Keeping Up with Water Reuse at the Point of Use

By Kelly A. Reynolds, MSPH, Ph.D.

Reduce, reuse, recycle: a mantra many of us chant in relation to being good stewards of the planet. For others, it is a necessity for survival in regions of growing need and limited resources. One unlimited resource, however, is human excreta. While human waste has been reused for a variety of purposes—from irrigation and drinking to fertilizing crops to creating art (yes, even fecal sculptures!)—the developed world is generally reluctant to repurpose this precious resource. Through technology and education, however, there appears to be a cultural shift occurring related to wastewater reuse perceptions. With increasingly available technology for treating water for reuse, more people and places can be expected to jump on the bandwagon. POU treatment technologies have a key role to play in terms of consumer safety in a world of recycling.

Wastewater, excreta and graywater reuse

Water reuse was rapidly accepted in the agricultural and industrial sector, but is becoming more mainstream among the general US public. While the benefits are clear—as we move forward into what could be a common practice of essentially decentralized wastewater treatment—the costs must be carefully weighed and the risks minimized.

Household wastewater production is divided into two major categories: blackwater and graywater. Water from toilets is considered black, while water from just about any other source (i.e., baths, sinks, washing machines, dishwashers) is considered gray. Graywater is the most widely accepted reuse product where the primary application is for irrigation. In the developing world, however, blackwater is often used for crop watering and fertilization. Due to the increased level of contaminants, particularly disease-causing microbes, blackwater requires a higher level of on-site treatment before use. Chemicals and microbes known to cause cancer and/or disease in humans are found in graywater supplies; however, technology exists to purify this water for safe reuse. The question is, how savvy is the consumer at recognizing the need and the effective application of POU treatment options for reused household water sources?

Approximately 70 percent of household water use results in graywater. Thus, it seems obvious that this resource should be captured. One roadblock to decentralized wastewater reuse is the individual cost. Collecting and reusing this water for irrigation or toilets is relatively easy but can be expensive post-construction. Some regions in the US are offering consumer incentives for installing water reuse systems in their homes. Another argument has been raised that water is never lost and that it should be reused via natural hydrologic cycles, or more controlled, centralized wastewater treatment systems. The fear is that the increase of decentralized wastewater treatment could short natural supplies or introduce unnecessary risks to individuals and communities who do not treat the contaminated supply properly.

Environmentalists and health officials in Israel have weighed these issues extensively. Decentralized treatment of graywater was illegal due to fears from the Ministry of Health related to improper treatment and subsequent health risks. Legalization of on-site water reuse, however, is now pending. Israel reportedly reuses 80 percent of household wastewater and has turned their marketing of reuse technologies into a billion-dollar industry.

Harmful graywater contaminants

Many studies have been conducted over the years to evaluate the safety of graywater. One study found that graywater, and soil irrigated with graywater, had a statistically significant increase in fecal bacteria. Certain sources, or household conditions, impacted the level of contaminants. Use of graywater from kitchen sinks and the presence of children in the home were associated with higher levels of fecal bacteria. In some instances, bacterial counts from kitchen sink water are as high as blackwater, presenting an unexpected risk for reuse. An ill person in the home could shed millions of harmful bacteria and viruses that could be expected to contaminate bath and washing machine water. Exposure to fecal bacteria and viruses at very low levels can cause disease in humans and thus the risk of exposure to, and illness from, pathogens in graywater must be considered as part of the overall cost of graywater reuse. During storage, bacteria (i.e., *Salmonella* and *Shigella*) can persist for months, and may even increase in numbers, further increasing exposure risks. The risks of contaminants in graywater should not necessarily discourage use of the product but rather encourage proper risk assessment and POU treatment for risk mitigation. More microbes in the environment of the household could lead to contamination of on-site drinking water supplies, which may also need to be considered for POU treatment.

Guidelines for safe wastewater reuse

Consumers need consistent information on the safe use of wastewater, excreta and graywater, and a consortium of global drinking water and sanitation agencies delivers. Specifically, guidelines for the safe use of human waste in developing countries for food production and health have been prepared by the World Health Organization (WHO), the Food and Agricultural Organization of the United Nations (FAO), the International Development Research Centre (IDRC) and the International Water Management Institute (IWMI), along with

two information kits clarifying concepts in, and expanding discussions on, the guideline content.

Much of the guidance focuses on the mitigation of pathogen exposures in wastewater farming. Suggestions are given for low-cost, on-site treatment and the use of a risk-assessment approach to set practical health-based targets that are necessary for the development of national standards for wastewater quality and reuse. In the US, and particularly in the arid Southwest region, guidelines are available to residents on how to safely and effectively reuse graywater. One has only to check the websites of local health departments, environmental quality departments or water utilities. California has been a pioneer state for water reuse and promotion as presented on the websites of the Bureau of Reclamation (www.usbr.gov/main/library), Department of Water Resources California (www.dpla.water.ca.gov/sd/recycling/so_cal_reclaim&reuse.html), and the Water Reuse Association (www.waterreuse.org).

POU water treatment needs

Wastewater reuse will continue to increase in both individual and municipal treatment scenarios. In 2008, the city of Tucson, AZ issued an ordinance requiring all new single-family and duplex residential dwellings to construct separate discharge systems for graywater from washing machine hook-ups. Similar requirements for collection of graywater from showers, bathtubs and other household drains are also included in the ordinance, in order to plan for future graywater reuse systems. To minimize risks of graywater reuse, the following suggestions have been published by the Washington State Health Department:

"Graywater does need to be managed properly to avoid exposing people to pathogens, harming plants, clogging the irrigation system, and creating unpleasant odors. Management options used to address the risk associated with graywater re-use include using a graduated framework to manage risks.

Potential risks can be reduced by regulating the following:

- Limiting the use of direct routing for graywater to the lowest risk sources
- Limiting the volume of graywater allowed for direct routing to the irrigation system
- Ensuring that untreated graywater does not flow to surface or ground water
- Ensuring that graywater stays below the surface by specifying the correct cover material
- Limit storage of untreated graywater to less than 24 hours
- Require filters be used to remove lint, hair and other solids
- Not allowing hazardous chemicals down the drain and recommending graywater tolerant plants and plant friendly cleaning products be used
- A diverter should be required to allow residents to divert the graywater to the building's wastewater system if people in the house are sick or during times irrigation is not needed."

Although guidelines are available to minimize the risk of reuse practices, what are the consequences if the guidelines are followed? There is currently no mechanism to evaluate household compliance with suggested guidelines. Problems with the risk-reducing strategies listed above are that sick individuals will shed pathogens for days prior to (and sometimes weeks after) symptoms occuring (if symptoms even manifest), making selected diversion of contaminated wastewater difficult. Further, it may be difficult to assess whether or not graywater contaminants flow to drinking water supplies. Whether from a centralized or decentralized source, water reuse should be implemented in conjunction with appropriate drinking water treatment technologies. Given that the water cycle eventually comes full circle, proper wastewater disposal remains important for protecting all drinking water supplies.

References

1. *Reuters*. Israeli wastewater currently recycled in state treatment facilities. *Haaretz*, November 2010.

2. Cassanova, L.M.; Little, V.; Frye, R.J.; Gerba, C.P. 2001. A survey of the microbial quality of recycled household graywater. *Journal of the American Water Resources Association*. 37(5): 1313-1319.

3. Ottoson J.; Stenstrom, T. 2003. Faecal Contamination of Graywater and Associated Microbial Risks. *Water Research*. 37(3):645-655.

4. Rose, J.B.; Sun, G.; Gerba, C.P.; Sinclair, N.A. 1991. Microbial quality and persistence of enteric pathogens in graywater from various household sources. *Water Research*. 25(1): 37-42.

5. World Health Organization (WHO). 2006. Third edition for the *Guidelines for the Safe Use of Wastewater, Excreta and Graywater in Agriculture and Aquaculture*.

6. Schneider, L. 2009. Graywater reuse in Washington state. *Rule Development Committee Issue Research Report*. Washington State Department of Health. Wastewater Management Program. 16 pp.

About the author

Dr. Kelly A. Reynolds is an Associate Professor at the University of Arizona College of Public Health. She holds a Master of Science Degree in public health (MSPH) from the University of South Florida and a doctorate in microbiology from the University of Arizona. Reynolds has been a member of the WC&P Technical Review Committee since 1997. She can be reached via email at reynolds@u.arizona.edu