

*Just as above the earth, small drops form and these join others, till finally water descends in a body as rain, so too we must suppose that in the earth the water at first trickles together little by little and that the sources of rivers drip, as it were, out of the earth, and then unite.*

—Meteorologica, Aristotle (384–322 B.C.)

## How To Keep Your Water “Well”

NSFC STAFF WRITER

Natalie Eddy

Since the beginning of human history, the search for water has guided the formation of kingdoms. History tells us its presence both sparked development and spurred devastation.

People searched for water, fought for water, and even died for it. It is nourishment—without it, life cannot exist. Yet today, most of us take it for granted—the clear, thirst-quenching liquid that flows effortlessly from our kitchen and bathroom fixtures. We turn the faucet on, and there seems to be no end to this precious resource.

With such convenience, it is not surprising that the U.S. uses more water than any other country. The average individual uses 40 to 50 gallons of drinking water per day. Although it is labeled “drinking water,” only a small portion is actually used for drinking. The majority is used for other purposes, such as toilet flushing, bathing, cooking, cleaning, and lawn watering.

The quality of our water reflects our general quality of life as a society. Whether we retrieve our water from a public treatment system or private well, all of the water we use comes from either surface water or groundwater.

Surface water sources include rivers, lakes, and reservoirs while most groundwater comes from rain and

melting snow, which soaks through the ground getting trapped in spaces between rocks and soils. These underground water formations, called aquifers, may be only a few miles wide or may encompass the areas of many states.

The majority of private drinking water supplies draw groundwater from wells, but some households obtain water from streams and cisterns (rain water collected from rooftops). In addition to individual home wells, there are also community wells that serve entire towns.

Large-scale water supply systems, found mostly in populated areas, are likely to rely on surface water sources, while small water systems, found in rural populations, tend to use groundwater as their source.

According to the U.S. Environmental Protection Agency (EPA), more than half of the U.S. population (53 percent or 151 million people) receives its drinking water from groundwater sources with approximately 8 percent or 23 million Americans retrieving their drinking water from private wells. Keeping wells free from contaminants requires careful planning, especially when an onsite system is in use nearby.

According to 1990 Census data, nearly one out of every four homes in the U.S. relies on some form of onsite system to treat and dispose of their household wastewater.

Because septic tank effluent contains bacteria, viruses, and high levels of nitrates from human waste, contamination is a major concern in the incidences of waterborne pathogens in private wells in the U.S.

It is estimated that septic tanks may have contaminated one to two percent of the nation’s usable aquifers. With 800 billion gallons of water per year being discharged to the subsurface in the U.S. via septic systems, contamination of wells is an important problem to address.

### Groundwater Quality

By nature, all water contains some impurities. Contrary to what you may read on bottled water labels, there is no such thing as naturally pure water.

As water flows through rivers and streams and filters through soil and rock, it absorbs many of the substances it touches. The water quality in an aquifer depends on the nature of the rock, sand, or soil in the aquifer and what contaminants are in the area.

The dissolved minerals and gases and the amount of suspended matter determines water quality. Some contaminants are harmless, but some compounds may make the water unpalatable and even unsafe.

One basic measurement of water quality is the total dissolved solids (TDS), a reflection of the total amount of solids remaining when a water sample is evaporated.

Water is made up of major constituents, such as chloride, sulfate, carbonate, and bicarbonate, and minor constituents, like iron, manganese, fluoride, nitrate, strontium, and boron. In addition, trace elements, such as arsenic, lead, cadmium, and chromium may be present. The trace elements are extremely important in determining water quality.

Prior to 1974, each state had its own drinking water program, setting the standards that had to be met. Standards were minimal at best. Since 1974, when Congress passed the original Safe Drinking Water Act, EPA has set uniform nationwide minimum standards for drinking water.

A process called risk assessment is used to set quality standards. EPA has issued more than 80 maximum contaminant levels (MCLs) for safe drinking water standards.

## A Deep Subject

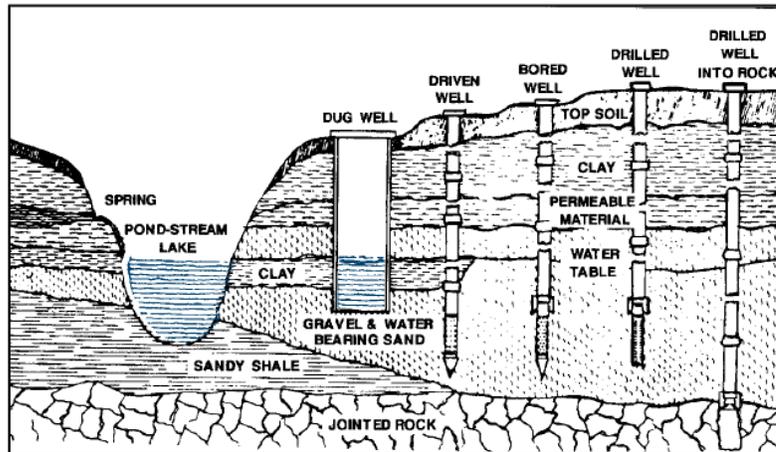
Private wells are not a new technology. People have been digging wells for centuries—long before modern technology was there to help. Primitive people would simply hand dig a hole deep enough to reach the water table. When the water filled the bottom of the hole, they would lower a bucket on a rope down to haul the water out.

Dug wells, which rarely exist today, are prohibited by many states because they are very susceptible to contamination from surface runoff.

Today most well drilling companies

use large, truck-mounted rotary drills or auger bits. Wells may range up to 1,000 feet deep. There are three common types of wells—bored, driven, and drilled.

Bored wells are constructed with an auger. After the water table is reached, the hole typically is lined with steel pipe. The lower part of the well is provided with a screen to keep sand and other material from entering the water. Like dug wells, bored wells are subject to contamination unless the casing is sealed with grout and the well is at least 15 feet below ground surface.



Typical cross-section of underground strata, showing various types of well construction. Reprinted with permission from the *Water Systems Handbook* described on page 17.

Driven wells are made with a series of pipes fitted with a well point on the end. The well point is forced through the ground by a series of blows on the pipe or by using water pressure, especially in sandy soils. When the point reaches the water table, water flows into the pipe through screened openings on the well point. Driven wells are useful when the water table is no deeper than 50 to 60 feet.

Drilled wells, the most common today, are used when the water table is at a greater depth, volume, or diameter or when the ground is too hard to use a well point. Drilled holes are lined with steel or plastic well casing.

Many experts recommend that the well casing extend to a depth greater than 25 feet or 10 feet below the static water level in sand and gravel formations.

## Location, Location, Location

Placement of wells in relation to septic tank systems is an imperative factor in preventing contamination. Setback standards for wells and septic tank systems vary widely from state to state, most ranging from 50 to 100 feet. (Contact your local health department for your particular setback regulations.)

Those setback distances may increase should limiting factors exist, such as the presence of limestone, karst, or fractured bedrock in the soil formation.

Table 1 on Page 15 presents the minimum horizontal separations required by the state of Washington from their on-site regulations.

Design and operating standards are meant to ensure that a septic system does not malfunction. Most wastewater treatment experts recommend that a septic tank be pumped out every three to five years, depending on the size of the tank.

Onsite owners also should inspect their system annually to make sure it is operating properly.

The minimum lot size per typical household septic system varies from 0.5 to 5 acres, depending on the state or municipality.

Still, contamination may occur when inadequately treated effluent rapidly infiltrates the unsaturated or vadose zone and reaches the water table.

The likelihood of septic tank contamination seems to be higher in areas where there is a high density of homes with septic tanks, the soil layer over permeable bedrock is thin or extremely permeable, and the water table is within a few feet of the land surface.

Having a well that is more than 10 years old or less than 50 feet deep increases the chance for contamination. In order for a septic system to function properly, it must be properly sited, designed, installed, and maintained. ▶

**Table 1** Minimum Horizontal Separations

<b>Items Requiring Setback</b>	<b>From edge of disposal component and reserve area</b>	<b>From septic tank, holding tank, containment vessel, pump chamber, and distribution box</b>	<b>From building sewer, collection, and non-perforated distribution line<sup>1</sup></b>
Non-public well or suction line	100 ft.	50 ft.	50 ft.
Public drinking water well	100 ft.	100 ft.	100 ft.
Public drinking water spring, <sup>3</sup>	200 ft.	200 ft.	100 ft.
Spring or surface water used as drinking water source <sup>2,3</sup>	100 ft.	50 ft.	50 ft.
Pressurized water supply line <sup>4</sup>	10 ft.	10 ft.	10 ft.
Properly decommissioned well <sup>5</sup>	10 ft.	N/A	N/A
Surface water <sup>3</sup>			
<i>Marine water</i>	100 ft.	50 ft.	10 ft.
<i>Fresh water</i>	100 ft.	50 ft.	10 ft.
Building foundation	10 ft. <sup>6</sup>	5 ft. <sup>6</sup>	2 ft.
Property or easement line <sup>6</sup>	5 ft.	5 ft.	N/A
Interceptor/curtain drains/drainage ditches			
<i>Down-gradient<sup>7</sup></i>	30 ft.	5 ft.	N/A
<i>Up-gradient<sup>7</sup></i>	10 ft.	N/A	N/A
Down-gradient cuts or banks with at least 5 ft. of original, undisturbed soil above a restrictive layer due to a structural or textural change	25 ft.	N/A	N/A
Down-gradient cuts or banks with less than 5 ft. of original, undisturbed, soil above a restrictive layer due to a structural or textural change	50 ft.	N/A	N/A

<sup>1</sup> "Building sewer" as defined by the most current edition of the Uniform Plumbing Code. "Non-perforated distribution" includes pressure sewer transport lines.

<sup>2</sup> If surface water is used as a public drinking water supply, the designer shall locate the onsite sewage system outside of the required sanitary control area.

<sup>3</sup> Measured from the ordinary high-water mark.

<sup>4</sup> The local health officer may approve a sewer transport line within 10 feet of a water supply line if the sewer line is constructed in accordance with section 2.4 of the Department of Ecology's "Criteria For Sewage Works Design," revised October 1985, or equivalent.

<sup>5</sup> Before any component can be placed within 100 feet of a well, the designer shall submit a decommissioned water well report provided by a licensed well driller, which verifies that appropriate decommissioning procedures noted in chapter 173-160 WAC were followed. Once the well is properly decommissioned, it no longer provides a potential conduit to groundwater, but septic tanks, pump chambers, containment vessels or distribution boxes should not be placed directly over the site.

<sup>6</sup> The local health officer may allow a reduced horizontal separation to not less than two feet where the property line, easement line, or building foundation is up-gradient.

<sup>7</sup> The item is down-gradient when liquid will flow toward it upon encountering a water table or a restrictive layer. The item is up-gradient when liquid will flow away from it upon encountering a water table or restrictive layer.

Source: Collected from the NSFC State Onsite Wastewater Regulations Database

But even if the septic system is functioning properly and within proper setback limits, another factor to be considered is the placement of septic leachfields.

Since leachfields are generally located in areas where wastewater percolates through soil as part of the treatment process, placing leachfields close to a drinking water source can cause problems.

If your well tests positive for indicator organisms (e.g. total coliforms or fecal coliforms), or chemical contaminants, but there are no septic systems nearby, public sewage treatment lines may be to blame. Leakage from sewer lines, which carry untreated raw sewage and may contain industrial waste, can introduce chlorides, microorganisms, organics, trace metals, and other chemicals.

### Identification of Contaminants

In addition to failing or improperly sited septic tanks, a variety of human activities impact water quality. Pollution sources can range from industry, landfills, pesticides, fertilizers, livestock wastes, stormwater runoff from agricultural and urban sources, and household wastes.

The EPA recommends that private water wells be tested annually for indicator organisms and nitrate to detect

contamination problems. Indicator organisms are not harmful in themselves, but their presence indicates that other pathogenic organisms, such as *E coli*, *Giardia lamblia*, *Cryptosporidium*, or hepatitis, could have survived.

The water also should be tested for other potentially dangerous contaminants, such as pesticides and radon.

In addition to the above annual tests, many water experts recommend a broad range of water tests should be done every 5 to 10 years.

Homeowners can access a list of certified laboratories from their state or local health department. Some health departments will conduct the tests for free. The average cost of a private laboratory test for nitrate and bacteria samples will typically range between \$10 to \$20.

### Contamination Happens

According to the EPA, in 1993 and 1994 there were 30 reported disease outbreaks associated with drinking water, 23 associated with public drinking water supplies, and seven with private wells.

Although no definite statistics are available to document the potential contamination threat onsite systems may pose to drinking water, several cases of infectious disease outbreaks have been documented.

In Polk County, Arkansas, a 1971 outbreak of viral hepatitis was traced to a well that was contaminated by seepage from a septic tank located 95 feet away. In 1972, Yakima, Washington, experienced a typhoid outbreak that was attributed to well water from driven well points. Septic tank wastewater from the home of a typhoid carrier was discharged into the ground 21 feet away from the contaminated well. Similarly, a septic tank located 50 feet above the spring supplying drinking water to a resort camp in Colorado was found to be the cause of 400 cases of gastroenteritis.

## Steps to Reduce Contaminants

### **The EPA recommends the following steps to protect groundwater supplies:**

- periodically inspect exposed parts of the wells to determine any cracking or corrosion or damage to the well casing or cap, and look for settling or cracking of surface seals;
- slope the area around the well to drain surface runoff away from the well;
- install a well cap or sanitary seal to prevent unauthorized entry to the well;
- disinfect drinking water wells once a year with bleach or hypochlorite granules;
- keep records of any maintenance, such as disinfection or sediment removal, that may require the use of chemicals;
- hire certified well drillers for any new construction, modification, or abandonment of wells;
- avoid mixing or using pesticides, fertilizers, herbicides, degreasers, fuels, and other pollutants near wells;
- do not dispose of wastes in abandoned wells;
- do not cut the well casing below the land surface;
- pump and inspect septic systems routinely; and
- never dispose of hazardous materials in septic systems.



## Well Water Wisdom

### **Signs that suggest you should test your well include:**

- water with an undesirable taste or smell,
- water that leaves a residue or stains plumbing fixtures or laundry,
- cloudy or colored water,
- corroded pipes or equipment that wears out fast, and
- family members with gastrointestinal distress.



Possible signs of contamination may include:

- water that tests positive for coliform,
- unexplained illnesses, such as gastrointestinal problems, hepatitis A, or typhoid, and
- neighbors finding septic system contaminants in their water.

Septic system effluent containing nitrates can pose a health hazard to infants, in particular. Nitrates have been shown to cause methemoglobinemia, known as Blue Baby Syndrome. ◀

Many health officials recommend testing well water in the vicinity of septic systems more frequently when children or pregnant women are present.

### Education a Key Component

Homeowner education is a key component in coordinating the management of private water supplies and wastewater treatment systems.

A study that was published in the 1998 *Journal of Soil and Water Conservation* illustrates the need for increased education programs. The study evaluated the water quality habits and beliefs of the approximately three million residents living in upstate New York who rely on groundwater to supply their drinking water and the 1.5 million households there with onsite wastewater treatment systems.

The study surveyed 244 homeowners in three counties. Drinking water was tested, and water supplies and onsite systems were inspected. An average of 32 percent of the drinking water tested positive for coliform. Nitrate levels varied with only two samples having concentrations greater than the current drinking water standard of 10 mg/L.

Despite these statistics, 82 percent of those questioned were satisfied with their water supply, although 31 percent of those satisfied had coliform in their drinking water.

Routine maintenance was also listed in the study as a problem since nearly half of the residents had not tested their drinking water, and more than one-third had never pumped their septic system.

The study concluded that "a general lack of homeowner knowledge suggests the need for increased educational programs targeted to the rural audience, as well as additional research to better understand what influences homeowner perceptions and management practices."

### The Final Word

Septic systems and drinking water wells can, and do, coexist harmoniously if the proper precautions are taken. Ultimately, the responsibility is left up to the homeowner.

David Pask, engineering scientist with the National Small Flows Clearinghouse (NSFC), has some additional advice for homeowners who may find that their well supply is contaminated by an existing or new septic system despite compliance with codes.

He said it might be possible to eliminate the problem by installing additional well casing to extend the depth of pumping to below any shallow septic effluent.

If the well casing was sufficiently below the static water level, it would be advisable to reduce the flow of the well

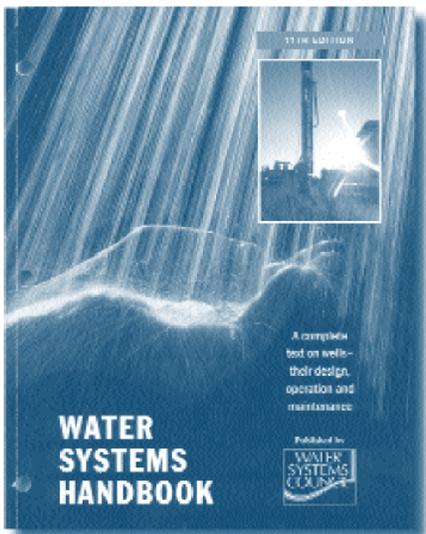
pump by a throttling valve or to install a pump of low capacity. However, a water storage tank may be necessary to allow for sporadic high water demand under a constant low pumping rate.

If all of the compliance regulations have been met and the homeowners' water still persistently tests positive for coliform and other contaminants, they may need to install filtration and disinfection device in the well system for proper treatment. ■

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**For more answers to your drinking water questions, contact the National Drinking Water Clearinghouse (NDWC), our sister program.**

The NDWC offers *On Tap*, a quarterly magazine; more than 250 free products; a bibliographic database; and RESULTS [Registry of Equipment Suppliers of Treatment Technologies for Small Systems] database. For more information, call (800) 624-8301 or visit their Web site at [www.ndwc.wvu.edu](http://www.ndwc.wvu.edu)



## Handbook Available for Well Owners

The 11th edition of the *Water Systems Handbook* is now available from the Water Systems Council. This handbook is a comprehensive technical manual on the proper siting, construction, and operation of wells. It is written for novices in the industry as well as experienced drillers, pump contractors, engineers, and end-users.

The handbook, which was revised and updated this year, includes information that well owners should know—such as details about water sources, well construction, pump operation, well caps, electrical supply, disinfection, and well design. The handbook costs \$20, which includes shipping and handling.

To order the *Water Systems Handbook*, log onto the Water Systems Council's Web site at [www.watersystemscouncil.org](http://www.watersystemscouncil.org), or write to them at Water Systems Council, National Programs Office, 1101 30th Street, N.W., Suite 500, Washington, DC 20007. You also may call toll-free (888) 395-1033 or fax (202) 625-4363. ■