As fresh water supplies dwindle and become more expensive in many areas of the country, using water once and then ‘throwing it away’ is becoming too costly, both financially and practically. The idea of removing the less-concentrated graywater from the home’s waste stream is attractive to engineers and homeowners alike as a way to reduce waste load and prolong the life of the system.

The average person generates approximately 40 gallons of graywater per day — a significant amount of water. (Refer to the table on page 5 for the average amounts of water generated by various household activities.) Careless misuse could mean creating a huge health risk. Can we reuse this water safely for such activities as watering the lawn, flushing the toilet or washing the car?

Recently, the state of Arizona issued new statutes allowing wastewater generated from a household’s shower, bathtub, bathroom sink, and washing machine. Water from the kitchen sink and dishwasher is usually not considered graywater, due to increased bacteria and should be sent to the septic system for treatment.

**Blackwater** – wastewater generated from a household’s toilet.

**Separate system** – a treatment strategy where the waste streams are separated into graywater and blackwater and each effluent is sent to its own individual treatment system. Typically, the separate systems employ different technologies.

**Graywater** – wastewater generated from a household’s shower, bathtub, bathroom sink, and washing machine. Water from the kitchen sink and dishwasher is usually not considered graywater, due to increased bacteria and should be sent to the septic system for treatment.

**What is graywater?**

The precise definition differs from state to state, but generally speaking, graywater is considered to be all the water from the sinks, bathtubs and showers, and the washing machine. Dishwasher and kitchen sink water are sometimes considered too full of potential contaminants and usually should be sent on to the main wastewater treatment system.

While the levels of contaminants are much lower as compared to wastewater that includes blackwater, graywater is not just soapy water. (Refer to the table on Page 4 for characteristics of domestic water.) *E. coli* is frequently present and can cause illness to humans if allowed to come into contact with it.

(Preliminary analysis of graywater reuse.)

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**Key Terms**

- **Graywater**: wastewater generated from a household’s shower, bathtub, bathroom sink, and washing machine.
- **Blackwater**: wastewater generated from a household’s toilet.
- **Separate system**: a treatment strategy where the waste streams are separated into graywater and blackwater and each effluent is sent to its own individual treatment system. Typically, the separate systems employ different technologies.

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**Peripheral Systems**

- **Wastewaterenerated from a household’s shower, bathtub, bathroom sink, and washing machine.**
- **Careless misuse could mean creating a huge health risk.**
- **Can we reuse this water safely for such activities as watering the lawn, flushing the toilet or washing the car?**

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**Table 1**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Amount of Water (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dishwasher and kitchen sink</td>
<td>10</td>
</tr>
<tr>
<td>Tub and shower</td>
<td>20</td>
</tr>
<tr>
<td>Bathroom wash</td>
<td>5</td>
</tr>
</tbody>
</table>

---

**Preliminary analysis of graywater reuse.**

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**References**

- **Graywater: Safe Reuse and Recycling**
- **Winter 2002 Vol. 13, No. 1**
- **Small Community Wastewater Issues Explained to the Public**
- **NESC**

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**Image**: A man and a woman are shown using a bathtub and a sink, respectively, with the text “Graywater: Safe Reuse and Recycling.”
from various households indicates that E. coli is higher where children are living.)

In all instances, blackwater always must be disposed of through a separate treatment system, and the graywater system must be plumbed so that it can be diverted to the sewage system, if necessary.

Is graywater use legal?

Another good question – and it all depends on your state’s regulations. The majority of states require graywater to be treated as carefully as blackwater, sending it through a separate system and purifying it to the same high standard before being dispersed. A few states are considering loosening the restrictions, especially in the Southwest where residents experience frequent water shortages. The National Small Flows Clearinghouse maintains an extensive regulations database with searches available upon request. (Please refer to the sidebar on Page 7 for details). Homeowners interested in graywater reuse also should contact their state or local health department for regulatory clarification or interpretation.

Depending on your state’s regulations, technology for graywater reuse can be as simple as saving the rinse water from the clothes washer to rather complex treatment systems, such as one which the graywater flows to an aerobic treatment unit, then to a recirculating filter, and it is only ready for reuse after being disinfected with an ultraviolet filter.

Most state regulations do not differentiate between gray- and blackwater systems. Some states allow graywater systems to be installed; however, in many cases, it must meet all requirements of the regulations that apply to a blackwater system, including a properly sized septic tank and absorption field and all setback requirements. In these states where separate systems are allowed, technologies are quite similar to those used in any other onsite wastewater treatment systems: for example, aerobic treatment units, septic tanks, sand filters, and disinfection methods.

Table 1

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>- recharges groundwater instead of depleting it</td>
<td>- if mishandled, can spread disease</td>
</tr>
<tr>
<td>- uses nutrients in the graywater to support plant growth</td>
<td>- becomes smelly if stored more than 24 hours</td>
</tr>
<tr>
<td>- reduces energy and chemical use</td>
<td>- may damage soil from salt buildup</td>
</tr>
<tr>
<td>- lowers water bills</td>
<td>- may effect movement of waste in sewer due to less water for transport</td>
</tr>
</tbody>
</table>

Tips for Homeowners Considering Graywater Reuse

When designing a household graywater reuse system, water-efficient plumbing fixtures are recommended. Examples of these are low-flow shower heads, faucet flow restrictors, and low-flow toilets. Depending on the state, these water-saving devices may be mandatory.

Graywater systems are easiest to install in new construction. Residences already constructed on concrete slabs or crawlspace are difficult to retrofit for a separate graywater system.

To further reduce water demand, it is recommended that the homeowner consider reducing turf areas (lawn grasses typically are especially high water-demand plants) and replacing them with native plants more tolerant of dry conditions. A special horticultural consideration is that graywater typically has an alkaline pH, and therefore should not be used on acid-loving plants. ☝
Arizona regulations allow for home irrigation with graywater

“Using your graywater is a great way to practice the motto ‘Reduce, Reuse, Recycle.’ By using graywater, you reduce the need to pump precious groundwater, and you reuse a resource so valuable in the desert.” So says the Water Conservation Alliance of Southern Arizona (CASA), an organization representing various water districts and the U.S. Bureau of Reclamation.

The Arizona Department of Environmental Quality has recently issued regulations by allowing homeowners to use reclaimed water. The new guidelines make it simple and affordable for residents to legally use graywater for landscape irrigation. Quite a few restrictions must be observed, but it is a giant step forward in the area of reusing graywater.

After in-depth research revealed the widespread reuse of graywater by homeowners (the most common use is surface irrigation of shade or ornamental trees), Arizona officials decided to make the practice allowable by law without a permit under limited conditions.

As described in the regulations, homeowners may recycle untreated graywater from washing machines, bathroom sinks, bathtubs, and showers, but only if the residence lies outside of an active floodplain. The graywater must originate from the residence and be used only for landscape irrigation. Specifically stated, the graywater from kitchen sinks, dishwashers, and toilets is not to be included. Special mechanical considerations include requiring an emergency discharge to the septic or sewer system in case of system failures, and all piping should be of PVC or ABS. Storage containers must be secured with bug- and childproof covers.

The Desert House Experiment

Desert House, a residential water and energy efficiency demonstration project located at the Center for Desert Living in the Phoenix Desert Botanical Garden, has been using graywater for landscape irrigation since 1996. The system uses the water retained from showers, baths, sinks, and washing machines resulting in an annual water savings of 11,370 gallons.

Continued on following page
Arizona regulations allow for home irrigation with graywater

Continued from previous page

Desert House has recently finished a 2-year study on the effect on the landscape plants being irrigated with graywater around the residence. The system is a drip system, buried a few inches underground. The study revealed no accumulated effect on the plants or the surrounding soil besides a slight increase in boron, probably from soap. And although elevated, the boron levels detected were still below acceptable levels.

The regulations stipulate that homeowner irrigation systems may only be flood or drip types (no spray systems, for instance) and caution against allowing graywater to pool, which creates a health risk. Graywater irrigation is for landscape plants only, never for plants intended for human consumption.

Reuse Increasing

When asked about the popularity of the graywater recycling program, Val Little, manager of Water CASA explains, “A year after becoming the law of the land, we are having a tough time staying ahead of the demand: the demand for more information about putting together a system, the demand for the dual plumbing of new construction, and the demand for a roster of folks who can and will specialize in doing graywater retrofits.”

Water CASA is currently developing a booklet to help homeowners analyze their own landscape water needs and their graywater accessiblity to determine whether or not a graywater retrofit makes sense. “Our county is asking us to request that all new housing stock be dual plumbed for graywater, and we are hoping to get our local plumbing contractors, etc., to work with us on generating a list of possible folks to do the retrofits that the public wants.” Water CASA has a great Web site at www.watercasa.org with lots of water-saving tips for homeowners.

### Table 2

<table>
<thead>
<tr>
<th>Water Source</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic Clothes Washer</td>
<td>Bacteria, bleach, foam, high pH, hot water, nitrate, oil and grease, oxygen demand, phosphate, salinity, soaps, sodium, suspended solids, and turbidity</td>
</tr>
<tr>
<td>Automatic Dishwasher</td>
<td>Bacteria, foam, food particles, high pH, hot water, odor, oil and grease, organic matter, oxygen demand, salinity, soaps, suspended solids, and turbidity</td>
</tr>
<tr>
<td>Bath tub and shower</td>
<td>Bacteria, hair, hot water, odor, oil and grease, oxygen demand, soaps, suspended solids, and turbidity</td>
</tr>
<tr>
<td>Sinks, including kitchen</td>
<td>Bacteria, food particles, hot water, odor, oil and grease, organic matter, oxygen demand, soaps, suspended solids, and turbidity</td>
</tr>
<tr>
<td>Evaporative Cooler</td>
<td>Salinity</td>
</tr>
</tbody>
</table>

Adapted from Water Quality Characteristics of Selected Domestic Wastewater, 1996, New Mexico State University Agricultural Communications.
Minnesota projects treat graywater separately

Unlike Arizona, Minnesota does not suffer from a shortage of water. Rather there often is too much water. Many of the remaining building sites in the state are adjacent to one of thousands of small lakes, and generally, these lots are too small for standard drainfields. An additional problem lies with the state’s geology: the underlying karst topography allows for direct recharging of the groundwater.

Success with separate systems

To demonstrate ways to reduce waste loads and to downsize the required drainfield area for onsite wastewater treatment systems, the caretaker’s residence at a county-owned park was retrofitted in 1993 with separate wastewater systems for graywater and blackwater. A range of public and private organizations and agencies worked together to complete this demonstration project, including the Minnesota Pollution Control Agency, the Rochester Public Utilities, the Peoples Cooperative Power Association and the South Zumbro Watershed Partnership. However, the primary partners were the Olmsted County Water Resources Center and the Equaris Corporation. Equaris (formerly Alascan®) is an engineering firm addressing sustainable onsite water treatment and wastewater recycling, specifically wastewater separation treatment coupled with nutrient and water reducing graywater reuse technologies.

Equaris has been developing alternative technologies for wastewater treatment since the 1980s. Working for the Alaska National Guard, as well as for private homeowners, the firm’s engineers have developed several new systems that provide sustainable onsite water treatment and wastewater recycling solutions, earning several patents for their efforts.

The firm’s main concern with current waste treatment systems is the use of so much water. Rather then using the mainstream approach of ‘solution to pollution is dilution,’ its intent is to reduce the amount of water needed for waste treatment and demonstrate how the water can truly be reused.

At the caretaker’s residence, the firm installed a composting blackwater system and an aerobic graywater treatment system to take care of the separated waste stream. Wastewater from the sink, bath, dishwasher, and clothes washer were sent to a tank for settling, aeration, and clarification, and then discharged to an outside dosing tank. Effluent was sent from the dosing tank to a drainfield. The graywater system was closely monitored and was calculated to have achieved a 90 percent or greater reduction in loadings of total nitrogen, biochemical oxygen demand, and suspended solids to the drainfield.

No discharge system now online

With the success of the park project, Equaris has expanded its use of a totally closed loop system, meaning that all water is reused within the house—there is no discharge. This project came about when the homeowner learned that due to poor soil conditions, an especially expensive wastewater treatment system would be necessary, and an extra-deep well would have to be dug due to high nitrate levels in the water table. The homeowner was intrigued.

Table 3

<table>
<thead>
<tr>
<th>Source</th>
<th>National Average (liters per capita per day)</th>
<th>Percent of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clothes washer</td>
<td>42.4</td>
<td>30</td>
</tr>
<tr>
<td>Shower/bath</td>
<td>39.4</td>
<td>23</td>
</tr>
<tr>
<td>Toilet</td>
<td>37.9</td>
<td>21</td>
</tr>
<tr>
<td>Faucets</td>
<td>56.4</td>
<td>20</td>
</tr>
<tr>
<td>Dishwasher</td>
<td>4.2</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>5.7</td>
<td></td>
</tr>
<tr>
<td><strong>Total indoor water use</strong></td>
<td><strong>185.8</strong></td>
<td></td>
</tr>
</tbody>
</table>

(From the American Water Works Association, 1997)
Minnesota projects treat graywater separately

Continued from previous page

by the idea of living in a home so environmentally-friendly, so the new residence was designed so rainwater could be collected from roof drains and one of Equaris’s separation systems was installed to handle the wastewater.

The home’s wastewater is separated into the blackwater, which flows to a composting waste chamber, and the graywater is pumped to a surge tank (for flow control), an aeration tank, and then to a clarification tank. Effluent is pumped across several filters and then to a reverse osmosis filter. Ultraviolet light is used for disinfection. The resulting product meets and surpasses drinking water quality standards.

Elston noted that most households require up to 75 gallons per day per person, but with this total reuse system, this need is reduced to five to seven gallons per day per person. The only real loss from the system is to the toilet, and makeup water is obtained from the rain collected from the roof.

Maintaining the system is fairly simple. On a quarterly cycle, the filters will have to be changed and the ultraviolet bulbs should be changed annually. As for cost, Elston admits the price is steep: $20,000 for the entire system. But at this site, the homeowner would have had to incur much greater expenses for the extensive well and drainfield system necessary.

In regard to any special permitting required for this project, Elston chuckled and pointed out that “You don’t need a permit if you aren’t discharging anything.” He sees great potential for these ‘closed loop’ systems in any area where fresh water is scarce or where it is impossible to install the usual treatment system. “This technology avoids zoning issues and really gives possibility to typically unbuildable property,” he said.

More information about the specific applications of Equaris Corporation’s technologies can be found on their Web site: www.equaris.com or by calling them at (763) 383-5138.

### Reuse Ideas

Here are a few easy ways to recycle ‘slightly used’ water in your household. This water can be used to pour-flush a toilet, supplement the washwater in your clothes washer, or irrigate inside or outside plants.

- Collect the ‘warm-up’ water from your shower or tub.
- Save the rinse water when rinsing fruits and vegetables at the kitchen sink.
- Reuse the condensed water from the air conditioner or dehumidifier.

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Graywater Reuse

Graywater Reuse

Continued from previous page

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Public Health and Environmental Quality Training Planned

Few things are more important to small communities than protecting the health of their residents and fostering sustainable economic progress. The National Environmental Training Center for Small Communities (NETCSC) is holding its third annual Environmental Training Institute for Small Communities titled "Public Health and Environmental Quality--Small Communities in the 21st Century," August 5-9, 2002 in Morgantown, West Virginia.

The training sessions will address financial, managerial, and regulatory issues critical for managing small drinking water and wastewater systems. Assistance providers, environmental trainers and consultants, state and local regulatory officials, consulting engineers, local officials, board members, utility managers and staff, and community and regional planners are invited to attend.

The sessions will help small community decision makers provide high-quality drinking water and adequate water treatment to citizens. These services are essential for public health, environmental quality, and economic growth in small communities.

Topics to be addressed at the 2002 Training Institute include:
- drinking water security issues,
- managing small drinking water and wastewater systems,
- GASB 34 financial accounting and reporting standards,
- model training programs that successfully reach local officials,
- alternative wastewater technologies, and
- the new drinking water requirements for arsenic and their implications for small communities.

NETCSC is a National Environmental Services Center program that provides environmental training to communities with fewer than 10,000 residents. NETCSC welcomes Institute co-sponsors and exhibitors. For more information or to participate in the Institute, see NETCSC's Web site at http://www.netc.wvu.edu. You may also call Training Specialist MaryAlice Dunn at (800) 624-8301 or (304) 293-4191 ext. 5538 or e-mail her at mdunn@wvu.edu.

Wastewater Discussion Group
Available Online

Do you want to talk about wastewater issues? The NSFC maintains an online discussion group for wastewater professionals and other individuals with an interest in small community wastewater issues.

Anyone wishing to post questions or to stimulate a wastewater-related dialogue is encouraged to participate. Users may read messages that others have posted, reply to them, and ask questions or make statements of their own.

Visit the NSFC Wastewater Discussion Group at http://www.nsfc.wvu.edu/forum/index.html.


Regulations Database

The NSFC maintains an extensive collection of regulations for onsite wastewater treatment systems in 48 of 50 states. This collection can help customers seeking information for a particular state or those who want to compare regulatory structures between states. It is particularly useful to states seeking assistance in revising regulations.

The Regulations Database helps customers not only by allowing them to request onsite wastewater regulatory documentation, but by helping the NSFC determine if it is meeting the growing and changing needs of the regulatory community.

For example, if an individual wants a summary of what technologies are permitted in each state, an NSFC technical assistant can compile this information. The NSFC works with state agencies to regularly update its holdings and ensure that agency officials are aware of this resource.

Please note that while information from the database is provided to customers upon request, NSFC does not interpret regulations for customers.

Plans are under way to make the Regulations Database available on the Web. In the meantime, you may call the NSFC at (800) 624-8301 or (304) 293-4191 to request a search.

Additional products from state and national regulatory entities, such as the EPA, are available from the NSFC as well. For information about these regulatory products, call the NSFC at (800) 624-8301 or (304) 293-4191.
This issue gives an overview of some of the most popular low-flow and waterless toilets on the market. The mechanics of several styles are presented as well as case studies where alternative toilets were installed. Item #SFPLNL22.

Evaluation of the Performance of Five Aerated Package Treatment Systems
Published by the Virginia Polytechnic Institute and Virginia state University’s Department of Civil Engineering and Department of Crop and Soil Environmental Sciences, this book evaluates the performance of five aerated package treatment systems. This evaluation costs $5. Item #WWBKRE24.

Article “Graywater Use – Still a Gray Area” Reuse is an integral part of ecosystem management, and the concept of separating graywater from a home’s waste stream to supplement a family’s water supply is becoming increasingly popular. But the actual process and permitting can be quite complex. Item #SFQUNL05.

For wastewater information, call the NSFC at (800) 624-8301 or (304) 293-4191