Groundwater—Nature’s Hidden Treasure
by Don Chmielewicz

A typical summer day—maybe you have just finished applying fertilizer to your lawn, or accidentally spilled some antifreeze or oil in the driveway as you worked on the car, or used solvents to clean the brush you painted your house with. You wipe the sweat from your brow as you make your way toward the house for a glass of ice cold water from the tap. Like 53% of all Americans, you expect a stream of clear, clean water to flow from its underground haven to your faucet. You probably don’t think about the impact that your summer day’s activities have on our hidden treasure, groundwater.

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Groundwater is water that fills underground cracks and pore spaces in beds of rock and sand called aquifers. It does not occur in underground lakes or rush like a river; in most cases it flows only a few inches per day. In the U.S., groundwater supplies 14 million water wells with 74 billion gallons of water each day. In fact, 90% of our freshwater supply lies underground. At any given time the supply of groundwater may be as much as 20 to 30 times the amount found in all lakes, rivers, and streams. Groundwater is renewable. Rain and melting snow infiltrate the soil and contribute to the groundwater supply.¹

We tend to take for granted the resource that provides us a safe, economical source of water for municipal, agricultural, and industrial use. If you live in a rural area, there is a 96% chance that the water you receive is pumped from a well that has tapped into an underground aquifer. Twenty-one of our 50 states derive all of their rural supplies from groundwater sources.²

We have come to assume that the water that flows from our taps is free from bacterial and chemical contaminants. Each day more and more households and communities are finding this assumption being shattered. The chemicals that we pour onto our land do not just go away as we watch the last traces disappear into the soil. The tons of fertilizers, pesticides, sewage, and industrial and household chemicals that routinely are dumped on land infiltrate it to become part of the groundwater supply. While much of the nation’s groundwater supply is uncontaminated, contamination is a very real and growing dilemma.
From the 1940s to the 1970s, pollutants rained into the soils from Otis Air Force Base on Cape Cod, Massachusetts. Among the myriad chemicals that seeped into the soil around the base were aviation fuel from practice fuel dumps by planes, degreasers, solvents, and emulsifiers. The soils in the area are typically sandy and have a high rate of permeability (the ability of a liquid to penetrate the soil). The chemicals strewed about the base disappeared as if sucked up by a giant sponge to become part of the aquifer that lay underneath. Today, these chemicals have contributed to the growing list of areas around the Cape that are unacceptable for wells. One sample from an abandoned well on the base contained chemicals such as tetrachloroethylene, trichloroethylene, toluene, naphthalene, xylene, polychlorinated biphenyls, and a host of heavy metals such as arsenic, lead, and mercury. Many of these chemicals are mutagenic and can cause cancer, stillbirths, and organ diseases.

What can be done to remediate this problem and others like it? While each situation is different, one technique used to contain contaminated aquifers—commonly called the "pump and treat" method—is to place a clay-rich barrier, down to the bedrock, at the leading edge of the contamination. Wells are drilled on both sides of the barrier and contaminated water from one well is pumped through a decontamination system. The resulting clean water is pumped into the well on the opposite side of the barrier to again be incorporated into the groundwater (see diagram).

Beginning in 1993, the Cape Cod area will utilize pump and treat, landfill capping to slow leachate, and excavation of contaminated soil. The excavated soil undergoes thermal treatment to drive off chemical contaminants into a carbon filter, which is then incinerated. To date, 20,000 cubic feet of surface soil have been successfully treated by this process.

Another technique, called air stripping, involves pumping contaminated water to the top of a tower, where it falls through a honeycomb that separates it into a fine spray. Volatile chemicals disperse and are carbon filtered. The carbon filters are then incinerated. The remaining chemicals make their way to a tank and settle into a sludge that is incinerated or buried in a landfill.

These costly techniques, however, are also time consuming, and would require decades, if not centuries, to remediate a situation such as Cape Cod's. In fact, a recent EPA study of 19 contamination sites where pumping and treating has continued for up to 10 years showed little success in achieving target levels of decontamination.

Some experimental techniques show promise for the future of groundwater cleanup. Photocatalytic detoxification, being tested at a World War II Navy flight training station in Livermore, California, will utilize solar energy to break down organic wastes into nontoxic compounds of carbon dioxide, water, and dilute acid. This solar method can be performed right at the contaminated site, and can even be used to pretreat wastes before release into the environment. Even with these experimental methods, economics is an inhibiting factor, with costs running as much as five times those of other cleanup methods.

Perhaps the most promising new technique to break ground is bioremediation—using microbes to turn harmful organic wastes into harmless compounds. Given a diet rich in the nutrients needed for growth, the bacteria secrete an enzyme which degrades chemicals such as oil, benzene, and trichloroethylene into non-hazardous salts. Bioremediation, however, works best with substances that closely resemble compounds the organisms are used to eating. Scientists now face the challenge of genetically engineering microbes that can act on organic waste not currently consumed by the organisms.

As more and more aquifers become contaminated, it becomes imperative that we do not take groundwater for granted. We can no longer afford to contaminate our hidden treasure with the spoils of progress. We are all accountable for what we put into the ground, from the household chemicals used on that typical summer day to the industrial chemicals used in the manufacture of the products we buy. Out of sight cannot be out of mind. W

Sources
1. National Ground Water Association, 6375 Riverside Drive, Dublin, OH 43017, (614) 761-1711.
4. Sue Nickerson, Executive Director, Assoc, for the Preservation of Cape Cod, Box 636, Orleans, MA 02653, (508) 255-4142.

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1. Define groundwater.

2. What percent of our freshwater supply lies underground?

3. How many wells does groundwater supply?
   How many gallons of water does it supply each day?

4. Is groundwater a renewable or non-renewable resource?

5. How many states derive all of their rural water supplies from groundwater sources?

6. Define permeability.

7. Starting in 1993, the Cape Cod area utilized what three methods to clean contaminated groundwater?

8. What is the most promising new technique to clean contaminated groundwater?