Water Softener BACKWASH and HOMEOWNER Onsite Systems

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Hard water is hard on the homeowner; you have to use more soap, it makes your skin itch, and has a number of unpleasant effects on fixtures and appliances. A water softener does away with those problems. The question that has been plaguing both water and wastewater industries for decades, however, is whether or not a water softener is hard on an onsite wastewater treatment system.

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Why Use Water Softeners?

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

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

Classifications of Hardness in Water

The harder the water, the more problems it creates for the homeowner. Water hardness is often expressed in grains of hardness per gallon of water (gpg), using the classifications in the table on page 8.

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Classification	gpg	mg/L (milligrams per liter) or ppm (parts per million)
Soft	0.35	0–60
Moderate	3.50–7	61–120
Hard	7.00–10.5	121–180
Very Hard	>10.5	>180

Public water companies can tell homeowners the hardness level of their water. Water hardness can also be tested by laboratories, some local health departments, and water treatment equipment dealers. For less than $10, a homeowner can purchase a water testing kit from a swimming pool supply store and quickly and easily determine water hardness level.

How Water is Softened

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

Water Softener Regeneration

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

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

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

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

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

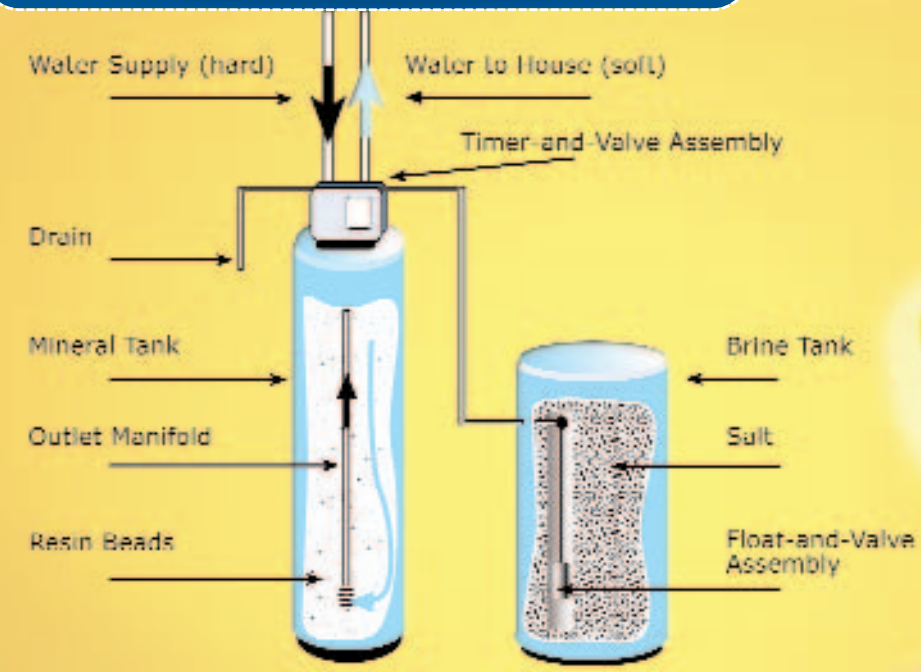
The number of times the tank is regenerated, the amount of salt used, and the volume of backwash produced depends upon a number of factors, including the hardness of the water, the volume of water used, the size of the water softener, and the capacity of the resins to remove calcium and magnesium, but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

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

Regulations and Research

Since the 1970s, many communities and states have enacted regulations that ban the disposal of water softener backwash into onsite

Water Softener Basics



systems based on the following assumptions:

- backwash contains high brine concentrations that can be harmful to the biological functions of the septic tank,
- regeneration of the water softener increases the hydraulic burden upon the septic system, adversely affecting its performance, and
- sodium from water softener discharge could cause changes in soil chemistry, making the soil less suitable to treat and dispose of effluent.

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

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

Research Results

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

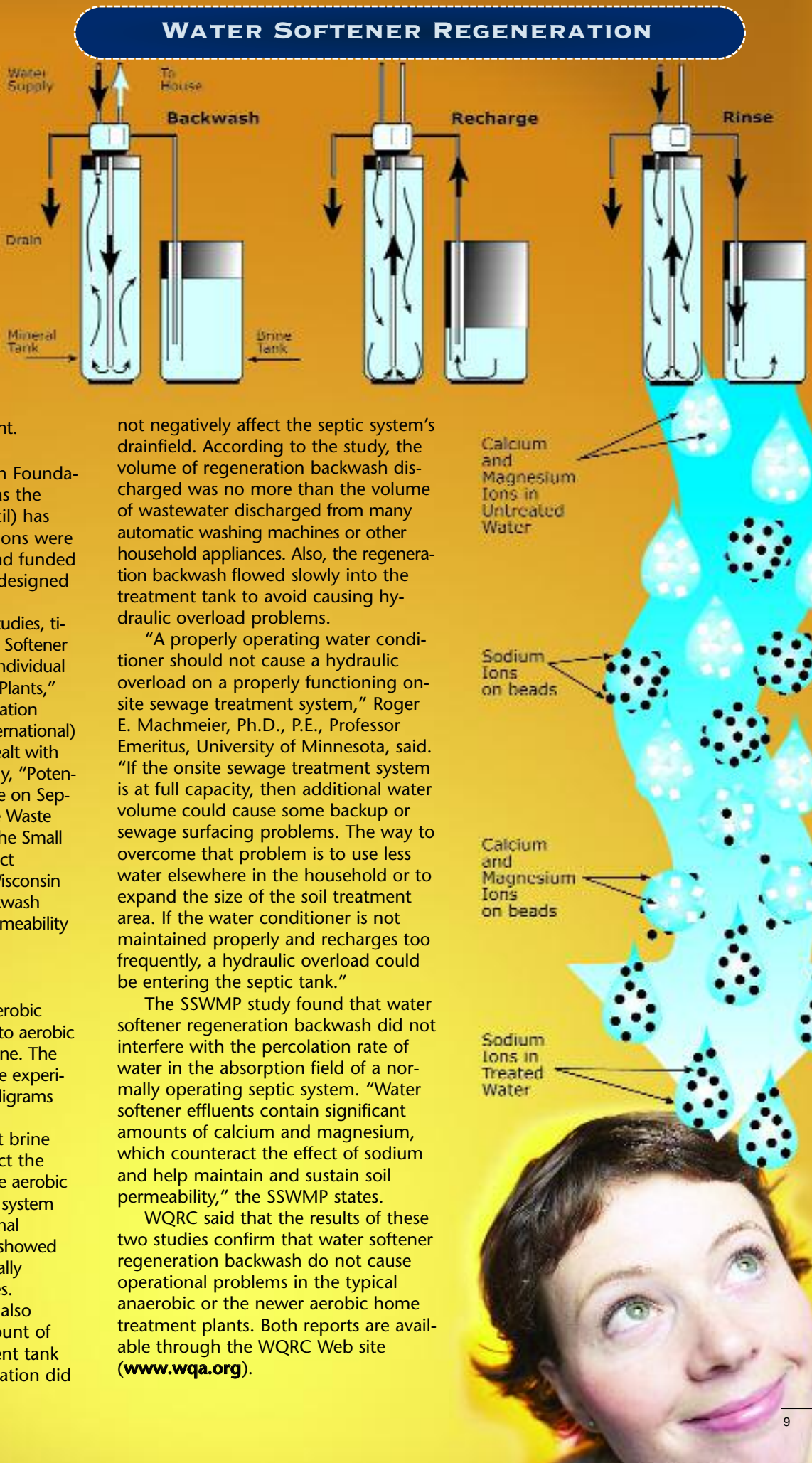
NSF researchers found that brine wastes did not negatively affect the bacterial population living in the aerobic treatment tank, even when the system was loaded with twice the normal amount of brine. Instead, tests showed that water softener wastes actually helped with treatment processes.

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

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

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

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



Other Views

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

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

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

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

Iron Content in Water

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

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

State Regulations

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

In February 2003, the Montana Department of Environmental Quality created the DEQ4 Circular, which stated that "back flush water from water softeners must be excluded from sewer systems." Water softener manufacturers balked at this statement, prompting Ray Lazuk, a subdivision program manager with the Montana Department of Environmental Quality, to issue a survey to sanitarians throughout the state asking about their experiences with backwash on septic system drainfields.

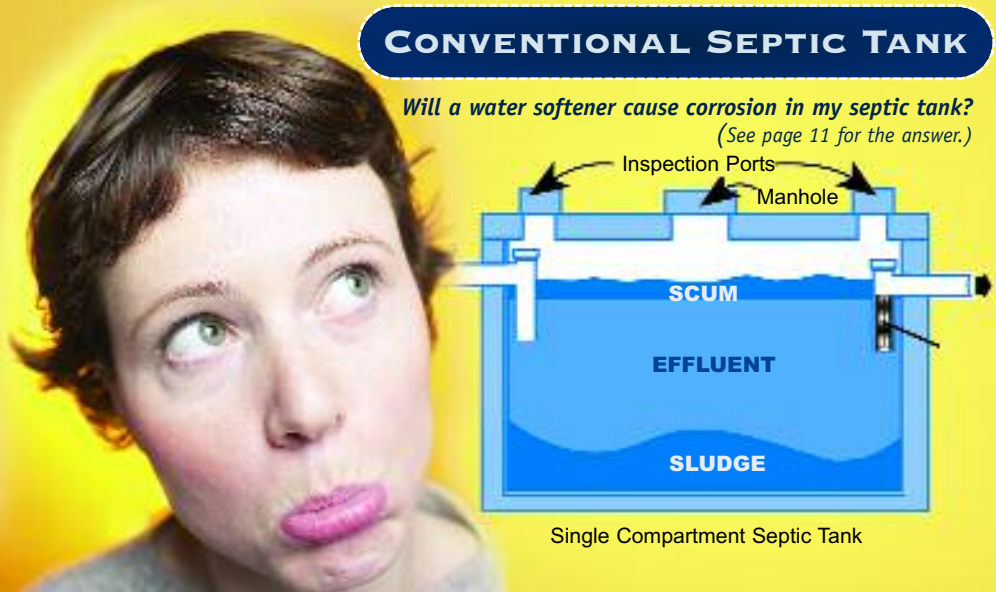
"Responses to the survey showed that some sanitarians believed that backwash could be a problem in clay soils, causing a hydraulic overload, and, therefore, the water department should be contacted for guidance," Lazuk said. "Other sanitarians responded that if a water softener is properly operated and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

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

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

EPA Fact Sheet

In its *Onsite Wastewater Treatment Systems Special Issues Fact Sheet 3: Water Softeners*, EPA states "Home



Single Compartment Septic Tank

water softeners, which periodically generate a backwash that is high in sodium, magnesium, and calcium concentrations, can affect wastewater treatment processes and the composition and structure of the infiltration field biomat and the underlying soil. However, attempts to predict whether impacts will occur and to estimate their severity are difficult and often inconclusive." The fact sheet cites the studies conducted by SSWMP and NSF and lists some of the studies' conclusions. The fact sheet neither endorses nor denounces the claims made in these studies.

Septic Tank Corrosion

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

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

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

Using Softened Water Outdoors

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

Health Risks

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

Possible Solutions

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

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

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

Future Research

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

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

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

Responsibility of Water Softener Manufacturers

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

For more information, contact you local county extension office or state health department, the National Precast Concrete Association at **www.precast.org**, the University of Minnesota Extension Service at **http://septic.umn.edu/homeowner/index.html**, Bounds at (800) 348-9843, Gorman at **jgorman@ wvu.edu**, Krukowski at **Eleanor.Krukowski@dep.state.nj.us**, Lazuk at **rlazuk@mt.gov**, and Spach at **Ken.Spach@ mail.state.ky.us**.