forbidden in their religion. I have seen this pattern in southern Iowa and eastern Ohio. Those areas have soils that are not suitable for a standard septic tank drainfield. Prescriptive code would require either installing a mound system, which requires a pump, or installing an aerobic system, which requires a blower. So if you are looking for a system that doesn't have any mechanical treatment components, that is going to be a constructed wetland, since its treatment systems runs 100 percent by gravity flow. This is perfect for the Amish because it allows them to put in a modern system that the county will approve, yet the technology does not go against their religious beliefs."

Constructed wetlands for single-family homes have been a wastewater treatment option for only the past 10 years, according to Wallace. "Before then, most codes were prescriptive, and constructed wetlands didn't fit the criteria for prescriptive code. Now, the onsite industry places more emphasis on performance-based systems, so constructed wetland technology has grown."

For more information about the constructed wetlands research project, contact Scott Wallace at **swallace@nawe-pa.com** or Jennifer Simmons, project manager, WERF, at (703) 684-2470.

To view wetland information from the WERF research project, go to **www.wetlandsurvey.org**. The final report can be purchased through WERF at **www.werf.org** (inside the U.S.), and through IWA at **www.iwapublishingl.com** (outside the U.S).

For Further Reading

East Texas Plant Materials Center et al. 1998. *Constructed wetlands for onsite septic treatment: a guide to selecting aquatic plants for low-maintenance micro-wetlands.* (Available from National Environmental Services Center (NESC), Item #**WW-BLOM37**. [800] 624-8301.)

Steiner, G.R., and J.T. Watson. 1993. *General design, construction, and operation guidelines: Constructed wetlands wastewater treatment systems for small users including individual residences.* 2nd ed. Tennessee Valley Authority, Water Management Resources Group. (Available from NESC, Item #**WW-BLDM65**. [800] 624-8301.)

See the list beginning on page 55 for more related resources.

Offensive Odors Don't Always Mean Septic System Failure

NESC STAFF WRITER
Caigan McKenzie

Is there a bathroom in the house that family members won't use? Do unpleasant odors sometimes surround your patio?

Septic odors can occur in the house, above the tank and drainfield, or around the vent pipe. Most homeowners understand that septic systems can produce an unpleasant odor, but they are unsure when an odor is a sign of system failure.

Although prolonged odors could indicate a serious problem with your system, most odors are either naturally produced by the biological decomposition of waste in the septic system or are a result of a problem that can be easily and inexpensively corrected. In either case, call a local wastewater professional to evaluate the problem.

Odor-Producing Substances in Domestic Wastewater

Odor-producing substances found in domestic wastewater are small, relatively volatile molecules. They are the result of anaerobic decomposition of organic matter containing sulfur and nitrogen.

Although other odorants such as amines, mercaptans, indole, or skatoles may contribute to an odor, hydrogen sulfide, ammonia, carbon dioxide, and methane are the common gases generated by wastewater decomposition.

Septic Gases Can be Lethal

In confined spaces, septic gases can be irritating, toxic, and explosive. "Within the house, septic gases would likely be in minute concentrations and would only cause headaches and nausea," said Jim Honce, president, W.S. Treatment Services Inc., Bridgeport, West Virginia. Within the septic tank, however, these gases are in concentrations high enough to cause death. This is the reason that only trained professionals should check inside the septic tank and then only when using prescribed safety measures.

Cause of Most Odors Within the House

"In my 30 years of business, I've found that septic odors in the house are caused by plumbing problems ninety percent of the time," said Paul Ashburn, president of Ashco-A-Corporation, a full-service designer, manufacturer, and installer of alternative wastewater systems in Morgantown, West Virginia. "Ninety-nine percent of the time, the plumbing problem is a dry trap," Honce said.

Wastewater Journey Through the Plumbing System

The house plumbing drainage system comprises water traps, waste pipes, and vent pipes. When water empties from sinks, toilets, tubs, and other plumbed appliances throughout the house, it enters a trap, which is a bend in the drainage pipe. Some water remains in the trap and acts as a barrier between the house and the sewer gas inside the drain network.

The septic tank and traps are vented through a large pipe, typically 4 inches in diameter, on the roof of the house. "Normally, after the wastewater has gone into the septic tank, there is a natural draw of air from the septic tank back up

Tessa Bowers–Princess/Mermaid/Ballerina
Photos by Christopher Metzgar

through the vent, causing odors to be released outdoors, Tom Ferrero, secretary of the National Onsite Wastewater Recycling Association and secretary/treasurer of the National Association of Wastewater Transporters said. Cross breezes carry the odors away from the house.

Common Plumbing Problems

Often, odors in the house can be traced to a dry trap. "Traps become dry when the water that settles there evaporates because a plumbed appliance is not used," Honce said. "Water can also be siphoned from a trap when a full flow of wastewater enters the drainpipe." Pouring several cupfuls of water into the drain will resolve this problem.

"Modern drains are made of plastic, but before plastic, traps were made of thin chrome. It could be that an older trap has rusted out, causing a need to replace the drainpipe to the plumbed appliance," Mike Miller, president, Dale Miller and Son, said.

"A floor drain that is hidden by a covering—carpet, for instance—is more difficult to find because the homeowner doesn't even remember it was there," Ashburn said. "Before covering a floor drain, the drain should be blocked off to keep gases from venting through it."

If traps aren't the problem, odor may be entering the house because of the plumbing vent. Vents allow air to enter the system to equalize the pressure so that the wastewater can flow out. According to home remodeling guru Bob Vila, "Think of a gas can or juice can: The liquid inside cannot flow out unless a vent hole is opened to allow air in to keep it flowing. Your home vent system works by the same principle. For wastewater to move freely through the network of drainpipes and out to the sewer, there must be a way for air to get into the system. Otherwise, the drains would empty slowly, if at all."

Vent piping must have a positive slope and be kept clean from debris to work properly. "Old, cast iron vents can get encrusted, significantly narrowing the diameter of the vent pipe," Ferrero said. "You'll find leaves in the vent, and you might even find that an animal crawled in and got stuck.

"One method the homeowner might use to check for a clogged vent pipe is to run water down it from a garden hose. If the water comes back out onto the roof after a couple of minutes, it's clear that the vent is clogged.

"I had a case that was puzzling because a second story bathroom wouldn't flush only on rainy days. What I found was that the roof vent contained a pile of leaves that, when the weather was dry, air could find its way through. But when it rained, moisture got into the vent pipe, clumping the leaves, and blocking the flow of air.

"Another unusual situation is when a bathroom has been added onto a house. If the horizontal distance between the new bathroom and the roof vent is too great, the bathroom fixtures won't drain properly. Building codes should prevent this, but sometimes a homeowner will surreptitiously add a bathroom."

Downspouts should not be connected to the sewer lines. If they are, this can also cause odor problems. "I worked on a house with downspouts on lower roofs that were below dormer windows," Ashburn said. "The odor came through the downspouts and went into the dormer windows."

Water from roof drains, house-footing drains, and sump pumps should be diverted away from the septic system. Excessive water floods the system, keeping the soil in the drainfield saturated and unable to adequately treat the wastewater.

Broken Pipes

Piping could crack or break when the house settles, allowing odors to enter the house through the cracks. A wastewater professional can place a smoke bomb in the septic tank to locate the crack. Before the smoke bomb is activated, occupants and pets should leave the house, and windows should be opened for ventilation.

Weather Conditions

Homes located in valleys, forested areas, or low areas could have temperature inversions or downdrafts from surrounding hills, causing wind currents to bring the gases down to ground level instead of expelling them into the air. Extending the vent pipe can help diffuse the odors. A vent fan, or carbon filters placed on the top of the vent will help to control the odor.

During prolonged cold periods, a plumbing vent could freeze closed, forcing odors back into the house. A jetter or warm water will open the vent.

Becoming an Odor Detective

Miller admits that locating the odor isn't easy, even for a wastewater professional. "You walk into the bathroom and smell an odor. Is it the tub, the commode, the vanity, or a cracked pipe in the wall?

"The best way to find the odor is to use a little common sense and your nose," Miller said. "Start with the most common scenarios like dry traps. Make note of what you are doing when you smell an odor. If you get an odor when you flush a commode, for instance, it probably means that the vent is plugged."

For more information, contact Honce at (304) 842-6824; Ashburn at (304) 291-0808; Ferrero at (800) 236-6298; Miller at (717) 382-4811; and **www.ext.nodak.edu/extpubs/ageing/structu/ae892-1.htm** for Bob Villa's article on drainage, wastewater, and vent systems.

The Cycle of Life: Wastewater Reclamation and Reuse

NESC STAFF WRITER
Natalie Eddy

> The good Lord didn't make any new water today. The glass of water you had at breakfast is used water. It went through seven Indians, 10 settlers, and 50 buffaloes before you got it. But you like to think the good Lord made it new, just for you, today.
>
> —John R. "Jack" Sheaffer, Ph.D.

That quote from John R. "Jack" Sheaffer, Ph.D., founder and chairman of Sheaffer International, illustrates his philosophy that all of life is cyclical and efficient reuse and reclamation of wastewater are imperative to the future.

"Once we realize that all water is used water, it's a management issue. People only have two choices: reclaim and reuse or relocate. And as we get more and more people, it becomes tougher to relocate."

Sheaffer's Web site, **http://sheafferinternational.com**, touts him as "the world's foremost authority on reclamation and reuse of wastewater." For more than 30 years, Sheaffer, who helped compose the Clean Water Act, has designed and built more than 100 discharge-free systems for municipalities, developers, food processors, and other operations looking for a cost-saving and nonpolluting way of handling wastewater.

Sheaffer's utopian vision of a green community includes a treatment process in which wastewater is 100 percent recycled, produces no sludge, and uses only time and oxygen for treatment. To date, that dream, called the Sheaffer System, has been realized in approximately 17 states and two European countries.

The Sheaffer system was first developed in the late 1960s, and Sheaffer thinks it's "an idea whose time has come. It's the wave of the future. To quote Victor Hugo, 'invading armies can be resisted, but not an idea whose time has come.'"

Background

Sheaffer started his career studying flood reduction at the University of Chicago. While doing his graduate work there, he attended a colloquium with C. Warren Thornthwaite, the famous geographer who pioneered the water balance approach to water resource analysis.

"His family produced frozen vegetables and had a lot of waste from the production process. He made a comment that stuck with me. He said you could produce a lot of food if you just used the waste for irrigation," said Sheaffer.

Later, as a research professor, Sheaffer focused on flood issues, where he first encountered the problems associated with wastewater treatment. "I was interested in floods. Whenever we'd go out on a flood damage survey, you would see the sewage treatment plants flooded. They always put them at the lowest point, which is the first to flood. You'd see piles of sludge washing downstream and the treatment plant totally under water," said Sheaffer.

"I would tell them to wake up. They said if I weren't so dumb, I would know that's where they had to be in order to discharge to the river. That was a challenge."

At the same time, the Illinois General Assembly passed a bill that created the Lake Michigan and Adjoining Land Study Commission. "They asked me to be the executive director," said Sheaffer. "Being young and arrogant, I said I would on two conditions: one, you let me add new money to what you appropriate; and, two, you don't pay me anything because I don't want anyone attempting to tell me what to say."

Sheaffer put together a research team, raised additional funding, and began to address that wastewater treatment challenge from the past. They researched all of the experimental projects of the time, including sewage farms and sanitary districts where reuse of wastewater was implemented.

"I said we should explore anything we can do with wastewater other than a treatment plant," said Sheaffer. "We knew that sewage treatment plants didn't have to be in the flood plain. And we thought you don't have to have sludge that needs to be relocated, and you don't have to have effluent you discharge into the river.

"That discharge contributes to the dead zone we're now seeing in the Gulf of Mexico—6,000 square miles of water void of any life because of all the sewage effluent riding down the river. We said if we're going to get clean water, you have to address three things: you have to eliminate odors, eliminate sludge,

The Sheaffer System at the Mill Creek development in Glen Ellyn, Il., (1,689 homes, 133 town houses, school, and golf course) includes components such as nonstructural drainage systems (above) and stormwater detention basins (below). Photos courtesy of Sheaffer International.

and eliminate discharges. To do that, we should reclaim and reuse the wastewater. So, we came up with some simple concepts. Use time and oxygen to treat the wastewater. Then, lengthen the treatment time and digest the solids first to reduce sludge. And the concept of the Sheaffer System was born."

The *Lake Michigan and Adjoining Land Study Report* became the Bill of Rights for Lake Michigan in 1970. Following Sheaffer's thought process about wastewater discharges, the bill basically sought to eliminate all discharges to navigable waters.

In September 1970, Sheaffer agreed to the request from the Secretary of the Army's office to serve as the science advisor in Washington, D.C. "I was intending to take our Bill of Rights for Lake Michigan down to Springfield to get the General Assembly to adopt it, so I wasn't really intrigued by going to Washington, but they finally convinced me," said Sheaffer.

"So I gave one of the members of the research team the bill and asked why don't you take it to Springfield? I am going to take these research boxes with me to Washington. To make a long story short, that research became important inputs to the Clean Water Act of 1972." (PL 92-500)

The Clean Water Act

As with the Lake Michigan study, Sheaffer's goal in helping to construct the act was to stop all discharges to navigable water. Sheaffer said he wrote some of the sections of the act, particularly where it talks about the purpose of reclaiming pollutants in the production of agriculture, silviculture, or aquaculture products. "You're to do it in conjunction with open-space planning. You're to sequester the pollutants that are not recycled," said Sheaffer. "The declaration of goals and policy states that it is the national goal that the discharge of pollutants into the navigable waters be eliminated by 1985."

In October 1972, the Clean Water Act was passed over President Nixon's veto. "At that time, President Nixon was probably the most powerful president we had ever had," said Sheaffer. "In November, he won all the electoral votes that year except for South Dakota and Washington, D.C. The vote to override the veto was 74 to 0. Every now and then I look at the Congressional Record because I don't think there has ever

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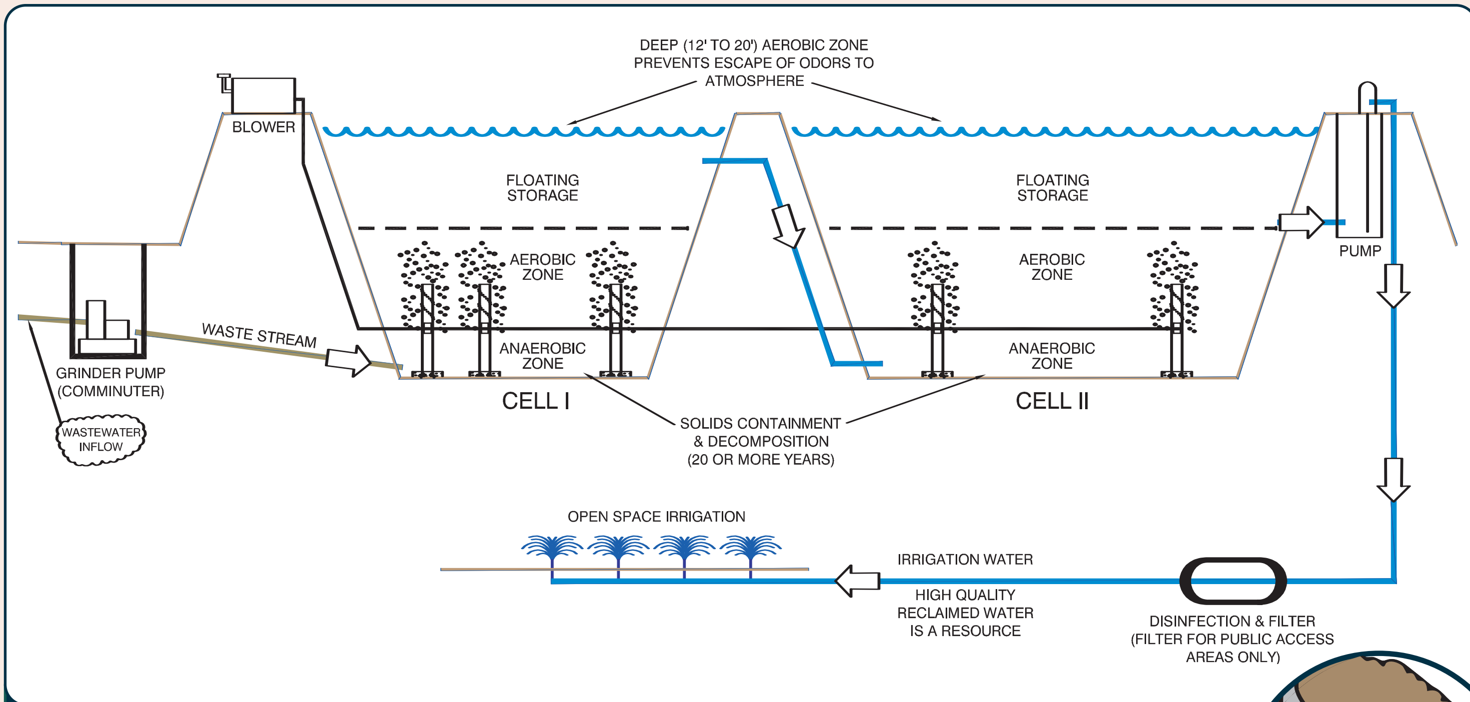


FIGURE 1 Schematic of Shearer's System

been a unanimous override of a veto except that one. That shows how Congress was thinking at the time."

During his three-year tenure as the Secretary of the Army Corps of Engineer's advisor, Sheaffer also started a Department of Defense Environmental Committee (which still exists) with representatives from the Army, Navy, Air Force, and Department of Defense bases as models of technology.

"As the third year came to an end, I knew I had to leave or I would be in Washington forever," said Sheaffer. And despite the good intentions of the Clean Water Act, Sheaffer saw that Congress could pass the laws, but could not execute them. So, he decided that by going to the private sector he could have more of an impact on the country's environmental problems.

Back to Chicago

Sheaffer returned to Chicago in 1974 and started a private company. "There were four people when we started," said Sheaffer. "Two years later, we had 76 engineers and lots of Ph.D.s. Then came the big recession in the early 1980s. We realized it would have been good if we had known something about business."

But the group persevered and gradually raised capital to become Sheaffer International LLC. The LLC status made the limited liability company a cross between a corporation and a partnership, incorporating more benefits of both worlds.

It was during the late 1970s that Sheaffer's earlier ideas about wastewater treatment became a reality with the company he had formed. Instead of filtration plants and sludge hauling, the Sheaffer System offered a different option. "We began installing systems. A number of private people liked what we were saying. We would take wastewater, recycle it all, eliminate sludge, and eliminate odors," said Sheaffer.

How the System Works

Sheaffer refers to the system as basically "a landscape project." It consists of two treatment cells of water and a storage reservoir. The wastewater is introduced at the bottom of the first treatment cell, 25 or more feet deep, called the anaerobic zone. There, a large portion of the organic load is broken down into methane, carbon dioxide, hydrogen sulfide, and water. The process is called digestion. Unlike conventional sewage treatment plants, the Sheaffer system uses it first rather than last.

"The best way to manage sludge is not to produce it," Sheaffer said.

An aeration system, introduced three feet from the bottom, delivers a coarse bubble diffusion of air that thoroughly mixes and aerates the top 22 feet of water.

"The oxygen-rich aerated zone provides aerobic biological treatment as well as chemical oxidation of soluble BOD [biochemical oxygen demand]," said Sheaffer. "In addition, odorous gases, such as hydrogen sulfide, are oxidized into non-odorous compounds, eliminating nuisance odors normally associated with wastewater plants.

"When people go and see a Sheaffer System, they stand with their toes next to the water and hyperventilate, trying to smell the normal odors associated with sewage. They say where's the odor? I say you've got to dive down about 25 feet. When it goes through 22 feet of water with high oxygen in it, you're not going to smell it at the surface."

Wastewater is typically processed in the first cell for 18 days, and it is then moved from the aerobic top of cell one to the anaerobic bottom of cell two, also 25 feet deep, where the process is repeated for an additional

12 days. Inorganic solids stay at the bottom of cell one and accumulate so slowly that the need to remove them occurs once every 20 to 30 years, according to Sheaffer.

Sheaffer added that the entire system operates on a gallon-in, gallon-out basis. Following the 30 days of treatment, the water enters a storage reservoir until it is reused. "We made what were really flood control reservoirs, and we lined them with compacted clay or a membrane liner to make sure we didn't loose any of the water," he said.

There are only three moving components in the system. The first is a comminutor or grinder pump, which macerates or pulps the solids and introduces them into the base of cell one. The second is a compressor/blower, which introduces the coarse bubble diffusion for the reclamation process. The third moving part is an irrigation system, which moves the water from the storage reservoir and applies it to nearby land, where it nourishes crops, shrubs, trees, lawns in the parks and turf grasses at golf courses and athletic fields.

The first model of the Sheaffer system came on line in 1980. "It's in its 24th year. We've never moved a pound of sludge yet," he said.

Sheaffer said that operating costs can be held down because the power can be interrupted. "If the power company can sell all their power this afternoon on a hot day, they need all that power. We tell them, 'Hey, cut us off. When you have surplus power, turn us on again.' So, it avoids a need for them to create more generating capacity, and we have the potential to get a considerably lower power rate," he said.

Projects Outlined

The first exhibit was in Muskegan County, Michigan. "Our first exhibit showed how we could recycle all the water on a 43.5 million gallons per day (gpd) project," said Sheaffer.

Although the Muskegan project is referred to repeatedly in the Clean Water Act amendments, Sheaffer did not like several aspects of the project. "I don't like that one. We put storage (151 days) in, but we only had a three-day treatment. We didn't have deep cells," he added.

Then, Sheaffer went to Washington, served his time, and came back to the private company and pursued other projects.

"We would work with private companies, golf course communities, people seeking to build a thousand houses, that sort of thing."

Some of those projects include a gated community in Illinois built around an 18-hole golf course designed by Jack Nicklaus called Wynstone and a 3,800-home adult lifestyle community called Saddlebrook Farms, also in Illinois.

Then they started working with high-strength industrial waste. One such project called the North Fork project in Timberville, Virginia, crosses the Shenandoah River. It incorporates two small towns and two poultry plants—one a kill plant and the other a processing plant where they make turkey hot dogs and turkey bacon.

"We put them all together in a cluster system," said Sheaffer. "We have wastewater there that comes in with a BOD sometimes at 10,000 milligrams per liter, and there's lots of grease. We average five-and-a-half tons of grease a day, and we break it all down. The point is that this project shows you can break down even high-strength waste if you add air and time."

Another project Sheaffer points to is a "Best in American Living" awarded community called the Fields of Long Grove near Chicago. It is an 87-home cluster system on a 160-acre site. The luxury homes are nestled in clusters of small lots of a quarter- to a half-acre each with the back yards opening onto the ponds, prairies, and woodlands of the grounds. An independent lab tested the quality of the pollutants in the irrigation water. It was always as good as EPA drinking water standards. But despite that fact, Sheaffer does not recommend drinking the irrigated water.

"We feel you ought to let it go through a soil system although technically, you could drink it. It's more of a psychological issue," he added. "People kept coming to that place in busloads to tour the technology. The homeowner's association now doesn't want anybody coming up, it was such a nuisance. That project showed that you could eliminate any adverse impact coming from wastewater treatment."

Green Communities

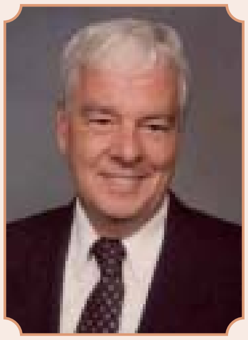
Taking that idea a step further, Sheaffer believes that air pollution should be addressed, too. "People have asked us how we can have a system with no adverse impacts when we're drawing cars to the area polluting the air," he said.

"We talk about the greenhouse effect, the buildup of carbon in the atmosphere. When we burn carbon products, like coal and oil, we put carbon into the atmosphere. We said let's return the carbon to the ground," he said.

"We knew that we could plant prairie plants, and they would grow much better if we integrated them with reclaimed water. The prairie grass can also be used to provide grass filtration for urban runoff (nonpoint pollution). Prairie grass can sequester 300 tons of carbon per acre per year."

Sheaffer believes the key is putting cycles in place. "Everyone is taught about the hydrologic cycle, but few people are taught the nutrient cycle. That's what we are doing. We are reclaiming. Say there's a growing plant. The animal eats the plant. And we eat the animal. The nutrients go through us. We reclaim them, and put them on the ground to grow more plants to feed more animals," said Sheaffer.

"It's not magic. It's all straight forward. Once you put everything together, you have the most environmentally friendly, cost-effective system that's available today. It's simple."



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Cost and Affordability of Phosphorus Removal at Small Wastewater Treatment Plants

CONTRIBUTING WRITERS
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Abstract:

This analysis presents estimated costs for phosphorus removal meeting a 1 mg/L concentration limit for six small communities, ranging in size from 360 to 14,900 persons, located along a phosphorus impaired river. In addition to total costs, the efficiency (cost per pound) and affordability measures (costs per person and per household) were developed. The affordability and efficiency of phosphorus removal varied greatly among the six WWTPs and displayed an inverse relationship to plant capacity. If all plants were assigned phosphorus reduction obligations, trading of phosphorus emissions among plants could potentially save the six communities about $185,000 annually over the no trading scenario.

New water quality initiatives, particularly total maximum daily loads (TMDLs), are likely to increase the number of wastewater treatment plants (WWTPs) requiring phosphorus removal technology. This is of particular concern for small communities whose treatment plants are not large enough to achieve the economies of scale typically needed to achieve low-cost phosphorus removal.

This study presents estimated costs for phosphorus removal (meeting a 1 mg/L concentration limit) for six small Texas communities ranging in size from 360 to 14,900 persons. The communities are located along the North Bosque River, a phosphorus impaired river. In addition to total costs, efficiency (cost per pound) and affordability measures (costs per person and per household) were developed.

Historical Perspective

Phosphorus problems associated with wastewater first gained prominence in the U.S. towards the end of the nineteenth century. In the 1880s, problems with algal growth were reported in the chain of Yahara lakes below Madison, Wisconsin. Direct discharge of sewage into one of these lakes (Lake Monona) from an expanding urban population, was deemed to be the cause of these blooms.

Further urban growth over the next 70 years in the Madison area led to all the lower Yahara lakes becoming heavily polluted by treated sewage discharges from municipal WWTPs (County of Dane, 2002). The lakes bloomed with different types of blue-green algae, whose presence in Europe had also been associated with treated discharges from urban areas. The problem was largely rectified by diversions of the wastewater first around Lake Monona in 1936, and subsequently, in 1958, around the entire chain of Yahara lakes.

In ensuing years, other metropolitan areas experienced poor water quality associated with municipal WWTP discharges as their populations boomed. In the mid 1950s, Lake Washington (near Seattle) experienced a buildup of pollutants. Lake waters became cloudy and algae proliferated. Research by, University of Washington (UW) zoology professor, W. Thomas Edmondson established that blue-green algae were especially able to thrive on the phosphates contained in wastewater pollutants (University of Washington, 1996).

Lake Tahoe, in California and Nevada, also experienced water quality problems related to wastewater in the late 1950s and early 1960s (Kauneckis et al., 2000). In both these cases, diversion was again the strategy used to eliminate the effects of wastewater on lake water quality. In the case of Lake Tahoe, treated effluent was pumped 27 miles over mountains and discharged into Indian Creek Reservoir. "By the early 1970s, it was generally accepted that phosphorus was the limiting nutrient responsible for accelerated eutrophication in the majority of lakes and reservoirs" (Litke, 1999, citing Likens, 1972; and Schindler, 1975) and phosphorus control remedies followed.

Phosphorus controls were established at WWTPs in the Great Lakes watershed as a result of the deterioration of water quality in the Great Lakes, which gained national attention in the late 1960s. Lake Erie was said to be dead; the Cuyahoga River, which flows into Lake Erie, had caught fire. The lake itself was smothered by algae and its fish population was shrinking rapidly as an expanding population placed strains on the ability of the lakes to assimilate increased sewage (Environment Canada, 2001).

In response, the U.S. and Canada signed the Great Lakes Water Quality Agreement (GLWQA) in 1972, which limited phosphorus concentration in domestic wastewater from plants of 1 mgd or more to 1 mg/L. The 1 mgd flow cutoff was based on expected large cost differentials between small and large treatment plants in meeting the 1 mg/L limit. The estimated cost for plants larger than 1 mgd was $0.01/person/day, whereas the cost for the smaller plants was estimated at $0.10/person/day (Lee and Jones, 1988).

In 1978, the GLWQA was extended in Lakes Erie and Ontario to reduce the phosphorus limit to 0.5 mg/L for plants larger than 1 mgd, although since then this requirement has been deferred and more focus has been placed on the control of phosphorus from nonpoint sources. Phosphorus controls in other regions of the country followed.

Vermont's efforts to control eutrophication in Lake Champlain in the 1970s initially focused on direct WWTP discharges to the lake, which were subjected to effluent phosphorus limits of 1 mg/L. Subsequently, all wastewater treatment facilities in Vermont discharging into the Lake Champlain basin were required to meet a monthly average effluent limit 0.8 mg/L, although some smaller facilities, 0.2 mgd or less, were exempted from the limit. Lake Champlain is currently subject to a phosphorus total maximum daily load (TMDL). One strategy under consideration for achieving reductions in point source loads is for larger facilities to meet a 0.6 mg/L phosphorus effluent limit.

In 1983, the Chesapeake Bay Program was established in response to deteriorating water quality in the bay during the 1970s. In 1987, the Chesapeake Bay agreement instituted ambitious targets for reducing nutrient levels. Phosphorus and nitrogen load reductions of 40 percent were targeted for the year 2000 (EPA, 1997). From 1985 to 2000, phosphorus loads from point sources were reduced by 58 percent (Chesapeake Bay Program, 2001). This reduction was achieved through the implementation of a phosphate detergent ban, the implementation of phosphorus effluent limits, and a program of WWTP upgrades focusing on biological nutrient removal (BNR) processes to achieve more efficient phosphorus and nitrogen removal.

Passage of the Federal Water Pollution Control Act of 1972 (Clean Water Act) has had a major impact on the operation of point source facilities, especially municipal WWTPs. Billions of dollars of funding were authorized and spent under provisions of the Clean Water Act for upgrading municipal WWTPs, and secondary treatment became the minimum acceptable standard.

The Clean Water Act also established the primary enforcement mechanism for point source pollution controls in the U.S.—the National Pollutant Discharge Elimination System (NPDES). Under NPDES provisions, discharge of pollutants from point sources is allowed only in accordance with permits, which specify effluent limits for specific pollutants. Pollutant limits for WWTPs are typically prescribed for total suspended solids (TSS), biochemical oxygen demand (BOD) or chemical oxygen demand (COD), pH, and bacteria. When needed to comply with state or federal law or with regional compacts, effluent limits for other pollutants, including phosphorus, are also prescribed in NPDES permits.

By most accounts, the NPDES program has been successful in limiting point source pollution, to the extent that impairments from nonpoint (dispersed) sources have become a larger percentage of remaining impairments. Pollution from point sources, however, is still a major concern, and more stringent load or effluent limits at WWTPs for phosphorus and other constituents can be expected.

The rise to prominence of the TMDL program is the most recent circumstance spurring additional phosphorus control at WWTPs. Although section 303(d) of the Clean Water Act, the legislation establishing the TMDL program, was largely ignored for the first two decades after passage of the Act in 1973, a series of lawsuits starting in the 1980s forced both the states and the U.S. Environmental Protection Agency (EPA) to gear up for what has become a veritable tidal wave of TMDL activity. Currently, EPA's 303d list includes over 26,000 impaired water bodies with over 48,000 impairments (EPA, 2004). Over 5,000 of these impairments are due to nutrients, the fourth largest classification after pathogens, metals, and sedimentation (EPA, 2004). While considerable phosphorus impairment is due to agricultural activity, municipal WWTPs have been identified as a significant or primary phosphorus source for many phosphorus impaired waters.

Figure 1 on page 38 presents a breakdown, by year, of the issuance of phosphorus concentration limits in permits at municipal WWTPs from 1970 to 1997. Prior to 1974, few effluent limits for phosphorus were issued. The number of new permits with phosphorus limits rose significantly towards the end of the 1970s, and reached a peak of 104 in 1986—corresponding with

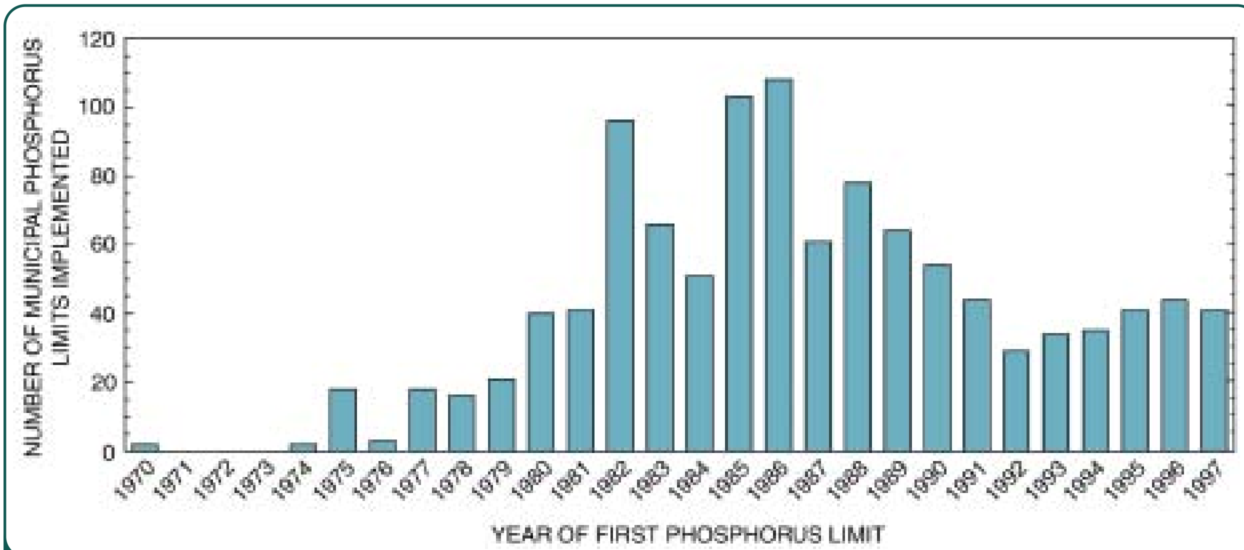

FIGURE 1 Implementation of phosphorus effluent limits by year, 1970 to 1997(Source: Litke, 1999).

Great Lakes and Lake Champlain initiatives. Since that time, the number of new permits with phosphorus concentration limits has declined, but has remained steady at about 40 permits a year during the 1990s. The numbers indicated in Figure 1 do not include restrictions on loads, per se, but only phosphorus concentrations. With the shift in focus toward allocation of loads, as prescribed in TMDL rules, there is an increasing emphasis on restricting phosphorus loads from dischargers rather than phosphorus concentrations.

The National Water Quality Inventory (EPA, 2002) summarizes the extent and sources of impairments for the nation's water bodies. Nutrients were reported as the leading pollutant/stressor for lakes and reservoirs, affecting 50 percent of impaired lake acres, while nutrients were the fifth leading pollutant/stressor for rivers, affecting 20 percent of stream miles (EPA, 2002). The report also indicates that 12 percent of impaired lake acres were a result of municipal point sources, while 10 percent of impaired river and stream miles listed municipal point sources as a leading source of impairment (EPA, 2002). While the focus of water pollution control has, in many respects, shifted from point sources to nonpoint sources, discharges of phosphorus from WWTPs continue to be a major source of impairment for many of the nation's waters.

Current Status of Phosphorus Control

As of August 1997, there were approximately 16,000 WWTPs listed in EPA's Permit Compliance System, serving almost 190 million people or roughly 75 percent of the U.S. population (Litke, 1999). About 7.3 percent of these plants (representing 17 percent of total WWTP discharge) had phosphorus limits in their permits, while 15.3 percent of listed plants (representing 40 percent of total WWTP discharge) were required to monitor phosphorus (Litke, 1999) [1]. Phosphorus limits at most plants ranged from 0.5 to 1.5 mg/L (Litke, 1999).

Figure 2 indicates the distribution of these plants. Most plants were clustered around the Great Lakes or on the Eastern seaboard, with a significant concentration around the Chesapeake Bay, a distribution that reflects the phosphorus control programs instituted in these regions.

Unlike the diffuse phosphorus emissions from agricultural nonpoint sources, WWTP emissions can be directly controlled through the NPDES permitting system. Thus, if several phosphorus sources are identified, phosphorus control at WWTPs may be deemed the source that can be controlled with the greatest degree of certainty, from both legal and biophysical perspectives. Thus, the number of nutrient 303d listings attributed to nutrients, a revitalized TMDL program, and the premise that emissions from point sources are more controllable than for nonpoint sources has given new impetus to additional phosphorus controls at WWTPs.

While phosphorus effluent limits have been instituted at WWTPs in several regions of the U.S., including the Great Lakes, Chesapeake Bay, and Lake Champlain watersheds, small WWTPs (usually defined by design flow) have generally been exempted from phosphorus limits. These exemptions have been based on the premise that it is too costly for small communities to fund phosphorus removal. In addition, other things being equal, the environmental impact of small WWTPs is much less than larger plants, because the amounts of phosphorus emitted are much smaller. Finally, from an efficiency standpoint, the cost per pound phosphorus removed is often much higher for smaller plants than for large plants because small plants cannot achieve the economies of scale typically needed to achieve low-cost removal.

Despite these factors, phosphorus removal for even very small WWTPs is sometimes considered. The following section of this paper presents a case study where phosphorus controls were considered for WWTPs in six small communities in a phosphorus impaired wa-

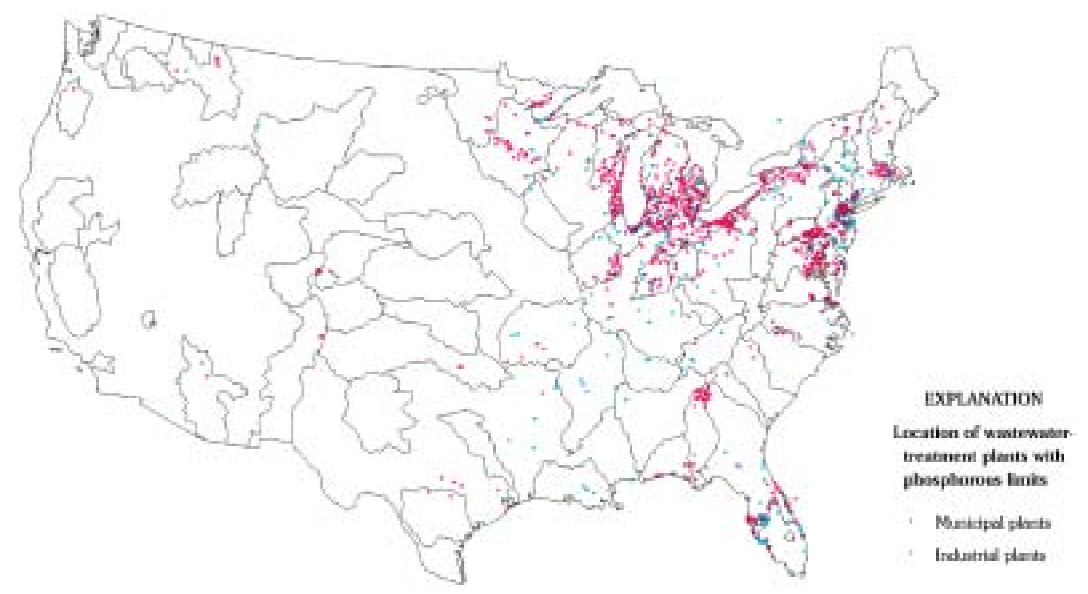

FIGURE 2 Locations of industrial and municipal WWTPs having phosphorus limits (Source: Litke, 1999).

tershed in north central Texas. Results of an evaluation of phosphorus removal costs are presented in succeeding sections. The potential for effluent trading designed to achieve the same load reduction at lower cost is also explored.

Case Study

TMDLs were issued for two segments of the North Bosque River in 2001 specifying significant reductions of soluble reactive phosphorus (SRP) loads and concentrations and expectations of 50 percent load reductions for both point and nonpoint sources (TNRCC, 2001). One control action considered during TMDL deliberation was the implementation of phosphorus controls designed to meet effluent limits of 1 mg/L total phosphorus (TP) at WWTPs serving the communities located along the North Bosque River.

The North Bosque River, a branch of the Brazos River, is located in north central Texas and flows through six small communities before draining into Lake Waco, a drinking water source for approximately 200,000 people located in and around the City of Waco (Figure 3). The headwater area of the North Bosque River basin is located in the state's top dairy production region. Along with phosphorus runoff from dairy waste application fields,

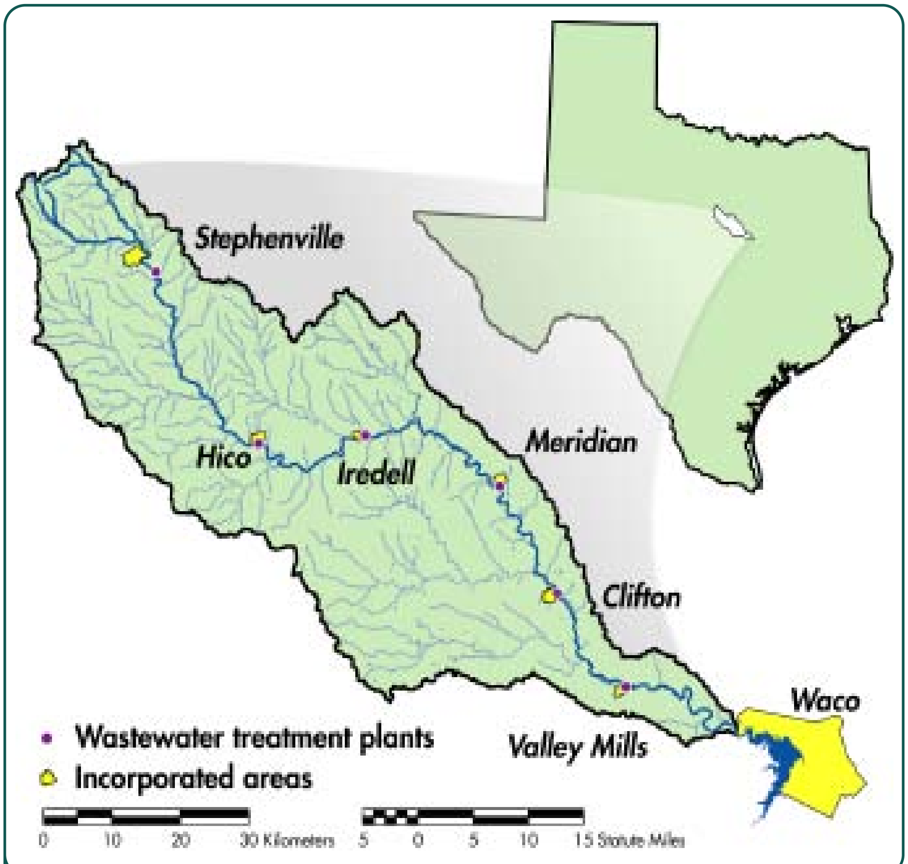

FIGURE 3 Location of North Bosque River WWTPs.

WWTPs serving the communities along the North Bosque River also provide a significant portion of watershed phosphorus loads and contribute disproportionately to in-stream concentrations (McFarland and Hauck, 1998).

Sporadic algal blooms and associated taste and odor problems in drinking water from Lake Waco have been a longtime concern for the City of Waco and have focused attention on the North Bosque River as a possible source of impairment.

TABLE 1 Wastewater Treatment Plant and Community Data for North Bosque Communities

	Stephenville	Clifton	Meridian	Hico	Valley Mills	Iredell	Total/Avg.
Population (U.S. Census, 2000)	14,921	3,542	1,491	1,341	1,123	360	22,778
Number of hookups							
Single family residential	4,307	1,155	583	460	453	179	7,137
Multi unit residential	107	44	0	10	0	0	161
Commercial	576	197	57	89	46	10	975
Total	4,990	1,396	640	559	499	189	8,273
Sewer usage (percent of total)							
Single family residential	55%	70%	61%	72%	83%	98%	61%
Multi unit residential	14%	5%	0%	3%	0%	0%	10%
Commercial	31%	25%	39%	25%	17%	2%	29%
WWTP discharge (mgd)							
Permitted	3.00	0.65	0.45	0.20	0.36	0.05	4.71
Self reported (2001 mean)	1.37	0.33	0.36	0.09	0.08	0.03	2.25
WWTP Effluent TP (mg/L)	2.69	2.40	3.36	3.52	3.14	2.96	3.01

Table 1 presents various community and WWTP data for the six North Bosque communities. To assist comparison, communities are ordered from left to right based on descending order of population. Populations of North Bosque communities vary considerably. The largest community, Stephenville, had a population of around 15,000 (U.S. Census, 2000), while populations were considerably smaller for the remaining five North Bosque communities, ranging from 360 to about 3,500 (U.S. Census, 2000).

Sewer hookups for the six North Bosque communities are classified into single family residential, multi-unit residential, and commercial. Number of hookups and the distribution of sewer usage by sewer hookup classification (Table 1) was collected from North Bosque communities and was used to calculate affordability measures. Sewer usage is defined as amount of effluent attributed to each hookup classification and is stated as a percent of total.

Actual and permitted flows at North Bosque WWTPs (Table 1) are consistent with their populations and commercial usage. Permitted flows ranged from 0.05 mgd (189 m3/d) to 3.0 mgd (11,400 m3/d) for the Iredell and Stephenville plants, respectively, while actual flows ranged from 0.03 mgd (95 m3/d) to 1.4 mgd (5,200 m3/d). Measured mean TP concentrations at WWTP outfalls, based on grab samples collected by the Texas Institute for Applied Environmental Research (TIAER) between 1993 and 2001, ranged from 2.4 mg/L to 3.5 mg/L (Table 1). These ending effluent concentrations are thought to be typical for WWTPs that are not specifically removing nutrients by tertiary chemical or biological treatment. Ending effluent levels, however, are all considerably higher than 1 mg/L—the concentration limit of the control action considered.

CDM (2001) considered the following four major treatment alternatives for reducing phosphorus at North Bosque WWTPs: chemical treatment, biological treatment with chemical polishing, wetlands treatment, and land treatment. Wetlands treatment did not appear to be cost-effective for North Bosque WWTPs because of the large pond areas required (CDM, 2001). Land treatment may have been feasible for the smaller North Bosque River plants but would have required additional detailed site-specific investigations that were not pursued.

Chemical removal by an iron or aluminum based precipitate and biological removal are the two most widespread forms of phosphorus removal and were considered feasible for all North Bosque WWTPs. Biological nutrient removal has become widespread at WWTPs across the U.S., but is often not cost-effective for small WWTPs. Chemical addition utilizing aluminum sulfate (alum) addition is the phosphorus removal method most often used in central Texas (Miertschin, 1999; CDM, 2001). This study confines its analysis to phosphorus removal utilizing alum addition as the primary supplemental removal mechanism. Estimated costs of biological treatment by CDM (2001) are higher than those of phosphorus removal utilizing alum, as estimated in this report, for all plants.

Costs of Phosphorus Removal

During TMDL deliberation, a generic engineering study of phosphorus removal costs was conducted (Miertschin, 1999) followed by a site-specific study for the six North Bosque WWTPs sponsored by the Brazos River Authority (CDM, 2001). Costs for several specific items for this study are based on the site-specific analysis. The methodology used in this study, however, departed from the site-specific study in that near-term costs of phosphorus removal under current conditions (versus the estimation of costs based on design parameters) were estimated. Costs were divided into two major categories: operation and maintenance costs, and capital costs.

Operation and Maintenance (O&M) Costs

O&M costs for phosphorus removal consist of additional expenses such as materials, supplies, utilities, maintenance, and labor, which would need to be incurred on an ongoing basis, in order to achieve the 1 mg/L TP standard.

alum expense

Table 2 presents estimations of the amount of alum required and associated expenses for the six North Bosque WWTPs.

Measured TP concentrations at WWTP outfalls and monthly self-reported WWTP discharge data (Table 1) were used to estimate the amount of alum needed at each plant. Alum use is based on the amount of phosphorus removed, which is based on the reduction of TP concentration required and plant discharge. In practice, WWTPs that are required to meet TP effluent concentration limits typically target concentrations below the limit. This practice provides a margin of safety if rapidly changing effluent conditions cause effluent TP to be above the target on any given day.

A study of phosphorus removal by WWTPs in the Great Lakes region (EPA, 1987) revealed that plants having a 1 mg/L TP effluent limit actually achieved ending effluent TP concentrations ranging from 0.70 to 0.86 mg/L, and averaging 0.77 mg/L. Thus, actual amounts of TP removal for North Bosque WWTPs were estimated assuming that they would achieve average TP effluent concentration of 0.77 mg/L.

Necessary concentration reductions were found by subtracting the target concentration (0.77 mg/L) from the mean TP concentration for each WWTP (Table 1). This value was then multiplied by average plant discharge to estimate the average daily load requiring removal. While the amount of TP removed varies considerably among plants based largely on their size, percent of TP removed is similar among the six plants, ranging from 68 to 78 percent (Table 2). The Stephenville plant, the largest of the six plants, would account for the majority (57 percent) of total TP removal at all 6 plants, while removal at the other five plants would range from 1 percent to 20 percent of the total.

Based on estimated amounts of phosphorus removal, alum requirements were calculated and are also reported in Table 2. Alum removes phosphorus in effluent by chemically binding with phosphate thereby forming new compounds, which are precipitated out by settling. The theoretical molar dosage required for phosphate removal is 1:1 aluminum:phosphate (Al:P), which translates into an alum:P dosage weight ratio of about 9.6:1. Due to competing reactions, actual dosage rates at plants utilizing alum addition are much higher than those predicated on the theoretical 1:1 Al:P molar ratio (Metcalf and Eddy Inc., 1991).

Organic phosphorus, however, is also removed by flocculation at higher rates of alum addition. A review of empirical plant studies (EPA, 1987) revealed that alum dosage rates vary considerably among WWTPs even when the same effluent limit is targeted, a finding that can be attributed to plant-specific effluent conditions. Alum dosages for plants targeting a 1 mg/L effluent TP limit averaged a molar alum:P ratio of 2.2:1 in EPA (1987), which translates into an alum:P weight ratio of about 21:1. This dosage was assumed for this study. It is noted, however, that due to the variability of effluent conditions, required alum dosages could be much higher or much lower. A few plants in the EPA (1987) study required dosage rates of almost twice the average value.

Multiplying the alum:P weight ratio of 21 by pounds of TP per day needing removal resulted in the daily alum dose required, from which the annual alum dose was calculated. Annual dosages of alum were divided by the number of pounds alum per gallon alum solution (5.328) to find the number of gallons of alum solution required. This value was multiplied by the price of alum to estimate the annual cost of alum for each North Bosque WWTP, as reported in Table 2. A price of $0.46/gal ($0.12/L) of alum solution was used, based on a price quotation from General Chemical in 2002 for bulk alum solution delivered to the North Bosque region of Texas. Estimated annual costs for alum ranged from $14,600 for the Stephenville plant to $307 for the Irdell plant.

other O&M expenses

Use of alum for phosphorus removal creates greater amounts

TABLE 2 Estimation of Alum Expense for North Bosque Communities, 1 mg/L TP Effluent Standard

	Stephenville	Clifton	Meridian	Hico	Valley Mills	Iredell	Total/Avg.
TP targeted for removal							
mg/l	1.92	1.63	2.59	2.75	2.37	2.19	2.24
lb/day	21.98	4.44	7.76	2.00	1.60	0.46	38.24
Percent removal	71%	68%	77%	78%	76%	74%	74%
Percent of total	57%	12%	20%	5%	4%	1%	100%
Alum required							
Daily dose (lb)	462.7	93.5	163.3	42.1	33.6	9.7	804.8
Annual amount (lb)	168,992	34,151	59,643	15,359	12,277	3,538	293,961
Annual amount alum solution (gal)	31,718	6,410	11,194	2,883	2,304	664	55,173
Alum cost ($/yr)	14,647	2,960	5,169	1,331	1,064	307	25,478

Note: In the Total/Avg. column, "mg/L" and "Percent TP removed" are weighted averages; other values are totals.

TABLE 3 Annual Expense for Phosphorus Removal at N. Bosque WWTPs

	Stephenville	Clifton	Meridian	Hico	Valley Mills	Iredell	Total/Avg.
O&M expense ($/yr)							
Alum cost	14,647	2,960	5,169	1,331	1,064	307	25,478
Add'l sludge disp. cost	3,006	225	1,172	273	210	60	4,948
Other O&M expense	46,760	11,590	24,849	7,610	18,880	7,215	116,904
Total O&M expense	64,413	14,775	31,191	9,215		7,581	147,329
Capital costs ($/yr)							
Capital costs	786,288	979,000	2,290,860	825,920	957,640	792,100	6,631,808
Capital service cost	47,744	59,445	139,102	50,150	58,148	48,097	402,686
Total expense ($/yr)	112,157	74,220	170,292	59,365	78,303	55,678	550,015

of sludge, which requires disposal. Sludge removal costs in this analysis are assumed proportional to the production of additional sludge, which is considered proportional to the quantity of alum used. Unit sludge removal costs and costs for other O&M expenses, such as polymer, maintenance, electricity, and labor, are based on estimates developed for the site-specific study (CDM, 2001).

Table 3 presents a summary of annual O&M expense for the six NorthBosque WWTPs and indicates that the cost of alum, while significant, accounts for less than a quarter of total O&M expense for every community.

Capital Costs

Capital costs consist of one-time expenses associated with physical plant upgrades or retrofits required for phosphorus removal, e.g., alum storage tanks, feed lines, feed pumps, etc. Capital cost estimates used in this study are based on site-specific capital costs estimated in CDM (2001).

Two significant adjustments, however, were made. First, a two-meter belt press and associated expenses was not included in the Stephenville estimate because the City of Stephenville recently purchased a two-meter belt press, thus, this expense would not need to be incurred again. Second, all capital costs were scaled up by 78 percent for all WWTPs. This decision was based on the recent purchase of the two-meter belt press by the City of Stephenville, whose purchase price was 78 percent higher than the site-specific estimate. Thus, there is some rationale for thinking that actual costs for all capital purchases could be higher than the a priori estimates by a similar percentage. Estimating project costs is usually problematic. Given these adjustments, we feel the cost estimates made in this analysis are conservative.

Capital costs for infrastructure improvements at WWTPs are typically financed through the issuance of municipal bonds. It is probable that funds could be secured through EPA's state revolving fund (SRF), as administered through the Texas Water Development Board (TWDB). SRF loan rates are subsidized and are approximately one percentage point lower than market municipal bond rates.

On November 15, 2002, the published rate for insured loans was 3.3 percent, while the rate for non-rated loans was 3.6 percent. An interest rate of 3.6 percent and a loan term of 25 years (the assumed life of the capital improvements) were used to calculate annual loan payments (capital service costs). One time capital cost estimates and associated annual capital service costs are also reported in Table 3.

Total Costs

Estimated total annual costs for phosphorus removal, also reported in Table 3, are the summation of estimated annual O&M expenses and the estimated annual capital service costs. Actual phosphorus removal costs for North Bosque River WWTPs are, of course, as yet unknown because no phosphorus removal technology has yet been purchased or installed at any of the plants.

Discussion

Figure 4 reveals that annual O&M expense varies considerably among North Bosque WWTPs but bears an observable relationship with the size of the plant. O&M expense ranges from $64,400 for the Stephenville plant to $7,600 for the Iredell plant, the smallest of the plants. The relationship between plant size and O&M expense is not smooth because of numerous site-specific factors (CDM, 2001).

Capital costs for phosphorus removal retrofits, however, did not bear an ostensible relationship to plant size (Figure 4). In fact, capital costs are relatively similar for five of the six plants, despite great variations in flow. Estimated capital costs for five of the six WWTPs, ranged between $780,000 and $980,000. Capital service costs on these amounts ranged between $47,700 and $59,500 annually (Table 3). Due to site-specific factors, costs for capital improvements are substantially higher for the Meridian plant. Capital service costs constitute a substantial portion of total annual costs for phosphorus removal, ranging from 42 percent at the Stephenville plant to 86 percent for the Iredell plant.

Affordability

The affordability of phosphorus removal from WWTP effluent is undoubtedly of interest to municipalities and ratepayers everywhere, especially for smaller communities, where smaller populations must

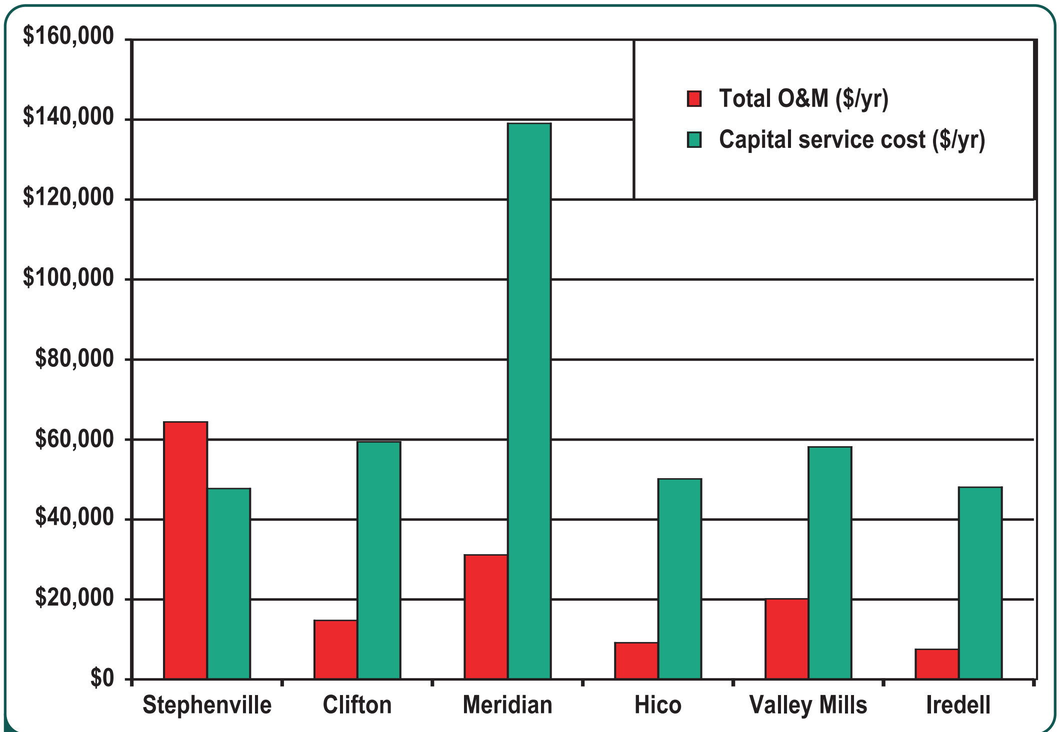

FIGURE 4 Estimated annual O&M and capital costs for North Bosque WWTPs.

bear the burden of high capital costs. Although affordability is an inherently subjective concept, measures of affordability are compared across communities to determine where phosphorus removal is relatively more or less affordable.

Table 4 presents affordability measures for phosphorus control in terms of dollars per household (residential hookup) per year and per month and dollars per person per year. The annual cost for phosphorus removal per household was calculated by dividing the single family residential portion of sewer use by the number of single family residential hookups. Annual costs were divided by 12 to estimate the monthly residential hookup cost. Since sewer charges are billed monthly, this cost represents the estimated cost increase for sewer service attributable to phosphorus control that an average household might see reflected on its monthly municipal utility bill, assuming that the costs for phosphorus removal was distributed to sewer accounts in proportion to usage.

Phosphorus control costs ranged from $1.19 per month for Stephenville households to $25.43 per month for Iredell households (Table 4). Figure 5 on page 44 reveals the generally inverse relationship between community size and affordability of phosphorus removal. High household costs for the smaller communities are due, in large part, to high capital costs being divided by a much smaller number of residential accounts.

Although affordability is a subjective concept, it can be said that phosphorus removal is much less affordable for the smaller North Bosque communities than for Stephenville.

Table 4 also presents phosphorus removal costs for residential accounts as a percent increase from current average monthly sewer bills. In 2002, monthly sewer bills for residential hookups ranged from $8.00 to $22.00. Percent increases in monthly sewer bills as a result of phosphorus removal ranged from 6 percent for Stephenville to 168 percent for Iredell.

Annual per person costs for phosphorus removal were calculated by first prorating total annual phosphorus removal expense (Table 3) by the summation of the single family and multi-unit residential portions of sewer use (Table 1). In turn, this portion of total annual phosphorus removal expense was divided by the population of the community, as reported in the year 2000 U.S. Census (Table 1). Per person costs for phosphorus removal ranged from $5.20/yr for Stephenville residents to $152/yr for Iredell residents (Table 4), again demonstrating the generally inverse relationship between community size and affordability.

TABLE 4 Annual Expense for Phosphorus Removal at N. Bosque WWTPs

	Stephenville	Clifton	Meridian	Hico	Valley Mills	Iredell
Avg. monthly residential bill in 2002 ($)	20.69	22.00	18.64	12.00	8.00	15.14
Affordability (add'l cost of P removal)						
Cost / res. hookup ($/yr)	14.23	45.29	176.73	93.26	144.25	305.20
Cost / res. hookup ($/mo)	1.19	3.77	14.73	7.77	12.02	25.43
Percent of average bill	6%	17%	79%	65%	150%	168%
Cost / person ($/yr)	5.18	15.80	69.10	33.23	58.19	151.75
Cost-effectiveness ($/lb TP removed)	13.97	45.74	60.09	81.35	134.24	331.18

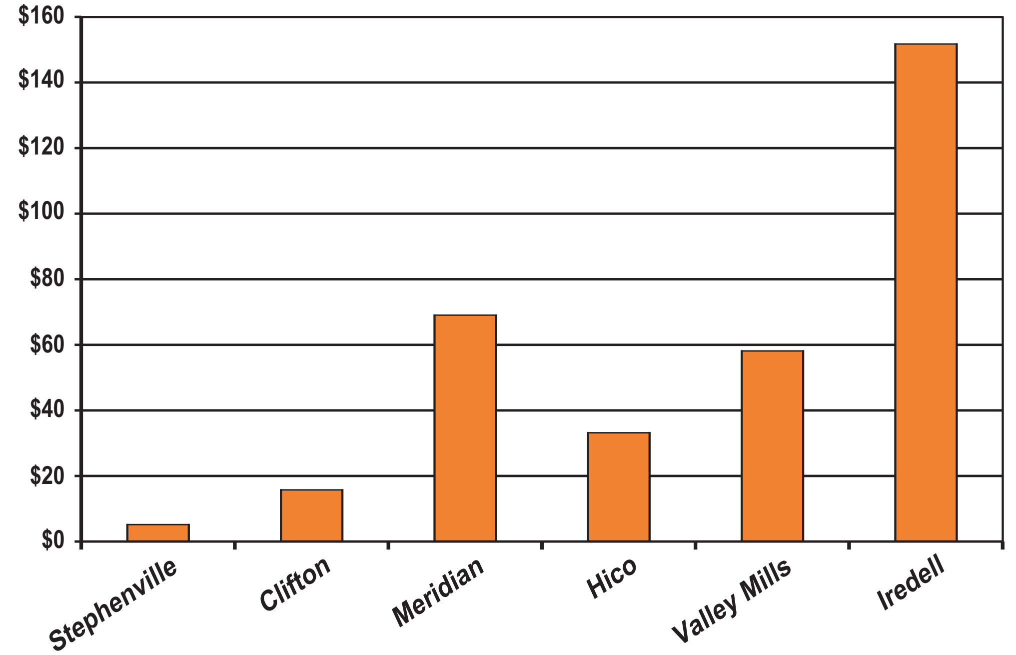

FIGURE 5 Estimated monthly household cost of phosphorus removal for North Bosque WWTPs.

Cost-Effectiveness

Effectiveness, within a water quality context, can be considered an improvement in a water quality measure that is associated with impairment. Ambient phosphorus concentrations in rivers and lakes have been shown to correlate, under certain circumstances, with excessive algal growth. Effectiveness is here defined as the estimated TP load removed from WWTP effluent as a result of phosphorus control, as reported in Table 2.

While bearing some resemblance to affordability measures, cost-effectiveness ratios are more direct measures of efficiency and are calculated by dividing the total cost of phosphorus removal by total pounds of phosphorus removed. Cost-effectiveness ratios, as presented in Table 4, indicate that the cost of TP removed at North Bosque WWTPs ranged from $14/lb ($31/kg) for the Stephenville plant to $331/lb ($730/kg) for the Iredell plant (an almost 24-fold difference). Figure 6 reveals the inverse relationship between estimated per pound phosphorus removal costs and plant size.

Trading Implications

The concept of trading marketable effluent permits to achieve environmental quality is of relatively recent origin. Dales (1968) is credited with first setting out the parameters of the type of "cap and trade" program for water quality receiving widespread attention today. The basic components of the program involve setting a cap on the total waste load, issuing emission permits, the aggregate of which equals the cap, and allowing the sale and purchase of permits among dischargers. Marketable credits are formed when dischargers with low removal costs reduce loads below permitted levels. These credits can in turn be sold to entities with high removal costs such that both parties gain, thereby generating savings in meeting the total waste load allocation.

The trading of emission credits has been implemented in a number of national programs to achieve air pollution goals (Tietenberg, 1999). Having achieved notable successes in the air arena, economists and policy makers have investigated the potential of applying the tradable permit concept to water pollution control and several programs have been developed (e.g., see Environmonist, 1999; EPA, 2001).

In 1996, EPA issued a *Draft Framework for Watershed-Based Trading* (EPA, 1996), which was designed to promote, encourage, and facilitate trading wherever possible provided that equal or greater water pollution control can be attained for an equal or lower cost. This was followed in January 2003 by a Water Quality Trading Policy to "encourage states, interstate agencies and tribes to develop and implement water quality trading programs for nutrients, sediment and other pollutants where opportunities exist to achieve water quality improvements at reduced costs" (EPA, 2003).

For a trading program to be successful, a number of conditions must apply. Among them, first, there must be substantive difference in compliance costs at the margin. Second, all potential trading entities must be given a verifiable and enforceable pollution reduction obligation. Third, there must be legal authority for trading and an administrative system must be developed to track trades and verify compliance. Fourth, the potential cost savings from trading should exceed the administrative and information costs (broadly referred to as transactions costs) of setting up and operating the program.

Because the trading among North Bosque WWTPs involves only point sources it avoids the complexities in determining nonpoint loads (see, e.g., Malik et al., 1993) that would be required for "point source/nonpoint source" trading. In addition, all entities are subject to the same regulatory regime—delegated NPDES authority—thereby further simplifying potential implementation of a trading program. For the present example, we assume that each North Bosque WWTP is obligated to reduce loads by an amount equal to that needed to consistently achieve ending effluent levels of 1 mg/L.

Trading of TP loads among North Bosque WWTPs would entail the removal of TP by one or more

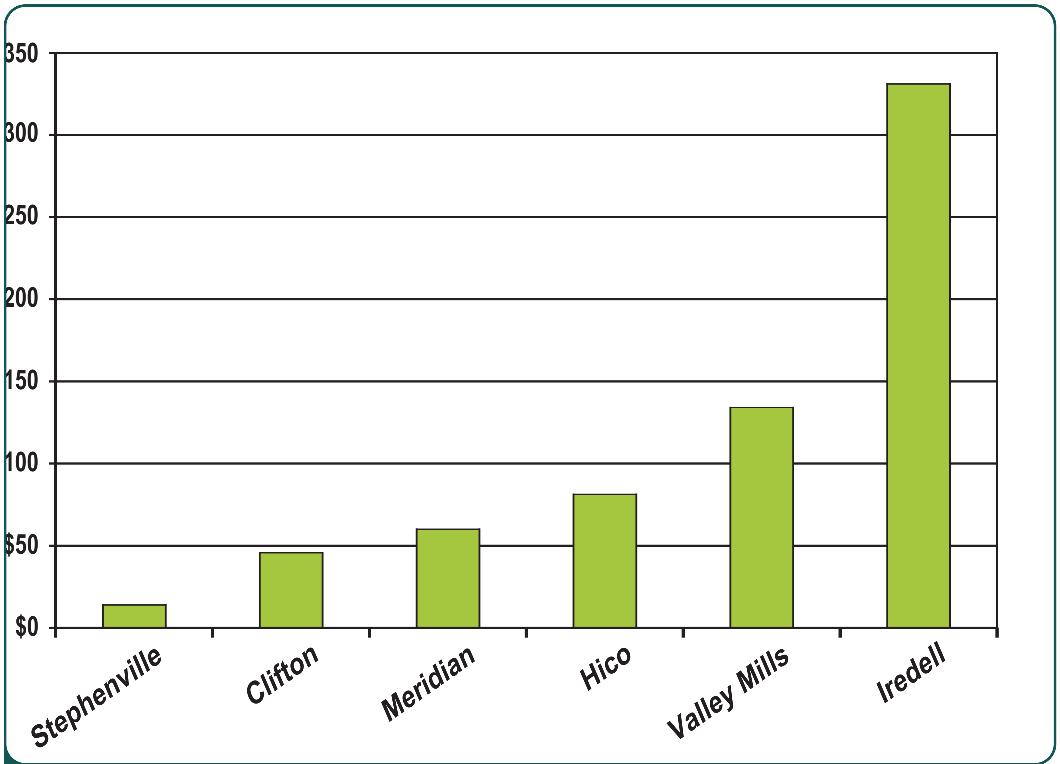

FIGURE 6 Estimated per pound cost of phosphorus removal for North Bosque WWTPs.

WWTP in excess of its own required TP removal, as reported in Table 2, in order to produce marketable credits. The Stephenville WWTP is the obvious candidate for additional TP removal because its unit cost of removal ($14/lb or $31/kg) is much less than the unit cost of TP removal for other North Bosque WWTPs (Table 4). In addition, the Stephenville plant is by far the largest of the six facilities and therefore has the greatest additional phosphorus removal capacity.

Another favorable feature of moving phosphorus removal from other WWTPs to the Stephenville plant is that Stephenville is the most upstream of the six communities (Figure 3), thus, any phosphorus removal at Stephenville would potentially impact more stream miles than reductions at more downstream sites.

A cost minimization analysis indicated that the least cost strategy for phosphorus removal for all six North Bosque WWTPs, such that required TP load allocations were met, entailed that the three smallest WWTPs engage in no phosphorus control, while the Stephenville WWTP would reduce TP emissions beyond its own obligation by an amount equal to that of the TP reduction obligations of three smallest WWTPs. Economic theory supports the concept that more efficient (less costly) solutions are achieved when trading is permitted. In practice, the cost of finding and executing trades (transactions costs) add to the costs of trading and often result in suboptimal post-trade solutions. Actual trading behavior is difficult to predict. In this analysis, we assume that trading will achieve the most efficient (least costly) solution.

The primary source of savings for this trading scenario are the phosphorus removal capital costs that could be avoided by the three smallest WWTPs, given the transfer of their phosphorus removal obligations to the Stephenville plant. In determining the optimal trading scenario, we assumed that the estimated capital cost associated with phosphorus removal plant upgrades were fixed and would need to be incurred for any additional phosphorus removal to have been made. Because phosphorus removal capacity is limited for any WWTP, the Stephenville plant could not meet the phosphorus removal obligations of all five of the smaller North Bosque WWTPs.

Impact on Stephenville WWTP

Table 5 on page 46 presents the impact on the Stephenville WWTP of the most efficient (least cost) trading strategy. While the ordering of the trades does not affect total savings, we here assume that the Stephenville plant will trade with the plant with the least cost-effective phosphorus removal first, then with the plant with the next least phosphorus removal efficiency, etc.

The first line in Table 5 shows the required removal for each trading plant in terms of lb/day TP removed. The second line shows the actual removal requirement for the Stephenville plant before trading and after each trade. The removal requirement for Stephenville (22 lb/day or 51 kg/day) assumes that the Stephenville plant will achieve an average ending TP concentration of 0.77 mg/L, rather than the required 1 mg/L, to provide a margin of safety. Required TP removal amounts for each trading WWTP are successively added to Stephenville's removal to determine Stephenville's required removal after each trade.

TABLE 5 Effect on Stephenville WWTP of Trades with Iredell, Valley Mills, and Hico WWTPs

	Stephenville (before trading)	After Trade with Iredell	After Trade with Valley Mills	After Trade with Hico
Phosphorus removal (lb/day)				
Required removal at each WWTP	19.35	0.41	2.14	2.52
Actual removal at Stephenville	21.98	22.40	24.54	27.06
Phosphorus concentration at Stephenville (mg/l)				
Target concentration required	1.00	0.96	0.78	0.56
Average concentration	0.77	0.73	0.55	0.33
Percent removal - Stephenville				
Additional	-	1.3%	7.0%	8.2%
Cumulative	71%	73%	80%	88%
Molar ratio assumed (Al:P)	2.20	2.24	2.42	2.64
Alum dose required (gal/yr)				
Total (cumulative)	31,718	32,841	39,003	46,929
Additional	31,718	1,124	6,162	7,926
Alum and assoc. expenses ($/yr)				
Add'l alum cost	14,647	519	2,845	3,660
Add'l sludge handling cost	3,006	107	584	751
Total	17,653	625	3,429	4,411
Cost-effectiveness of additional P removal ($/lb)				
Trading scenario (add'l cost for Stephenville)	n/a	4.16	4.38	4.79
No trading (each plant removes phosphorus)	13.97	331.18	134.24	81.35
Average cost for Stephenville	13.97	13.79	12.97	12.20

The second section of Table 5 shows the TP concentrations required for the Stephenville plant in order to remove its own removal requirement plus that of its trading partners (first line); and average actual concentrations that would be expected in order to consistently meet those limits (second line). Ending target and actual TP concentrations must be successively lowered to achieve the increased removal requirements for Stephenville after each trade. Trading stops after the trade with Hico because of insufficient phosphorus reduction capacity at the Stephenville WWTP to perform additional trades.

Based on industry experience, we assume that a TP effluent concentration target of 0.5 mg/L is the lowest concentration target that can be consistently met with the conventional alum addition technology considered here. After a safety factor of 0.23 mg/L is subtracted from this value to assure that target concentrations are consistently met, an ending effluent concentration averaging 0.27 mg/L is assumed to be the lowest average TP effluent concentration achievable.

No additional trades for the entirety of any plant's phosphorus removal requirements are feasible because they would necessitate reducing average TP concentrations below the 0.27 mg/L threshold. Trades involving less than the entirety of required removal for a plant would potentially generate only small additional savings because the greatest portion of phosphorus removal expense for the five smallest WWTPs are capital costs, which are considered invariant to the amount of additional phosphorus actually removed. Because any savings based on trades for less than the entire phosphorus obligation would be small, we do not consider such trades.

Table 5 shows that 71 percent of effluent TP must be removed to meet Stephenville's own reduction obligation, while 88 percent of effluent TP would need to be removed to meet TP reduction obligations for Stephenville plus all three potential trading partners. Table 5 also presents Al:P molar ratios assumed to be required to meet a lower effluent standard at the Stephenville plant. Based on previous studies, higher molar ratio alum dosages are considered necessary to achieve higher phosphorus removal rates. Studies of phosphorus removal by alum addition (EPA, 1987) suggest that the Al:P molar ratio must increase by one-tenth (0.1) for every one-tenth mg/L reduction in target effluent TP concentration below 1 mg/L.

The cost of additional phosphorus removal at the Stephenville WWTP as a result of trading (Table 5) is assumed to consist solely of the cost of additional alum and sludge removal expense, both of which are a function of the additional amount of alum used. All estimates assume that alum solution can be purchased for $0.46/lb ($1.02/kg) and that additional sludge removal at Stephenville costs $0.095/gal ($0.21/kg) of alum solution used.

The first line of the last section of Table 5 shows the unit cost or cost-effectiveness ($/lb) of additional TP removal at the Stephenville WWTP as a result of trades. This can be considered a marginal analysis in that the unit cost of additional phosphorus removal required for each trade (or phosphorus removal cost at the margin) is presented. These costs are compared to the unit costs of TP removal for the trading WWTPs assuming phosphorus removal at their own plants, which are presented on the next line.

Comparison of the first two lines of the last section of Table 5 illustrates the gains in economic efficiency that are achievable when the Stephenville WWTP removes additional phosphorus in lieu of the three smallest WWTPs removing phosphorus on their own. For example, the cost to Stephenville would be $4.16/lb ($9.17/kg) for additional phosphorus removal equivalent to Iredell's obligation, whereas an equivalent amount of removal at the Iredell plant is estimated to cost $331/lb ($730/kg). The last line in Table 5 shows that although the marginal costs of phosphorus removal increase, the average cost per pound of phosphorus removed at the Stephenville WWTP decreases because high capital costs are distributed over a greater amount of removal.

Gains to Trade

Table 5 indicates that Stephenville would incur addition phosphorus removal expenses of $8,465 annually if it were required to remove an additional amount of phosphorus equal to the amounts required for the three smaller WWTPs. On the other hand, the three smaller communities (Iredell, Valley Mills, and Hico) would be entirely relieved of phosphorus removal expense totaling and estimated $193,346 annually. Net savings as the result of trading among the four WWTPs, thus, would total $184,881 annually. Exactly how these savings would be distributed between the four trading WWTPs would depend on the price for traded phosphorus credits. Estimating this price is beyond the scope of this analysis. However, all WWTPs would gain from trade if the price of traded phosphorus credits were anywhere between $5 and $81 per pound. Lower prices would, of course, benefit the three smaller WWTPs, because these plants would need to purchase phosphorus credits from Stephenville in order to meet their obligation under the trading scenario.

Conclusions

This study supports the generally accepted inverse relationship between unit phosphorus control costs and WWTP capacity. In large part, this inverse relationship can be attributed to substantial capital costs, which, for this analysis, bore no ostensible relationship to the size of the plant. From an affordability standpoint, this means that per person phosphorus removal costs are higher for small communities than for large communities, because high capital costs must be distributed among smaller populations.

Annual phosphorus removal costs for Stephenville, the largest of the six communities assessed, were estimated at about $5 per person, while for Iredell, the smallest community assessed, annual costs were estimated to be $152 per person. Unit phosphorus removal costs followed a similar pattern, ranging from about $14/lb ($31/kg) for the Stephenville plant to $331/lb ($730/kg) for the Iredell plant—an almost 24-fold variation. High unit costs for phosphorus removal at small WWTPs, especially as it impacts affordability, is undoubtedly one reason why small capacity WWTPs have often been exempted from meeting phosphorus limits, or have been held to less stringent standards, in regions of the U.S. that have implemented phosphorus limits at WWTPs. If, however, all WWTPs within a watershed were required to remove additional phosphorus, then large unit phosphorus removal cost differentials would create opportunities for equivalent phosphorus removal to be achieved at much lower cost, through the trading of phosphorus removal obligations.

The trading analysis presented in this paper suggests that if all North Bosque WWTPs were required to attain effluent phosphorus concentrations of 1 mg/L, that effluent trading would be an attractive option, saving North Bosque communities an estimated $185,000 annually. This analysis demonstrates the substantial gains to trade that could be achieved to meet phosphorus load allocations at WWTPs within a TMDL, presuming, in this case, that all WWTPs would be obligated to meet an ending effluent phosphorus limit of 1 mg/L. Judging by past phosphorus control actions in the U.S., however, a more likely scenario may be to exempt the small WWTPs from phosphorus effluent limits based on their much higher removal costs and their relatively smaller contribution to ambient phosphorus loads.

Epilogue

On December 13, 2002, the Texas Commission on Environmental Quality (TCEQ) approved a TMDL implementation plan for the North Bosque River TMDLs (TCEQ and TSSWCB, 2002). In addition to specifying dairy waste control actions and management measures, a key component of the plan was the implementation of municipal WWTP effluent limits.

Phase I of the plan specified initial load allocations for the six existing WWTPs analyzed in this paper plus a planned facility at Cransfill's Gap, a small community of less than 200 people currently serviced by septic systems. These load allocations were based on the load that would be generated by WWTPs discharging effluent at fully permitted levels with TP concentrations of 1 mg/L plus a future growth allocation of of 5 lb/day (2.3 kg/day), which was partially distributed among the WWTPs, except for the Stephenville plant (TCEQ and TSSWCB, 2002).

For phase II of the implementation plan, which commences after Phase I load allocations have been reached, communities are given a choice of complying with either the TMDL load allocation, or a concentration limit of 1 mg/L TP for discharge volumes appropriate for their population and plant design capacity.

According to TCEQ's load allocations and analysis (TCEQ and TSSWCB, 2002), the Stephenville plant was the only plant already exceeding the phase I limits. None of the smaller facilities exceeded phase I limits, in large part because of the future growth allocations granted them. Stephenville was allocated a TP load of 25.4 lb/day (11.5 kg/day), whereas its average TP load was estimated to be

39.4 lb/day (17.9 kg/day) (TCEQ and TSSWCB, 2002).

Under the phase II load limit option, the Stephenville plant would need to reduce average phosphorus effluent concentrations, but by a smaller amount than would be needed if the alternative option—meeting an TP effluent concentrations of 1 mg/L—where chosen. Based on average concentrations and flows used in the TCEQ analysis, Stephenville would need to reduce ending TP effluent concentrations to 1.3 mg/L. Based on the lower flows the Stephenville plant has been able to achieve in recent years (as represented by the 2002 flows used in this report), Stephenville could achieve the phase II load allocation by reducing its average TP effluent concentration to only 2.2 mg/L. However, as Stephenville grows and flows increase, concentrations will need to be further reduced to achieve its load allocation.

Municipal WWTP TP load allocations in the North Bosque TMDL implementation plan (TCEQ and TSSWCB, 2002) were designed such that only the Stephenville plant would be required to implement phosphorus controls, at least in the short-term. However, the smaller WWTPs, too, could be required to implement phosphorus controls in the future, when and if expanding populations or industrial growth in the smaller communities cause TP loads to exceed allocations. This underscores the possibility that, in some situations, even very small WWTPs may be asked to control phosphorus.

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Notes

1. No doubt, the numbers the WWTPs with phosphorus limits and those required to monitor phosphorus have increased since August 1997.

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Small Flows Quarterly

JURIED ARTICLE

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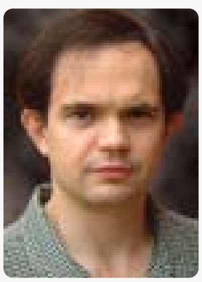

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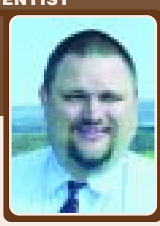

Editor's Note:
This column is based on calls received over the National Environmental Services Center (NESC) technical assistance hotline. If you have further questions concerning roof drains, call ***(800) 624-8301*** *or* ***(304) 293-4191*** *and ask to speak with a technical assistant.*

Roof Drains and Septic Systems

The local sanitarian said I couldn't tie my roof drains into my septic system? Why not? It's just getting rid of rain water, so what would it hurt?

Your septic system is designed to treat the wastewater generated by your residence. Treatment means protecting public health and the environment. The size of your septic system is dictated by the amount of wastewater that needs to be treated and dispersed into the environment on a daily basis.

The most important number here is the soil loading rate, which is a property of the soil in your yard. The loading rate, given in terms of gallons per square foot per day, says how much water can be spread out over your yard and be treated without backing up and creating a mess. Once this is determined by a site evaluation (a percolation test or soil assessment) the design flow is determined by the size of your house.

It is an accepted engineering number that people use a certain amount of water each day. Usually this amount is agreed to be around 70 gallons a day. So if three people live in your house, the design flow would be 210 gallons a day. If seven people live there, it would be 490 gallons a day.

Systems are not designed, however, based on who lives there, but on how many could live there, if you were to sell the house. So a four-bedroom house could support eight people or 560 gallons per day. A three-bedroom home could house six people or 420 gallons a day. The number of bathrooms is not that important. Six people using one bathroom, while crowded, would still generate 420 gallons a day. One person living in a home with four bathrooms would still probably only use 70 gallons a day.

Now, if you divide the design flow by the soil loading rate, you arrive at the size your drainfield needs to be. Now you want to run additional rainwater into the system. While it may not be contaminated like your sewage, it will still increase the hydraulic load on your drainfield and would cause slower acceptance of the water and thus lead to backups.

The other issue is that the septic tank is designed to hold the sewage for at least a day to allow solids to settle out. Now, a 1,000-gallon tank is plenty big enough to hold 420 gallons a day (if that's your design flow) when it is new. But as solids settle out and sludge accumulates, you have less space in the tank to hold water.

Thus the less water you use, the more time it has to sit in the tank and let the solids settle to the bottom. So taking shorter showers would certainly help, but more to the point, keeping unnecessary water out of the tank, like your roof drains, is an important aspect. Along the lines of water use, it is better for your onsite system to spread your laundry out over the week rather than doing five or six loads all on one day.

New NESC Products Are Available

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Performance of a Textile Filter, Polishing Sand Filter & Shallow Trench System for the Treatment of Domestic Wastewater at the Northeast Regional Correction Center

McCarthy, Barbara; Geerts, Stephen Monson; Axler, Richard; Henneck, Jerald; Natural Resources Research Institute

An estimated half million households in Minnesota are not connected to public sewer systems. Along with the growing use and expansion of lakeshore cabins and resorts, many have the potential to degrade surface and groundwater resources as they depend primarily on individual sewage treatment systems (ISTSs) for the treatment and dispersal of domestic wastewater. The Northeast Regional Correction Center research site provided an excellent location to evaluate the treatment and operational performance of a proprietary recirculating textile filter (for enhanced pathogen removal) and shallow infiltration trenches for final treatment and dispersal. This 28-page research study about third-party testing provides the industry, homeowner, and regulators with an unbiased evaluation of the treatment and operational performance of the system.

This report is free. Request item #WWBLRE47.

Performance of Pre-engineered Modular Peat Filters for the Treatment of Domestic Wastewater at the Northeast Region Correction Center

Geerts, Stephen Monson; McCarthy, Barbara; Axler, Richard; Henneck, Jerald; Natural Resources Research Institute

Approximately 500,000 Minnesota residences rely on the use of onsite wastewater treatment systems and more than 50 percent of these systems may be in noncompliance with state rules or are failing to the surface. A research site at the Northeast Regional Correction Center (NERCC) near Duluth was established in 1995, involving approximately 50 private and public sector partners, to design, construct, and monitor the performance of advanced onsite treatment systems. The NERCC research site provided an excellent location to evaluate the first Puraflo peat filter systems in Minnesota. Third-party monitoring provides the onsite wastewater treatment industry, local and state regulators, contractors, and interested homeowners with an unbiased evaluation of year-round treatment and operational performance of this peat filter system, especially in a cold climate. This evaluation also provides data regarding the suitability of Minnesota peat as a possible substitute for the standard peat imported from Ireland.

This 24-page booklet is free. Request item #WWBLRE48.

Soft Path Integrated Water Resource Management: Update on Training, Research & Development Activities of the NDWRCP, Opportunities for New Projects & Collaboration

Nelson, Ph.D., Valerie I.; National Decentralized Water Resources Capacity Development Project

In February 2002, the National Decentralized Water Resources Capacity Development Project (NDWRCDP) co-sponsored a national workshop, "Distributed and Nonstructural Water and Wastewater Systems: Charting 'Soft Paths' to Integrated Water Resource Management." Two reports based on the discussion and conclusions of the workshop have already been released; the first outlines recommendations for federal policies, and the second de-

scribes funding, training, research and development needs. This 23-page report summarizes the training and research and development activities funded by the NDWRCDP and related National Community Decentralized Wastewater Demonstration Projects funded by the U.S. Environmental Protection Agency (EPA). This report also describes opportunities for new projects and collaborations with other organizations related to soft-path integrated water resource management. These potential projects have been identified by the author subsequent to the workshop and have been reviewed and discussed by the NDWRCDP Project Steering Committee (PSC).

This booklet is free. Request item #WW-BLMG32.

Technical Overview: Biological Filtration

Edward Winant; National Environmental Services Center

This 8-page technical overview focuses on biological filtration as an onsite wastewater treatment option. A biofilter, short for biological filter, is a secondary treatment process. Primary treatment refers to settling out of solids, a physical process, whereas secondary treatment comes after and usually involves biological treatment. Filtration is one of the more common secondary treatment processes. Filters are commonly constructed using sand, gravel, peat, or synthetic materials such as, foam, fabric, textile, or plastic. Biological treatment is a natural process, where bacteria living in the wastewater or in the environment consume organic contaminants in the waste stream. The basic idea of a filter is to provide a place for the bacteria to attach to while they eat the contamination in the effluent that passes by. Biofilters using foam, plastic, textile, or peat provide a high ratio of surface area to volume so the mechanism can support a large amount of bacterial growth while still allowing water to filter past. The difference in using a biofilter is mainly cost and maintenance. However, all of these systems provide effective pretreatment of residential wastewater, allowing it to be dispersed onsite, even with tight or low-impermeable soils.

The price of this booklet is $1.25. Request item #SFBLT002.

Technical Overview: Soil Absorption Systems

Edward Winant; National Environmental Services Center

Soil absorption systems (SAS) are the conventional and long-accepted solution for many onsite system applications. Many different configurations exist for soil absorption systems that include: trenches, beds, serial distribution, contour trenches, and low-pressure pipes. This overview discusses the use of soil for final treatment and dispersal of wastewater effluent. Each of the configurations mentioned above is discussed in detail along with advantages and disadvantages for each. Basic operation and maintenance techniques are detailed, and general cost ranges for each type of SAS are provided as well. This overview serves as an introduction for the various SAS configurations, highlighting each for the reader to compare and contrast and determine which SAS may be best for their site.

The price of this 12-page booklet is $1.25. Request item #SFBLT003.

See page 55 for other ordering options.

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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.

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Is Congress Turning Off the Tap for Clean Water Funding?

Note: The following is excerpted from a document produced by the Natural Resources Defense Council, a national, nonprofit organization of scientists, lawyers and environmental specialists dedicated to protecting public health and the environment.

Clean water is vital to safeguarding public health and the environment, yet our nation's waters are at risk; more than 300,000 miles of rivers and shorelines—and some 5 million acres of lakes—are considered "impaired" (polluted) by the U.S. Environmental Protection Agency (EPA). In the U.S., there are an estimated 8 million cases of infectious waterborne illnesses every year from drinking contaminated water, eating tainted shellfish, and swimming in polluted waters.

Cleaning up our lakes and streams will take a substantial commitment of resources, especially money. The EPA's Clean Water State Revolving Fund (SRF) is one of the principle sources of such funding. The Clean Water SRF offers long-term, low-interest loans to state and local governments to help them meet federal water quality standards by fixing old, decaying sewer pipelines, building and repairing wastewater treatment plants, and controlling other sources of water pollution.

State and local officials agree on the importance of this federal aid. "The Clean Water State Revolving Loan Fund is among the most successful federal programs and is responsible for significant water quality improvements nationwide," says Roberta Savage, Executive Director of the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA). "Now, more than ever, communities rely on this federal funding to tackle a wide array of water quality problems."

Clean Water at Risk

The EPA estimates that clean water infrastructure needs nationwide will cost $390 billion over the next 15 years. Funding to meet these needs will come from a variety of sources, including a hefty federal contribution. But consider these sobering statistics:

- Continual funding of water infrastructure is essential in the U.S. since many systems have antiquated pipes that are 50–100 years old and in need of replacement.
- ASIWPCA estimates that nationally there are $4.1 billion in projects ready to move forward in less than 90 days that are stalled due to the lack of funding. Funding these projects would help reduce pollution while creating jobs in those places.
- Since the Clean Water Act was passed more than thirty years ago, the federal government's funding for clean water infrastructure in America has decreased by 70 percent; today the federal government funds a mere 5 percent of national infrastructure costs.
- At the current rate of expenditure, the gap in funding for clean water and safe drinking water infrastructure would be more than half a trillion dollars by 2019, according to the EPA's 2002 *Clean Water and Drinking Water Infrastructure Gap Analysis*.

House Votes to Drain Clean Water Funds

Without ample Clean Water SRF funding, water infrastructure throughout the nation will be jeopardized. Unfortunately, the House Appropriations committee voted on July 22, 2004 to accept EPA's FY 2005 budget proposal, which would provide only $850 million in Clean Water SRF funding—a nearly $500 million reduction (37 percent) from last year's budget. This sets up a likely floor fight in the House when Congress resumes its session in September.

In the past, congressional appropriators have championed clean and safe water in the face of repeated presidential attempts to cut environmental funding. This year marks the first time that the House Appropriations committee has endorsed the Bush administration's drastic budget cuts for the popular and successful Clean Water SRF.

States, localities, and private sources working to address their water infrastructure problems cannot meet this funding gap alone. For many states, water quality needs are urgent—yet projects are already seriously under-funded.

State Funding At Risk

The House budget's across-the-board cuts for CWSRF are illustrated in the chart below.

Fighting for Clean Water Funding

Aside from the threat to America's long-term water needs, the House Appropriations committee's half-a-billion dollar reduction in funding for the Clean Water SRF would translate into a loss of nearly 25,000 jobs nationally. A diverse coalition of organizations supports a substantial increase in clean water funding.

Impacts on States of FY 2005 Budget Cuts to EPA's Clean Water SRF[1]
(in millions of dollars of budget authority)

State	Enacted Funding for FY 2004	Proposed Bush Budget/House Appropriations Committee	Net Decrease[2] Dollars	Net Decrease[2] Percentage
AL	15.0	9.5	-5.5	-36.7
AK	8.0	5.1	-2.9	-36.3
AZ	9.0	5.7	-3.3	-36.7
AR	8.8	5.5	-3.3	-37.5
CA	95.7	60.6	-35.1	-36.7
CO	10.7	6.8	-3.9	-36.4
CT	16.4	10.4	-6.0	-36.6
DE	6.6	4.2	-2.4	-36.4
DC	6.6	4.2	-2.4	-36.4
FL	45.2	28.6	-16.6	-36.7
GA	22.6	14.3	-8.3	-36.7
HI	10.4	6.6	-3.8	-36.5
ID	6.6	4.2	-2.4	-36.4
IL	60.5	38.3	-22.2	-36.7
IN	32.3	20.4	-11.9	-36.8
IA	18.1	11.5	-6.6	-36.5
KS	12.1	7.7	-4.4	-36.4
KY	17.0	10.8	-6.2	-36.5
LA	14.7	9.3	-5.4	-36.7
ME	10.4	6.6	-3.8	-36.5
MD	32.4	20.5	-11.9	-36.7
MA	45.5	28.8	-16.7	-36.7
MI	57.6	36.5	-21.1	-36.6
MN	24.6	15.6	-9.0	-36.6
MS	12.1	7.6	-4.5	-37.2
MO	37.1	23.5	-13.6	-36.7
MT	6.6	4.2	-2.4	-36.4
NE	6.8	4.3	-2.5	-36.8
NV	6.6	4.2	-2.4	-36.4
NH	13.4	8.5	-4.9	-36.6
NJ	54.7	34.6	-20.1	-36.7
NM	6.6	4.2	-2.4	-36.4
NY	147.8	93.6	-54.2	-36.7
NC	24.2	15.3	-8.9	-36.8
ND	6.6	4.2	-2.4	-36.4
OH	75.4	47.7	-27.7	-36.7
OK	10.8	6.9	-3.9	-36.1
OR	15.1	9.6	-5.5	-36.4
PA	53.0	33.6	-19.4	-36.6
RI	9.0	5.7	-3.3	-36.7
SC	13.7	8.7	-5.0	-36.5
SD	6.6	4.2	-2.4	-36.4
TN	19.4	12.3	-7.1	-36.6
TX	61.2	38.8	-22.4	-36.6
UT	7.1	4.5	-2.6	-36.6
VT	6.6	4.2	-2.4	-36.4
VA	27.4	17.4	-10.0	-36.5
WA	23.3	14.7	-8.6	-36.9
WV	20.9	13.2	-7.7	-36.8
WI	36.2	22.9	-13.3	-36.7
WY	6.6	4.2	-2.4	-36.4
A.S.*	1.2	0.8	-0.4	-33.3
GU	0.9	0.6	-0.3	-33.3
NMI**	0.6	0.4	-0.2	-33.3
PR	17.5	11.1	-6.4	-36.6
VI	0.7	0.4	-0.3	-42.9
I.T.***	20.1	12.7	-7.4	-36.8
	31,342.0	**850.0**	**-492.0**	**-36.7**

(1) CWSRF: the Clean Water State Revolving Fund, which provides long-term, low-interest loans to states for sewage plant construction.

(2) Net Decrease: the total decrease in funding from all listed programs from the FY 2004 estimate to the FY 2005 proposal.

(3) Totals may not add due to rounding.

*Amer. Samoa **N. Mariana Islands ***Indian Tribes

Executive Director

National Environmental Services Center

West Virginia University

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.nrcce.wvu/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.

National Environmental Services Center

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Constructed Wetland Performance in Cold Climates

Federal Sources of Funding for Wastewater Treatment Projects

New Indiana Wastewater Training Center

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A 25-YEAR HISTORY OF THE ONSITE INDUSTRY: Where have we been and where should we be going?

Got an Opinion?

Who wants your opinion?

The editor of the *Small Flows Quarterly* does, 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.

We are open to all aspects of small-flow wastewater treatment. 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

Community Snapshot From Our Readers

Crivitz, Wisconsin

The village of Crivitz, Wisconsin, was originally settled in the 1870s by a German family. Today, the village still has many residents of German descent and maintains a relationship with its sister city in Germany, which bears the same name. Crivitz is located in scenic Marinette County in the northeast portion of the state, which is famous for its waterfalls. Tourism in the area centers around water, including fishing, whitewater rafting, and waterfall tours, making the job of Crivitz's utilities supervisor, Glen Franzen, all the more critical. He and two other employees make up the village's entire public works department.

According to Franzen, Crivitz's wastewater treatment system, an activated sludge compact plant, serves all of the village's 1,050 residents or 500 households within 870 acres. Franzen estimates that he spends 10 hours per week operating and maintaining the wastewater plant itself, measuring dissolved oxygen and changing the sludge wasting grate, as well as performing general cleaning and pump maintenance. In addition, Franzen and his crew must maintain the wastewater collection system and the drinking water and distribution systems.

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