# A Guide to Private Wells

**Virginia Water Resources Research Center**
**Blacksburg, Virginia**
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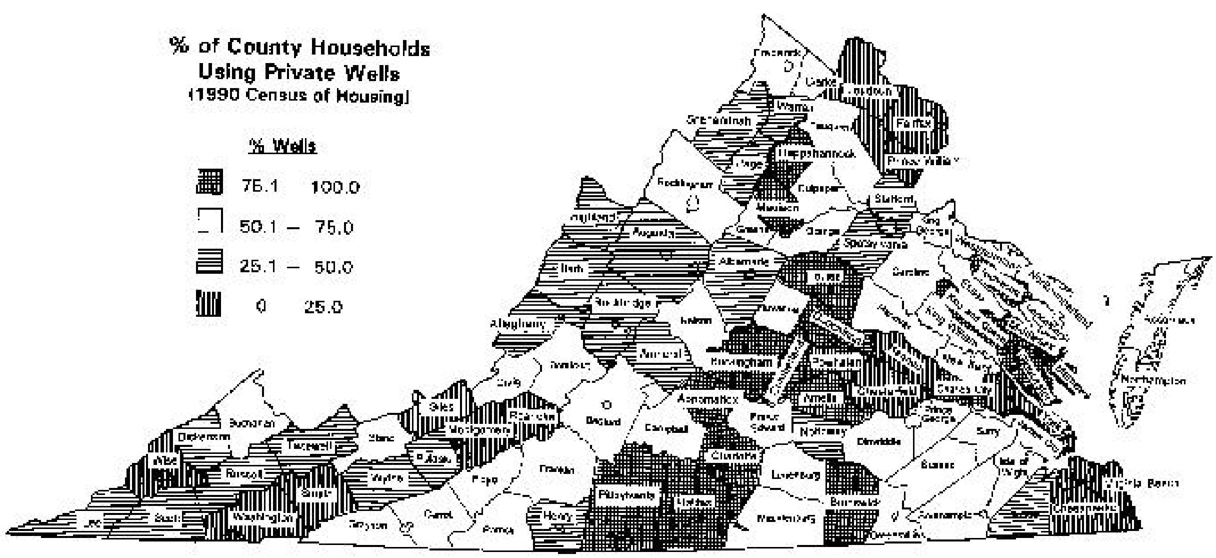
## Introduction

In 60 of Virginia's 95 counties, the majority of households " about 1.4 million Virginians " continue to obtain their domestic water supplies from private wells, using an average of 75 gallons daily per person (Figure 1). Well users often take it for granted that their wells will always produce a dependable supply of clean, safe drinking water. However, neither the quantity nor the quality of the supply is guaranteed. If you rely on a well for your water supply, you want answers to some basic questions:

Where does well water come from?
How are wells constructed?
Does a well need regular maintenance?
Is well water always safe to drink?
Can water quality be tested?
Can water be treated to remove unwanted contaminants?
How far should a well be located from possible pollutants?

In this publication, we provide the answers to these questions and give suggestions on how to protect your water supply by avoid-ing practices that may contaminate ground water. Let's take a brief look at ground water " the source of water for wells.

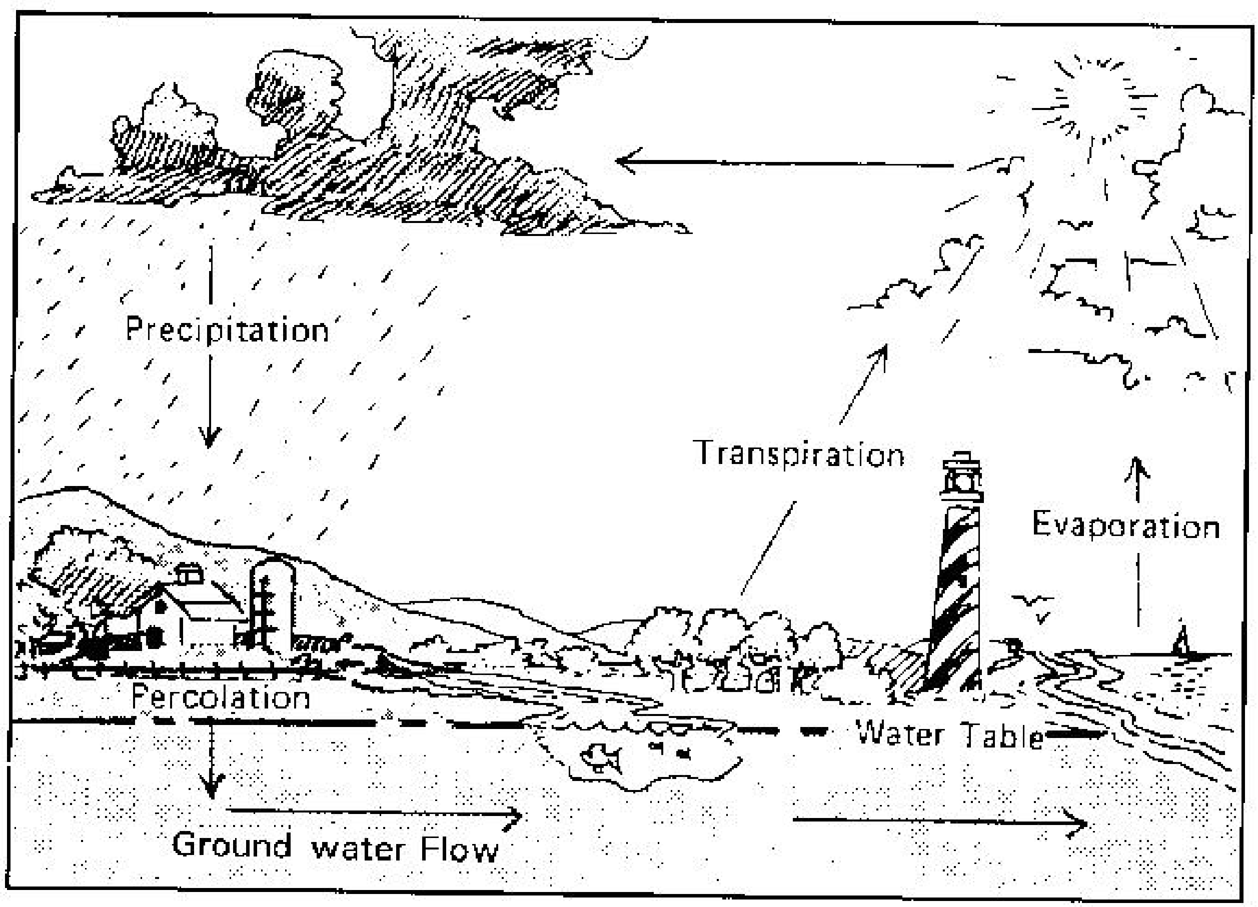
**Figure 1. Percentage of county households using private wells (1990 Census of Housing)**



## What is Ground Water?

Ground water is by far the world's largest source of fresh water. Scientists estimate the amount of ground water is 400 times greater than all the fresh water in lakes, reservoirs, streams, and rivers. The water on the earth's surface and in the ground moves continually through the hydrologic cycle, an endless circulation of water in nature (Figure 2). When precipitation falls on land, some water evaporates and returns to the atmosphere, some flows to streams and rivers, and some seeps into the soil and is absorbed by plant roots. Water not used by plants moves deeper into the ground, downward through cracks, empty spaces, or pores in the soil, sand, and rocks until the water reaches a layer of rock through which it cannot easily move. The water then fills these empty spaces above that layer. The top of the water in the soil, sand, or rocks is called the water table and the water that fills the empty spaces is called ground water.

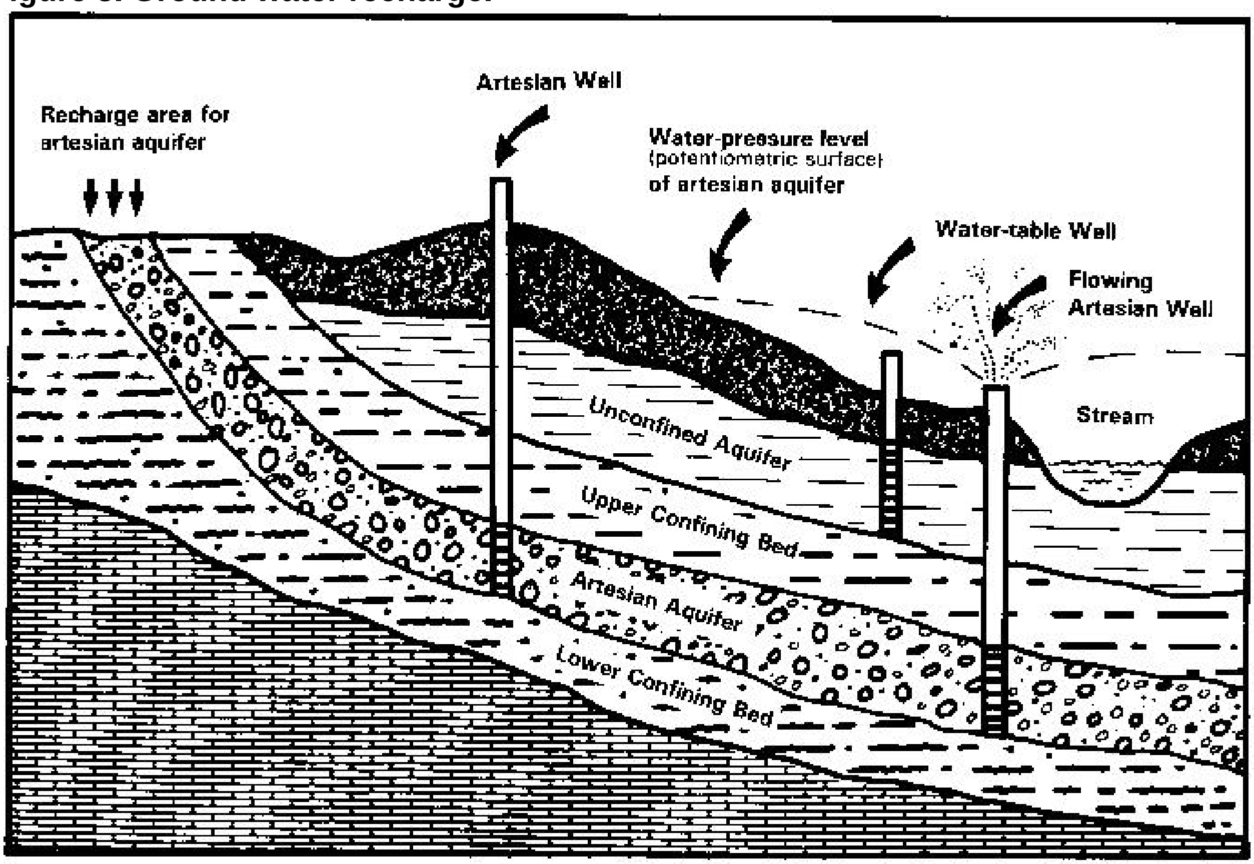
**Figure 2. Ground water is one stage in the earth's hydrologic cycle " the continuous movement of water above, on, and beneath the earth's surface.**



An underground soil or rock formation through which ground water can easily move is called an aquifer. The amount of ground water that can flow through the soil or rock depends on the size of the spaces and the connections between spaces. An aquifer may be of any size or thickness and may occur at depths of less than fifty feet or more than a thousand feet. Several aquifers may exist at various depths below a particular point on the land surface.

Ground water moves very slowly through aquifers " usually less than one foot a day " until it eventually seeps into streams, lakes, wetlands, or the oceans. Springs release ground water to the surface. About 30 percent of the flow of U.S. streams comes from ground water. In turn, rivers and lakes may contribute large amounts of water to an aquifer. The process of water entering an aquifer is known as ground water recharge (Figure 3). The quality and quantity of available ground water are affected by the geology, climate, land use, and human activities in the area of recharge.

**Figure 3. Ground water recharge.**




If more water is pumped from an aquifer than enters it, the aquifer eventually will be depleted of ground water. Overpumping an aquifer eventually reduces the supply available for use and the amount available to flow into streams and surface water supplies. Overpumping in coastal areas, such as Virginia Beach, may cause salt water to enter freshwater aquifers and ruin drinking water supplies. Overpumping may also cause the land to subside, sometimes forming sinkholes.

**Photo of a sinkhole formed in karst soil.**

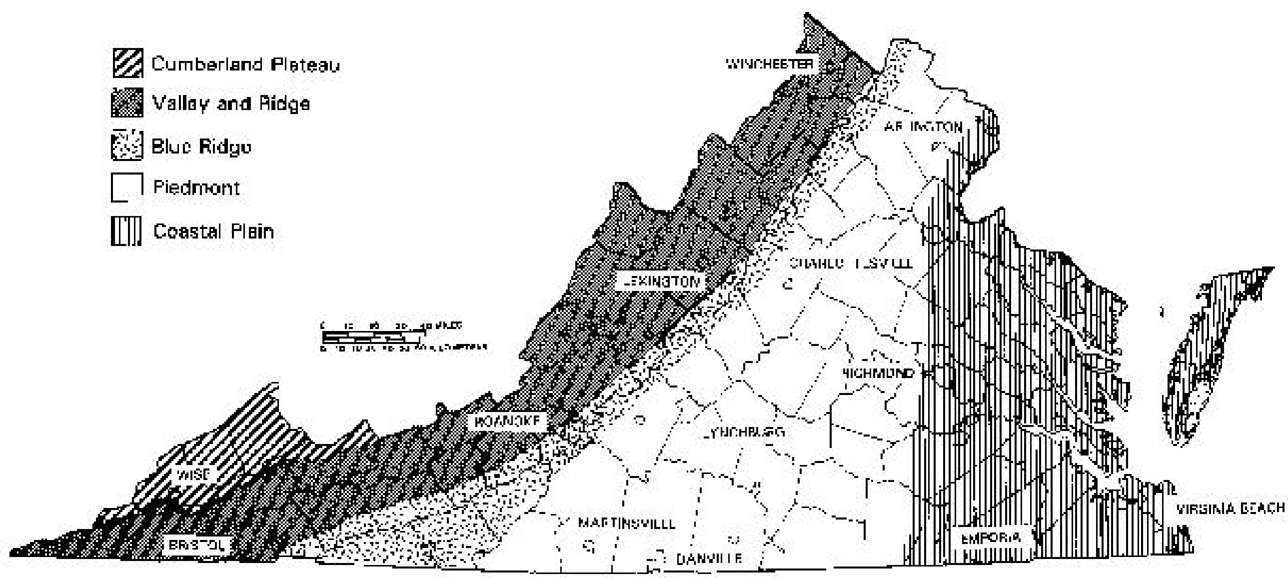
The natural degradation of pollutants in ground water occurs slowly, so contamination that reaches an aquifer can make a water supply unusable. Harmful pollutants in ground water are often difficult to detect because they may be colorless, odorless, and tasteless. Because ground water generally moves slowly, contamination may go undetected for years. Unfortunately, ground water contamination is almost always discovered by accident or after people have become ill from drinking contaminated water. Compared to other states, Virginia has had relatively few severe ground water contamination incidents. However, the threat exists.

## Ground Water in Virginia

About 8 of every 10 Virginians use ground water " from public water supplies, private wells, or springs " for at least part of their daily water supply. Virginia's ground water is generally of good quality and in many cases does not require treatment before use except as a precautionary measure. Dependable ground water supplies for private wells are available at depths of less than 300 feet in most areas of the state. A well yield of at least 6 gallons per minute is usually needed for home use, though 10 gallons per minute is more desirable. Low-yield wells (less than 4 gallons per minute) require a properly sized storage tank and pumping system to supply an adequate amount of water for domestic use. If you use a low-yield well, you should buy a storage tank four to five times larger than your total consumption (approximately 75 gallons a day per person).

Ground water quality, well depth, and well yield vary widely across the state. The Commonwealth has five distinct physio-graphic provinces, each of which has characteristic ground water conditions (Figure 4). Well yield, well depth, and ground water quality also vary locally, even on adjacent parcels of land.

**Figure 4. Ground water availability for wells varies among Virginia's five physiographic provinces.**




## Domestic Wells in Virginia

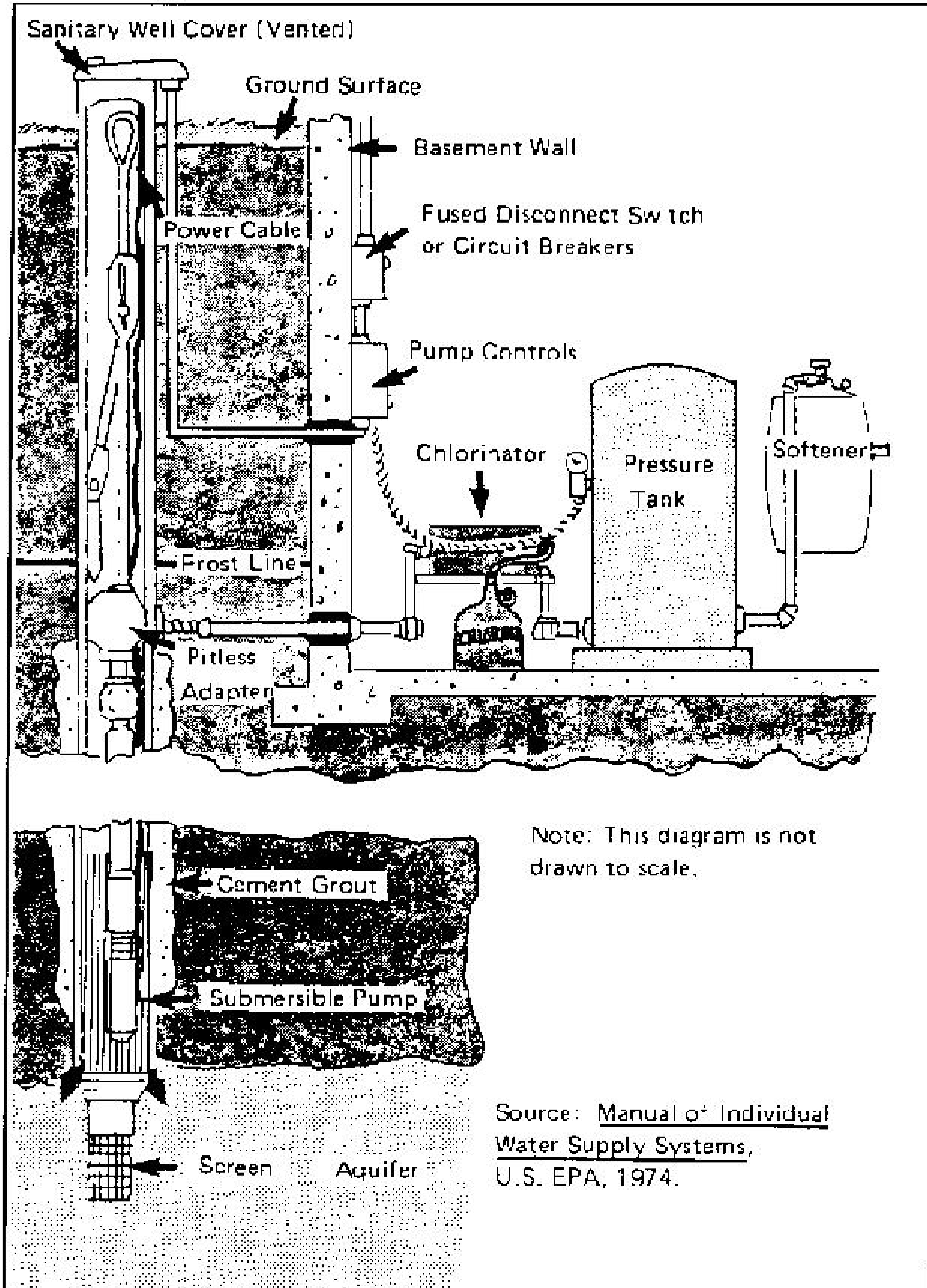
Ground water is made accessible for household use by a water well. It is important that the homeowner understand the factors affecting ground water quality to ensure that the well is properly located, constructed, and sealed. The safety of a drinking water source depends on the homeowner taking every precaution to safeguard the water supply system.

A well consists of pipes extending into the ground through which ground water is drawn from an aquifer to the surface (Figure 5). The well casing supports the walls of the well so that rocks and debris do not enter. The space between the outside of the well casing and the inside of the bore hole must be sealed to prevent well contamination. A slurry of cement or clay, called grout, is used to seal this space. In water-bearing sand and gravel formations, a well screen may be installed at the bottom end of the casing to prevent small particles from entering the well. In well structures without a screen, water from the aquifer enters the well at the open lower end of the casing or through the joints between the casing sections. The upper portion of the casing can serve as a housing for the pumping equipment. A tightly fitting seal or cap should be installed at the top of the casing to prevent dirt, rodents, and other foreign material from entering the well. In some small wells, the pump is connected directly to the top of the well casing or to a suction pipe inside the well. The ground water is brought to the surface via the pump and pipe assembly.

**Well Construction**

Wells are classified into four categories according to the method of construction and intended use of the well as defined in the Commonwealth of Virginia's *Private Well Regulations* (VR 355-34-100, April 1992). Class I and Class II wells are public water supply wells. Class III wells are private wells used as a source for drinking water. Class IV wells are private wells used for any other purpose other than drinking water. Wells are constructed by four methods: drilling, boring, jetting, and digging. The most prevalent methods for constructing wells in Virginia are boring and drilling. Geologic conditions at the site and cost usually determine which method is used.

**Figure 5. Water is pumped from a domestic well to supply a home water system " chlorinators and water softeners are used in some cases when well water needs treatment before consumption.**

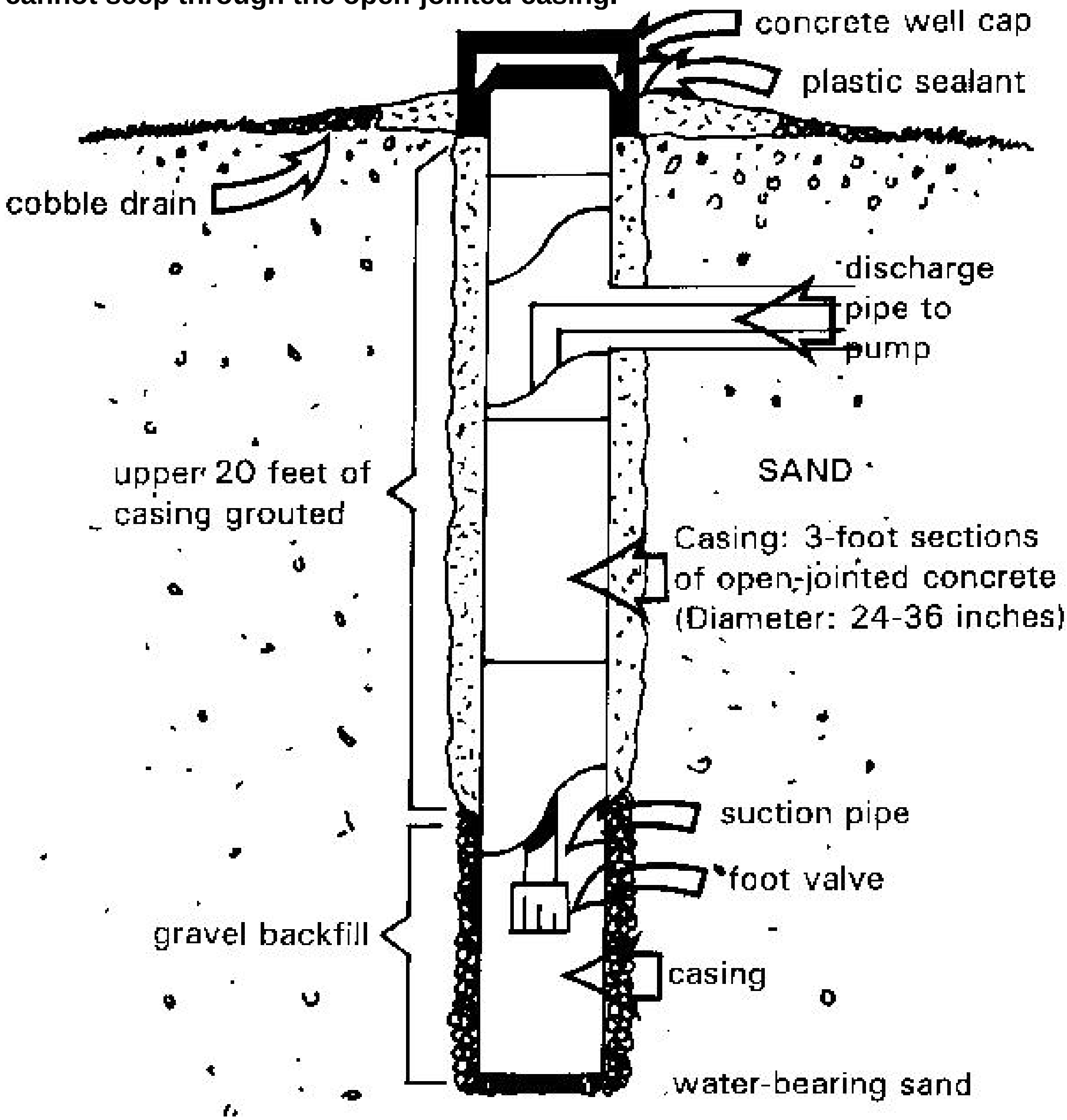



Note: This diagram is not drawn to scale.

Source: Manual of Individual Water Supply Systems, U.S. EPA, 1974.

Bored wells are the type most often constructed in the south central Piedmont and Coastal Plain (Figure 6).

**Figure 6. Bored wells are grouted to a depth of 20 feet so that contaminants cannot seep through the open-jointed casing.**

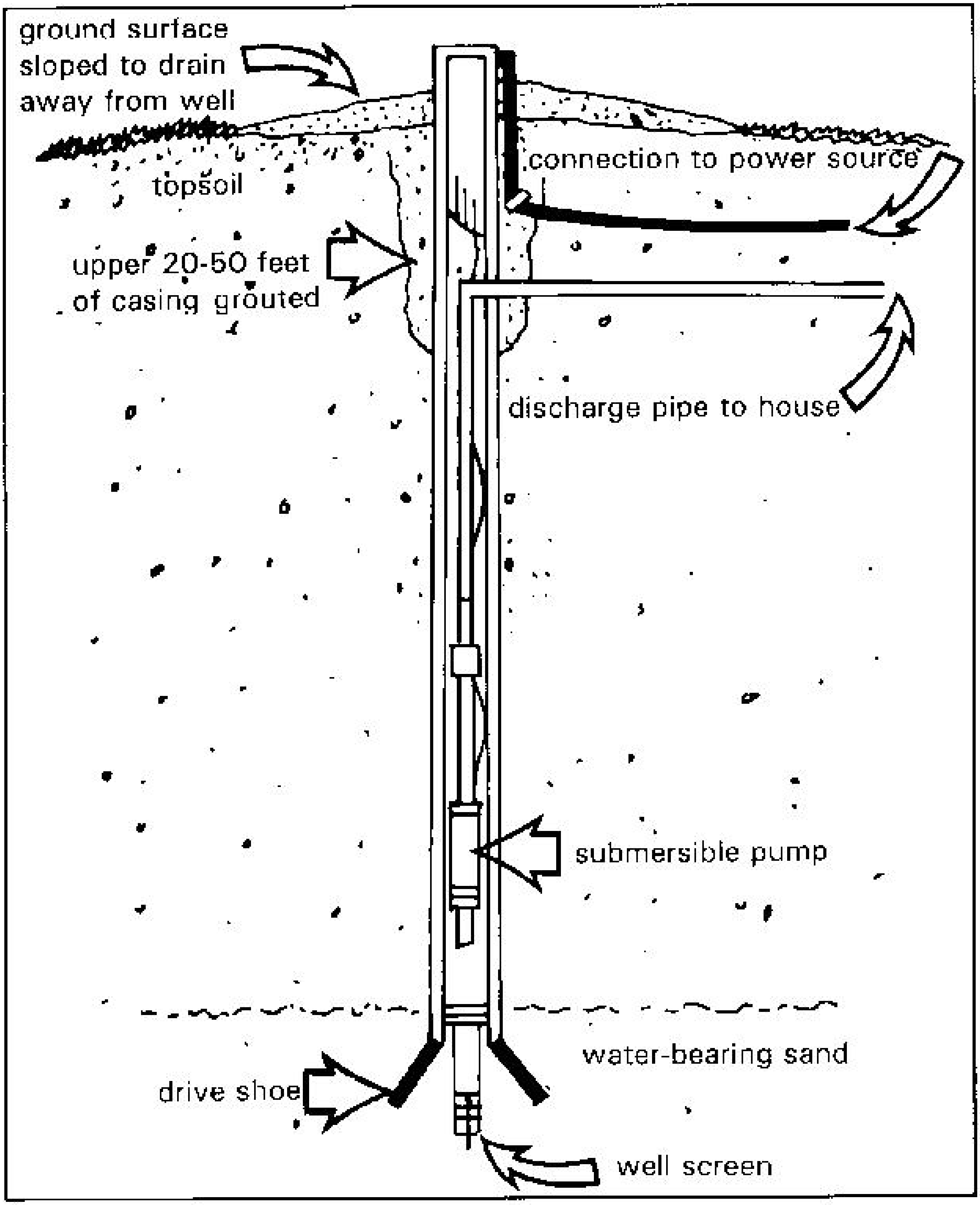



An earth auger is used to remove the earth and other material to reach the water-bearing formation. This method of construction is practical only at depths of less than 100 feet in areas where few large boulders exist. Bored wells are generally lined (cased) with open-jointed concrete pipe, and the space between the borehole and the well casing is filled with gravel from the bottom of the hole up to 20 feet below the land surface. From this point to the surface, the space must be sealed with cement grout or bentonite (as described in the *Private Wells Regulations*, VR 355-34-100, April 1992) to prevent contamination of the well water.

A drilled well can be constructed in many types of geologic formations by using either a percussion or rotary hydraulic drilling rig (Figure 7). The percussion method uses a heavy drill bit to crush and dislodge pieces of rock. The cuttings and loosened materials are removed from the hole by a bailer. To prevent the hole from caving in during the drilling, a casing is driven into the ground as drilling progresses. In the rotary hydraulic drilling method, the drill bit breaks up the material as it rotates through the formation. A drilling fluid is used to carry the material up the hole to a settling pit on the surface. The drill pipe, which carries the fluid down the hole, is removed when drilling is completed and the well is cased. The space between the casing and hole wall is usually filled with cement grout or bentonite to a depth of at least 20 feet.

**A drilled well using the rotary hydraulic drilling method. The drilling fluid is used to bring material to the earth's surface.**

**Figure 7. Drilled wells can be constructed to much greater depths than bored wells.**



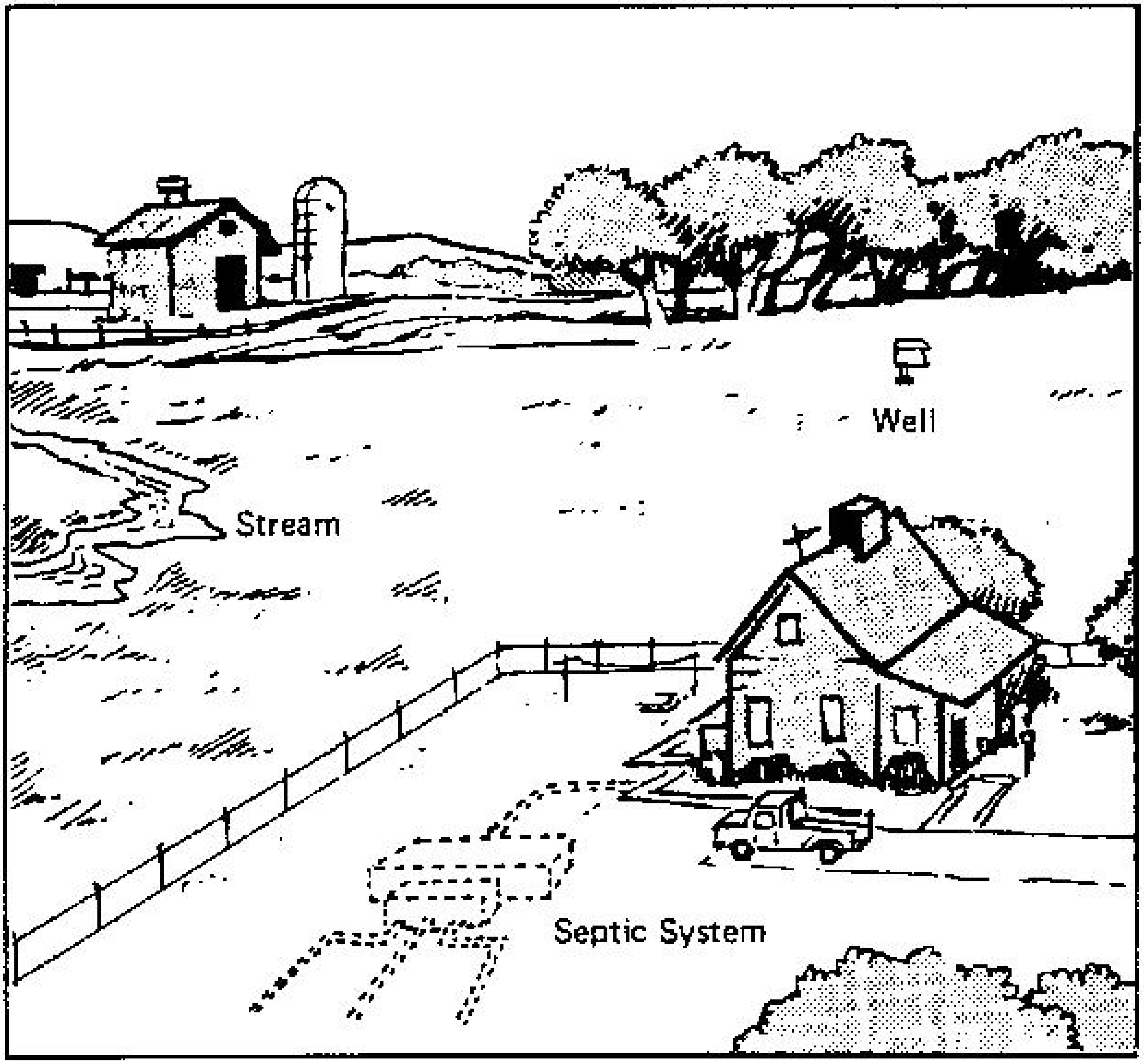
To prevent contaminants from entering the well, the well casing should extend above ground and the top of the casing is sealed with the pump and power units. The pump platforms and well covers should be constructed of watertight concrete and elevated above the ground.

Each method of well construction has advantages and disadvantages related to cost, type of geologic formations penetrated, well diameter and depth, sanitary protection, and intended use of the supply. The construction plans for a water well need to take into consideration the geologic and ground water conditions of the area to make full use of the sanitary protection provided by nature.

**Well Location**

Good well construction and the proper location are critical in ensuring a safe drinking water supply. Prevent contaminated runoff water or other materials from entering a well by locating it on the highest suitable ground and far from potential pollution sources. Surface drainage should be directed away from the well site, and the well should not be located in an area subject to flooding. Pollutants may only travel a short distance in fine sand, silt, or clay, but may travel long distances in course gravel, fissured rock, dried cracked clay, or solution channels in limestone.

**Figure 8. A well should be located where it will not be polluted by contamination from surface sources.**




A suitable well location is shown in Figure 8 and the recom-mended minimum distances between wells and various natural and man-made features are given in Table 1. Specific site conditions may dictate different requirements. Contact your local health department to obtain the current recommendation for minimum distances between a well and a structure or topographic feature.

**Table 1. Distances (in feet) between a well and a structure or topographic feature.**

| Structure or Topographic Feature | Class IIIC(1) or IV(3) | Class III A(2) or B(4) |
|---|---|---|
| **Building Foundation** | 10 | 10 |
| **Building Foundation (termite treated)** | 50 | 50 |
| **House sewer line** | 50 | 50 |
| **Sewer main including force mains** | 50 | 50 |
| **Sewerage system** | 50 | 50 |
| **Septic tank** | 50 | 50 |
| **Drainfield, sewage disposal system or other contaminant source (e.g., underground storage tank, barnyard, hog lot, etc.)** | 100 | 50 |
| **Cemetery** | 100 | 50 |

**Modified from Table 3.1, Virginia's Private Well Regulations, VR 355-34-100, April 1992.**

**(1) Drilled, bored, driven, or jetted wells other than Class IIIA and Class IIIB.**
**(2) Drilled wells in which the annular space around the casing is grouted to a minimum depth of 20 feet and the well is drilled and cased to a depth of 100 feet. The cased drill hole must pass through at least 50 feet of collapsing material such as caving sand, gravel, or other material.**
**(3) Private wells constructed for any purpose other than used for drinking water.**
**(4) Drilled wells in which the casing is installed to a minimum depth of 50 feet and the annular space around the casing is grouted to at least 50 feet.**

**Well Drillers**

Private citizens can legally dig or drill their own well in Virginia if they have obtained a building permit, but most wells are constructed by contractors. Well-drilling contractors are required by the Commonwealth to be licensed through the Board of Contractors under the Department of Professional and Occupational Regulation (DPOR). Well drillers must pass an examination before they can apply for a license from the DPOR. Homeowners should check with the Board for Contractors (804)367-8511 to verify that the well driller they have selected holds a current license.

In selecting a well-drilling company, consider the experience and reputation of a contractor, repair and emergency services offered, and the recommendations of previous customers. The names of local well drillers can be obtained from the local health department, telephone directory, extension agents, local banks, and neighbors who have wells.

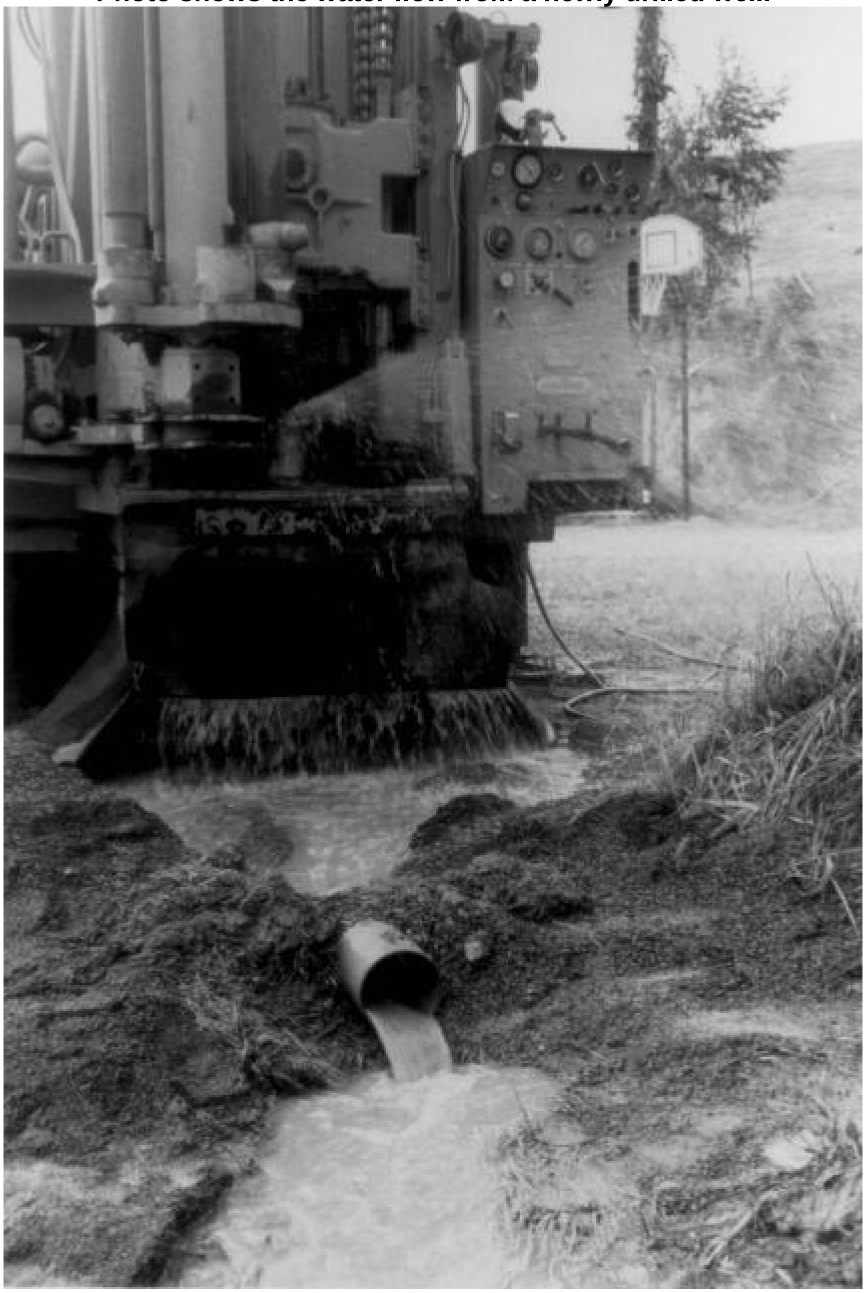
When consulting with the well driller, ask for a written contract. The contract should contain information on the type and method of construction, expected depth and diameter of the well, anticipated yields, method of disinfection, sealing of the completed well, and local water treatment requirements. Also, the materials and services that will be supplied, the unit costs of these items, the date of expected completion, the payment schedule, and information on the type and extent of insurance the contractor carries should be provided in the contract. Because of the uncertainty of the depth of drilling necessary to reach water, a well driller will usually quote a price based on a per-foot basis. The cost of the well covers only the work and material required for the well. It does not include the pumping system, plumbing, and electrical work required to get the water from the well to the use point. Usually, the well driller is qualified to perform these services, but you should specify the work to be performed in the contract before the well is started.

Once negotiations have been completed and all questions have been satisfactorily answered, either the contractor or homeowner should provide a written agreement. A contract helps avoid misunderstandings and provides protection for both the contractor and homeowner.

All phases of well construction should be promptly completed by the well contractor. If a well is drilled but not grouted until a later date, ground water contamination is very likely. Any openings made through the well casing when the plumbing is installed should be properly sealed.

Upon completion of the well, the contractor should furnish pump operating manuals and a well log containing detailed information on all aspects of well construction and water quality tests. This log should include a record of the well construction information: depth, geological formations penetrated, length of casing and subsurface changes in casing, diameter type and length of well screen (if used), depth to water, and depth of grouting. This information can be important if well maintenance and repair become necessary.

**Photo shows the water flow from a newly drilled well.**



## Treating Drinking Water

Ground water used for domestic purposes should be of the highest possible quality. The best protection against ground water contamination is proper well siting and construction. Unlike surface water, most ground water does not contain disease-causing organisms and contaminants because it is naturally filtered as it seeps through the ground. However, treating well water to ensure safe drinking water is often advisable. Two general kinds of water treatment are disinfecting and conditioning. To ensure that the supply is free of harmful bacteria, water is disinfected. Objectionable tastes, odors, and matter are removed by conditioning.

**Disinfection Methods**

Drinking water is most commonly tested for coliform bacteria, which live in the intestine of warm-blooded animals. Testing for coliform bacteria is easier and less expensive than testing for specific, disease-causing microorganisms. Coliform bacteria generally do not cause illness, but are indicators that the water supply is contaminated and that disease-causing bacteria may be present.

Coliform bacteria in a well are usually the result of a faulty septic system or contaminated surface water entering the well or water delivery system. The standard test is called a total coliform. Water samples that contain any coliform bacteria are reported as "total coliform positive." If the test results indicate a "total coliform positive", a fecal coliform test should be performed. Fecal coliform bacteria indicates contamination by human or animal waste. It is unacceptable for fecal coliform bacteria to be present in any concentration.

Materials and tools used in well construction are frequently contaminated with bacteria that live in the soil, and these can be introduced into the water system while constructing the well, installing components of the piping system, or servicing any part of the water supply system. It is very important that the water system be disinfected following construction and after all repairs.

The four types of water treatment that can be used to remove bacteria are chlorination, ozonation, ultraviolet light, and heat. Chlorination is the most commonly used means of disinfection in both municipal and private water systems. Homeowners selecting a disinfection method should check first with local health department officials for recommendations of appropriate methods for their area and for any restrictions or regulations.

Chlorination is used to disinfect private supplies because it destroys bacteria within a reasonable contact time and provides residual protection. Chlorine, readily available at a low cost, is also effective in controlling algae. However, ordinary levels of chlorination are not always effective in destroying Giardia cysts, which cause a severe gastrointestinal illness. Super-high levels of chlorination, boiling, or filtering are the only effective methods to destroy or remove these cysts.

Five factors determine the efficiency of chlorination: (1) chlorine concentration, (2) type of chlorine, (3) contact time, (4) temperature of water, and (5) pH (acidity or alkalinity) of water. The Virginia Department of Health recommends the use of Shock Chlorination (see directions on the following page) to clean and sanitize the well and entire plumbing system. Chlorine compounds are usually added to the water in solution form and may be fresh liquid chlorine bleach (sodium hypochlorite), containing 5.25 percent available chlorine (Table 2a), or soluble tables or powder used for disinfecting swimming pools (calcium hypochlorite), containing about 70 percent available chlorine (Table 2b). Shock chlorination is most effective when the chlorine level is relatively high, the chlorine is in contact with the water for a long time, and the water is warm and acidic. The chlorine should be in contact with the water for at least 12 to 24 hours. In cases where this is not possible, continuous chlorination is an option. To provide sufficient contact time for the continuous chlorination process, most household chlorination systems require a relatively large storage tank. Disinfection is more effective if the water is free of other compounds that might combine with the chlorine.

**Shock Chlorination Process for Wells**

1. Pour the proper amount of liquid chlorine bleach or powdered chlorine mixed with several gallons of water directly into the well (See tables 2a and 2b).

2. Connect a garden hose to a nearby faucet and wash down the inside of the well for about 15 minutes.

3. Open each faucet inside and outside the house one at a time and let the water run. Close the faucet after a strong odor of chlorine is detected. If a strong odor of chlorine cannot be detected, add more chlorine to the well.

4. Let the water stand in the plumbing system for 12 to 24 hours. Do not run any water during this time.

5. Flush the system of remaining chlorine. Do this, one faucet at a time, starting with the outside faucet(s). This order will reduce the load on your septic system. Let each faucet run until the chlorine odor is no longer noticeable.

When handling concentrated chlorine, always wear rubber gloves, goggles, and a protective apron. Should you accidently get chlorine on your skin, flush the area immediately with water. Never mix chlorine solutions with other cleaning agents or ammonia because toxic gases may be produced. Use plain chlorine laundry bleach for disinfecting water. Do not use bleaches containing perfumes, "all fabric" bleaches, or fabric softeners. Chlorine solutions exposed to sunlight lose strength. Make fresh solutions frequently to maintain effectiveness.

**Table 2a. Quantities(1) of liquid chlorine bleach (5.25% chlorine) required for water well disinfection.**

**Well Diameter (in.)**

| Depth of water in well (ft) | 2 | 3 | 4 | 5 | 6 | 8 | 10 | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 42 | 48 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **5** | 1C | 1C | 1C | 1C | 1C | 1C | 1C | 1C | 2C | 4C | 1Q | 2Q | 3Q | 3Q | 4Q | 5Q |
| **10** | 1C | 1C | 1C | 1C | 1C | 1C | 2C | 2C | 1Q | 2Q | 3Q | 4Q | 4Q | 6Q | 8Q | 2.5G |
| **15** | 1C | 1C | 1C | 1C | 1C | 2C | 3C | 4C | 2Q | 2.5Q | 4Q | 5Q | 6Q | 2G | 3G | 4G |
| **20** | 1C | 1C | 1C | 1C | 1C | 2C | 4C | 1Q | 2.5Q | 3.5Q | | | | | | |
| **30** | 1C | 1C | 1C | 1C | 2C | 4C | 1.5Q | 2Q | 4Q | 5Q | | | | | | |
| **40** | 1C | 1C | 1C | 2C | 2C | 1Q | 2Q | 2.5Q | 4.5Q | 7Q | | | | | | |
| **60** | 1C | 1C | 2C | 3C | 4C | 2Q | 3Q | 4Q | | | | | | | | |
| **80** | 1C | 1C | 2C | 4C | 1Q | 2Q | 3.5Q | 5Q | | | | | | | | |
| **100** | 1C | 2C | 3C | 1Q | 1.5Q | 2.5Q | 4Q | 6Q | | | | | | | | |
| **150** | 2C | 2C | 4C | 2Q | 2.5Q | 4Q | 6Q | 2.5G | | | | | | | | |

**Table 2b.Quantities(1) of calcium hypochlorite (70% chlorine) required for water well disinfection.**
Well Diameter (in.)

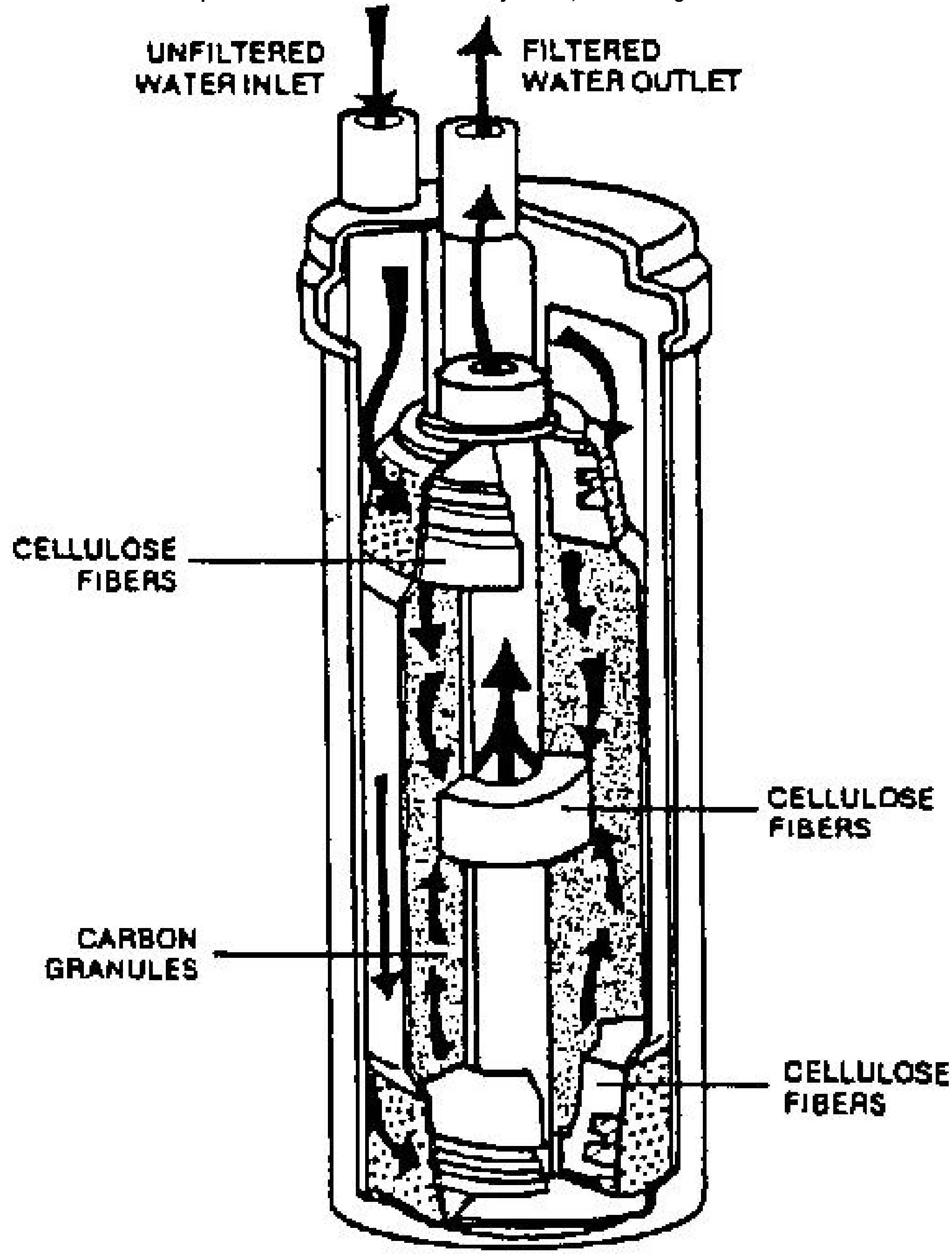
| Depth of water in well (ft) | 2 | 3 | 4 | 5 | 6 | 8 | 10 | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 42 | 48 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **5** | 1T | 1T | 1T | 1T | 1T | 1T | 2T | 3T | 5T | 6T | 3oz | 4oz | 5oz | 7oz | 9oz | 12oz |
| **10** | 1T | 1T | 1T | 1T | 1T | 2T | 3T | 5T | 8T | 4oz | 6oz | 8oz | 10oz | 13oz | 1.5lb | 1.5lb |
| **15** | 1T | 1T | 1T | 1T | 2T | 3T | 5T | 8T | 4oz | 6oz | 9oz | 12oz | 1lb | 1.5lb | 1.5lb | 2lb |
| **20** | 1T | 1T | 1T | 2T | 3T | 4T | 6T | 3oz | 5oz | 8oz | | | | | | |
| **30** | 1T | 1T | 2T | 3T | 4T | 6T | 3oz | 4oz | 8oz | 12oz | | | | | | |
| **40** | 1T | 1T | 2T | 4T | 6T | 8T | 4oz | 6oz | 10oz | 1lb | | | | | | |
| **60** | 1T | 2T | 3T | 5T | 8T | 4oz | 6oz | 9oz | | | | | | | | |
| **80** | 1TC | 3T | 4T | 7T | 9T | 5oz | 8oz | 12oz | | | | | | | | |
| **100** | 2T | 3T | 5T | 8T | 4oz | 7oz | 10oz | 1lb | | | | | | | | |
| **150** | 3T | 5T | 8T | 4oz | 6oz | 10oz | 1lb | 1.5lb | | | | | | | | |

**(1)Quantities are indicated as: C = cups; Q = quarts; G = gallons; T = tablespoons; oz. = ounces (by weight); lb. = pounds**

**Source: Manual of Individual and Non-public Water Supply Systems published by the U.S. EPA Office of Groundwater and Drinking Water, EPA 570/9-91-004, Washington, DC, May 1991.**

High chlorine concentrations can have objectionable tastes and odors, and even low chlorine concentrations react with some organic compounds to produce strong, unpleasant tastes and odors. To eliminate these offensive tastes and to remove excessive amounts of chlorine, the water is then dechlorinated. Activated carbon filters (Figure 9) are the most common devices used to dechlorinate water, remove objectionable chlorine tastes, and reduce corrosion of plumbing systems. In addition to removing taste and odor problems, reports have shown that granular activated carbon absorption is the best method currently available to remove specific organic chemicals (including some pesticide residues), and as a method for radon removal.

**Figure 9. Activated Charcoal Filter. Water passes between inner and outer cylinders, then through cellulose fibers.**




Filters are available for installation in the water system or under the sink. Units fitting on the kitchen tap, generally treat 100 to 300 gallons of water effectively before a filter change is needed. While small household filters can improve the appearance and taste of well water, they should not be relied on to remove disease-causing bacteria. In some cases, filters installed on faucets have been the source of increased bacterial contamination because of the ideal bacterial growth environment provided by these units.

Of the many types of continuous chlorination equipment available, positive displacement feeders are the most common type used in domestic systems. This type of equipment uses a piston or a diaphragm pump to inject the chlorine solution. These electrically powered chlorinators are adjustable during operation to give reliable application dosages " a desirable feature for systems where water pressure is low or fluctuating.

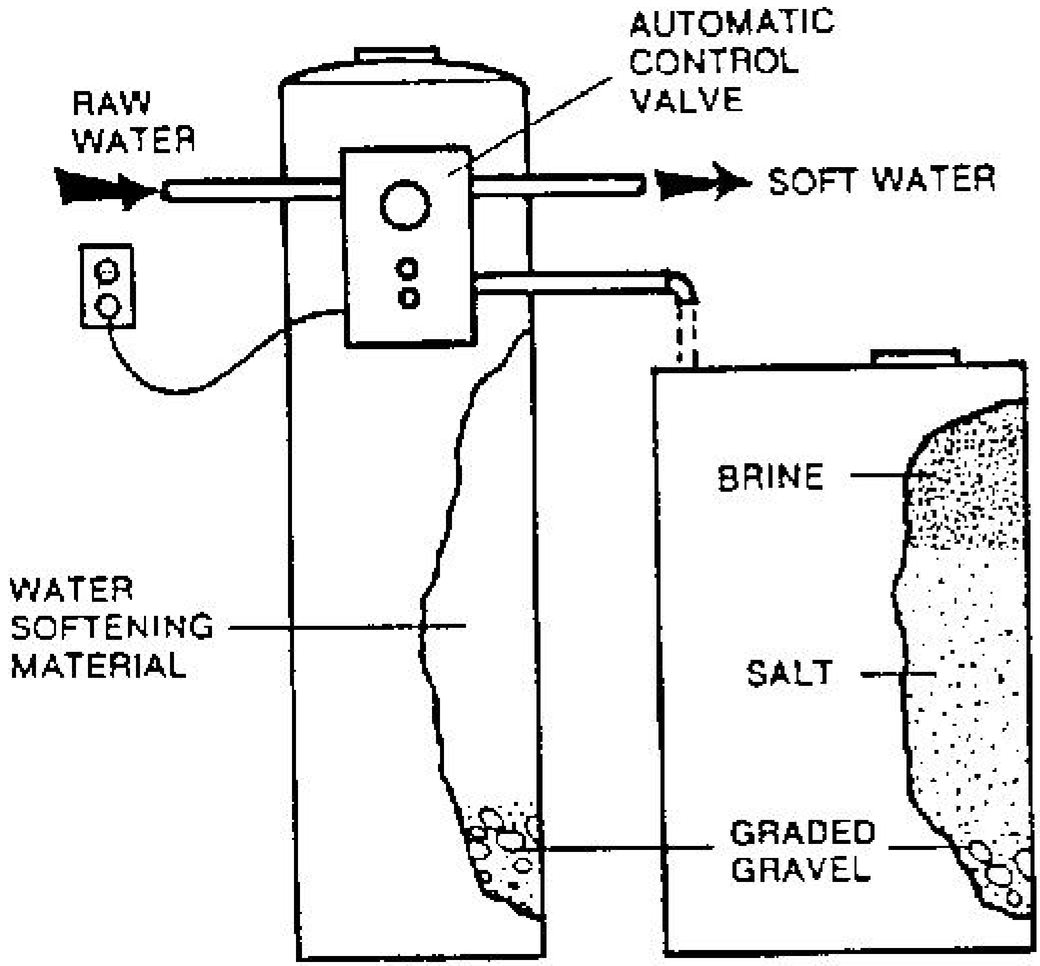
Continuous chlorination systems require frequent testing to ensure proper disinfection levels are being maintained. The homeowner should keep accurate records of the amount of water treated, amount of chlorine used, time and location of tests, and all settings on the chlorinator.

**Conditioning Methods**

In addition to bacteria that may exist in domestic water supplies, contaminants include minerals that naturally occur in the soil or enter ground water as a result of human activities. While many natural contaminants such as iron, sulfate, and manganese are not considered serious health hazards, they can give drinking water an unpleasant taste, odor, or color. Conditioning the home water supply makes the water more pleasing to the senses. Conditioning the water supply may include water softening, iron removal, neutralization of acid water, reverse osmosis, turbidity control, removal of objectionable tastes and odors, and aeration. Water softening and filtering are the most common methods of conditioning well water.

Hard water is a problem for many Virginia well owners, especially those west of the Blue Ridge Mountains. Hard water contains minerals, such as calcium, magnesium, and iron. Water containing 7 - 8 grains of minerals per gallon (equivalent to approximately 125 milligrams per liter) of water can reduce the cleaning action of soaps and detergents and can form a scale in cookware, hot water pipes, and water heaters. Domestic water supplies are commonly softened by using a tank containing an ion-exchange material, which takes up the calcium, magnesium and small amounts of dissolved iron from water in exchange for sodium (Figure 10).

**Figure 10. Automatic water softener. The unit completes all regeneration steps automatically. The salt in the brine tank must be replenished periodically.**




A serious problem associated with water softeners is that iron bacteria or high iron concentrations can clog the ion-exchange material and make the water softener ineffective. The clogging can be prevented by chlorinating or filtering the water prior to softening. Filtration removes iron, reduces objectionable tastes and odors, and makes water clear. Filtration may be used in con-junction with chlorination to destroy iron bacteria and to remove hydrogen sulfide, the substance often recognized by a rotten egg smell.

Another potential problem with water softeners is the addition of sodium to the water. Before installing a water softener, individuals on a sodium-restricted diet should talk with their physician about drinking softened water. An alternative is to soften only the hot water supply and to leave the cold water available for consumption by those on sodium-restricted diets.

Ground water of high acidity is frequently a problem in the Cumberland Plateau. In some cases, acid water can corrode plumbing and leach toxic metals into drinking water, creating a health threat. The four most common methods of neutralizing acidity and controlling corrosion are aeration, caustic soda feed, soda ash feed, and calcium carbonate filters. To detect the cause of the acidity and to select the most appropriate treatment method, the pH value (a measure of acidity), hardness, and gas concentration of the water must be analyzed.

Many homeowners find the quality of their water is improved by a supplemental treatment that adds air (aerates) the supply. Aeration is helpful in removing hydrogen sulfide, methane, and carbon dioxide gases, and in removing bad tastes or the flat taste of oxygen-deficient water. Aerating water also helps remove iron.

Conditioning equipment should be chosen on the basis of the characteristics of your water supply as determined by laboratory analysis (see "Testing Drinking Water"). Distributors of treatment devices frequently offer basic water tests " such as pH, hardness, and iron content " as a free service for potential customers. The specifications and prices of various kinds of treatment equipment should be compared prior to purchase or rental, and the equipment should always have a performance guarantee.

## Well Maintenance

Wells require regular maintenance to perform properly. Many homeowners tend to forget the value of proper maintenance until problems reach crisis levels that demand immediate and often drastic action. Maintaining a well involves early detection and correction of problems that could reduce well performance. Keep up-to-date records of well installation, repairs, pumping tests, and water tests. Periodic chemical analyses of your water supply are more reliable than sporadic testing which may not reveal a decline in water quality over time. A regular maintenance routine is important because the problems that affect well yields often occur out of sight inside the well.

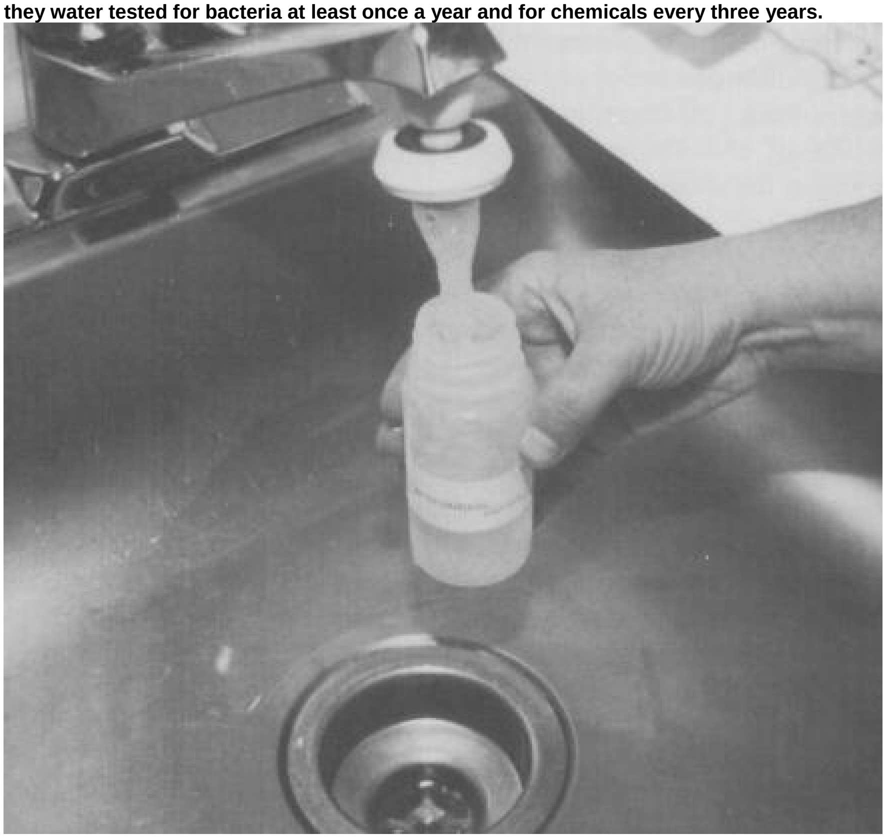
A number of factors affect well yield. The normal wear of pump parts, the changing conditions in and around the well, incrusting deposits on metal parts, and corrosion of the well screen can hinder well performance and shorten the useful life of the entire water system. Increased power consumption, indicated by a higher-than-normal electric bill, without increased water delivery could be evidence of reduced pump performance or a problem in the well.

Visually checking the well cap and upper casing to make sure the cap is free of cracks and is tight enough to keep out debris, animals, or contaminants should be done frequently. If you have a drilled well, never remove the cap. You could break the sanitary seal and the well would need to be disinfected.

Periodic chemical analyses of the water can indicate the presence of chemicals that cause incrustation in wells, the type of incrustation that might form, and the rate at which it will form. The formation of incrusting deposits depends on the mineral content of the ground water and the rate of pumping. If incrusting deposits are not treated early, rehabilitation will become more difficult, or even impossible, as deposits grow thicker. Although there are no methods that will completely prevent incrustation in wells, it can be delayed by using properly designed well screens and by reducing pumping rates.

One method to remove incrusting deposits is to put acid into the well and agitate it out through the screen openings into the surrounding formations. Chlorine treatments are an effective way of loosening clogs caused by bacterial growths and slime deposits caused by iron bacteria. A third treatment method uses chemical cleaning agents to dislodge the incrusting deposits rather that dissolve them as the acid and chlorine treatments do. Removal of incrusting deposits should be done by a professional and not by most homeowners.

**Laboratory tests can reveal water quality problems that may not be apparent to well users. Homeowners should have they water tested for bacteria at least once a year and for chemicals every three years.**



## Testing Drinking Water

The quality and quantity of the supply delivered to the rural home is usually the responsibility of the homeowner. Homeowners with wells should have their water tested for bacteria at least once a year and for chemicals every three years. If an unexplained gastrointestinal illness develops suddenly among any of the water users, the supply should be tested immediately and the local health department consulted. If the taste or color of the supply changes suddenly, an extensive chemical analysis may be warranted. Notify the local health department or the regional office of the Department of Environmental Quality (DEQ) of unusual conditions.

### Water Testing Laboratories

Approximately 108 public and private laboratories are certified by the Division of Consolidated Laboratory Services (DCLS) to test drinking water quality in Virginia. More than 100 out-of-state water laboratories are also approved by the DCLS to test water. Contact your local extension agent or health department to obtain the names of water testing laboratories closest to you. Each laboratory sets its own prices for water testing. Check with individual laboratories to get prices and the kinds of tests they are certified to perform. For a complete up-to-date list of all state-approved laboratories and the specific tests they are certified to perform, write or call the:

**Division of Consolidated Laboratory Services**
**State Laboratory**
**1 North 14th St.**
**Richmond, VA 23219**
**(804)786-3411**

## Precautions for Home Buyers

Several precautions should be taken before you buy a house that is served by a private well. The present owner should provide written information about the location and construction of the well, along with the type and age of the well, pump, and piping. If the house is served by a septic system, information should be provided about its location, age, and maintenance. Copies of the original installation and operation permits for the septic system may be obtained from the local health department if the system was not installed too long ago.

The water should be tested by a reputable laboratory and the household plumbing should be checked by a plumber to deter-mine if any components of the system need to be replaced. You should also look for obvious problems with the well itself, such as inadequate grout around the well casing, leakage around the point where the supply pipe (to the house) leaves the casing, and "in bored wells " leakage around the joints of the upper casing.

You may wish to consult with an attorney to see if the purchase agreement should be contingent, in writing, on proof that the water supply system provides adequate quantities for domestic use, does not pose a health threat, and is acceptable to the buyer. This precaution may save you hundreds of dollars and prevent unforeseen trouble.

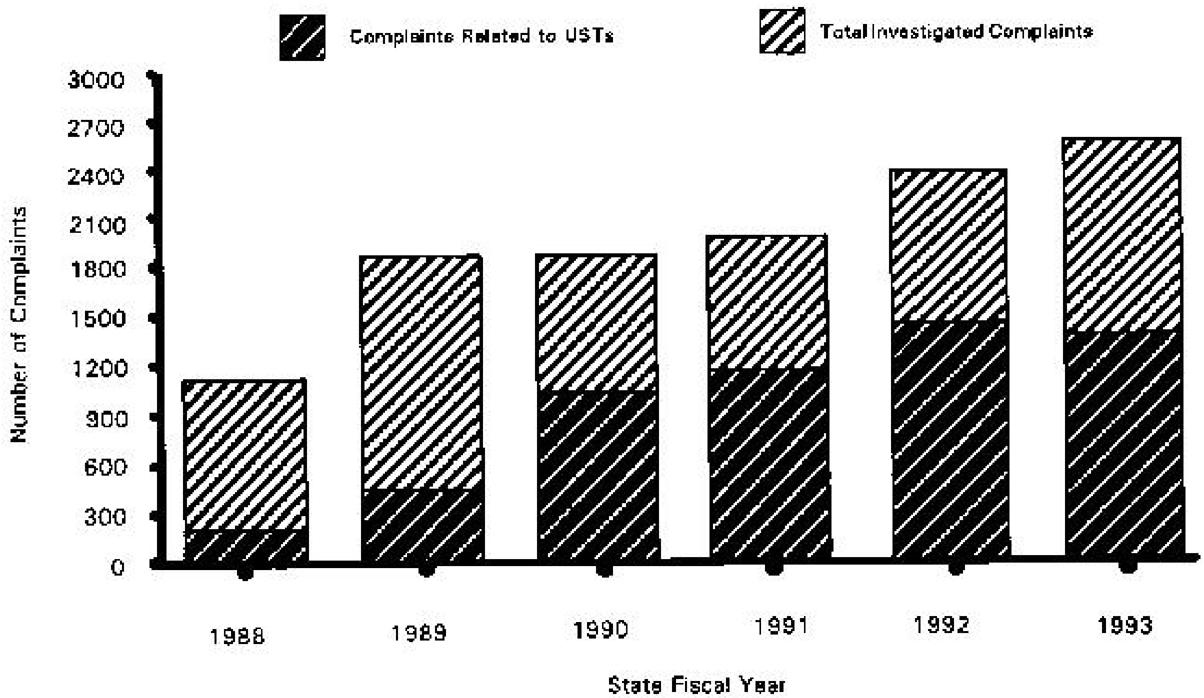
If you are planning to buy land on which to build a house, have a percolation ("perk") test done to see if the soil appears suitable for a septic system. Your local health department can provide information about perk tests and septic system construction regulations. Before buying property, it is wise to talk to neighboring landowners, local well drillers, extension agents, reputable realtors, and the local health department about well depths, well yields, and ground water quality in the area. Keep in mind that local variations are such that you may not find water at the same depth and of the same quality as your neighbor.

## Protecting Your Ground Water

A wide variety of compounds and toxic chemicals have been developed, used, and disposed of in recent years without regard to their impact on our water resources. In the past, some experts felt that the pollution effect of many chemical wastes would be reduced through dilution or by percolation through the soils. Today, we know that numerous man-made compounds are contaminating ground water. The toxic effect of these materials " many of which are carcinogenic " is often not reduced by filtration through soils. In fact, some compounds react with other components in the soil to produce other toxic substances.

The ability of water to pick up and release a variety of substances in the environment has important implications for well owners. Since the recharge area that serves a well is frequently on the same property as the well, the home owner is responsible for the quality of the well water. Many well users are unaware that the quality of the well water is affected by activities on the land surface and by waste and fuel storage tanks buried in the ground. For example, the Department of Environmental Quality received 19,000 pollution complaints from July 1985 to June 1995. Over 1,600 of these complaints related to releases from underground storage tanks (USTs) (Figure 11). Preventing contamination to the ground water resources from USTs is a high priority at both the state and federal level. Although well users cannot control every potential threat to ground water, eliminating practices that can result in serious contamination of well water can help maintain a clean, safe supply.

**Figure 11. Number of complaints reported to DEQ from 1988-1993.**




Described below are some practices that well users should adopt and some they should avoid.

Fertilizers, pesticides, and herbicides should be used with caution and applied according to the manufacturer's instructions. Many of these chemicals can dissolve in rain or irrigation water and percolate through the soil into the ground water. Never mix, store, or use these chemicals near a well.

Improper disposal of leftover pesticides and herbicides and their empty containers can harm humans and animals and can be a source of dangerous water contamination. Unused pesticides and their containers should be taken to an approved landfill, or contact your local extension agent or health department to determine the most appropriate method to dispose of these chemicals and their containers.

Sprayer equipment should be carefully checked for proper calibration so that recommended application rates are not exceeded. Excessive pesticides use may increase the potential for percolation of residues into ground water. Devices to prevent back-siphoning should be installed on all faucets and hoses used to fill pesticide and herbicide sprayers.

An improperly located and maintained septic system can contaminate well water.

Septic system wastewater carries disease-causing bacteria and viruses into the soil. If the septic tank has not been properly maintained (pumping the tank regularly) or if the drain field is not operating properly, ground water drawn by the well can become contaminated and infect well users.

Toxic and hazardous substances poured or flushed into household plumbing can pass through your septic system without being treated and contaminate ground water. Such chemicals include paints, varnishes, photographic solutions, paint thinners, waste oils, pesticides, antifreeze, wood preservatives, and household cleaners that contain lye or petroleum distillates. Proper disposal of these substances is essential. Consult the fire department, health department, or the Department of Environmental Quality's Waste Division, Office of Technical Assistance for acceptable methods of disposal. Disposing of these substances through a septic system can destroy the beneficial bacterial action in the septic tank.

Careless land use can contaminate ground water. Locate livestock pens and barns as far downhill from the well as possible. Utilize sound agricultural practices to reduce soil erosion and prevent surface runoff. Routinely check for leaks in underground tanks used to store home heating oil or gasoline.

In karst areas, limestone and dolomite are dissolved by the action of water and form sinkholes, caves, underground drainage systems, and springs. Using sinkholes and caves for waste disposal can contaminate water supply wells.

Collect used motor oil for recycling at oil collection centers located at participating service stations throughout Virginia. Contact your local service stations to find out if they accept used motor oil for recycling.

Practice water conservation. Reduce the amount of water used by installing inexpensive flow restrictors in faucets and shower heads and by using conservation equipment in toilets. Repair leaks promptly. Virginia has abundant ground water, but the quantity is not unlimited.

Each individual discards an average of five pounds of material each day. Practice proper litter control and recycle aluminum cans, newspapers, and paper products. Improve garden soil by composting kitchen wastes and lawn trimmings. Reduction of the amount of solid waste disposed in landfills will contribute to the preservation of ground water quality.

Wells that are no longer usable or are abandoned must be properly sealed to prevent possible contamination of ground water and to preserve the yield and pressure of the aquifer. Wells temporarily abandoned should be sealed with a water-tight cap or well head seal. If the well is permanently abandoned, procedures outlined in Virginia's Private Wells Regulations, VR 355-34-100, section 3.11 Well Abandonment should be followed. The proper sealing of an abandoned well should restore the geological conditions as closely as possible to what existed before the well was constructed. An abandoned well should never be used for disposal of wastes of any kind.

**Pouring used motor oil on the ground can contaminate ground water. Contact your local service station for information on recycling used oil.**

### Conclusion

As a homeowner and well user, the single most important point to remember is that you have a large degree of control over the quality of your ground water supply. Your use of the land and your waste disposal practices can have a detrimental effect on the quality of the well water that you and your neighbors need each day for drinking, washing, and cooking. By being careful about activities that could potentially contaminate ground water, you can help ensure a safe, dependable water supply for years to come.

## For More Information

**Publications**

The following publications may be helpful to well owners.

Manual of Individual Water Supply Systems, 1982. EPA-570/9-82-004. U.S. Environmental Protection Agency, Washington, DC 20460. Available from the National Technology Information System for $27. Doc number PB92117944, (800)553-6847.

Private Well Regulations, VR 355-34-100, Bureau of Sewage and Water Services, Department of Health, April 1992.

A Homeowner's Guide to Septic Systems, Virginia Water Resources Research Center, Virginia Polytechnic Institute and State University, Blacksburg, VA 24060.

Publications available from the American Ground Water Trust, P. O. Box 1796, 16 Centre St., Concord, NH 03301. (603)228-5444. Fax: (603)228-6557.

America's Priceless Ground Water Resource
Before You Hire a Water Witch
Domestic Water Treatment for Homeowners
Everything You Ever Wanted to Know About Septic Tanks
Ground Water Heat Pumps
Ground Water Pollution Control
Water Conservation in the Home
When You Need a Water Well
Rural Drinking Water " Private Wells or Public Water Supply?

Publications available from the Virginia Cooperative Extension Distribution Center, Virginia Polytechnic Institute and State University, Landsdowne St., Blacksburg, VA 24060, (540)231-6192.

Household Water Treatment, publication 356-481.
Interpreting Your Water Test Report, publication 356-489.
Household Water Testing, publication 356-485.
Bacteria and Other Microorganisms in Household Water, publication 356-487.
Hydrogen Sulfide in Household Water, publication 356-488.
Nitrates in Household Water, publication 356-484.
Home Water Quality Problems " Causes and Treatments, publication 356-482.
Questions to Ask When Purchasing Water Treatment Equipment, publication 356-480.
Lead in Household Water, publication 356-483.

## Government Agencies

Your local health department can provide help with problems concerning wells, quality of well water, and septic systems. Virginia Cooperative Extension agents in your area may be helpful in providing information on local ground water conditions, water testing, and water-related information. Telephone numbers for local health departments and extension agents are listed in your phone book under the county or city offices.

## Department of Environmental Quality Regional Offices

Contact your regional office to report suspected ground water contamination incidents.

***Southwest Regional Office***
*355 Deadmore St.*
*P. O. Box 1688*
*Abingdon, VA 24212*
*(540) 676-4800*
*FAX: (540) 676-5584*

***West Central Office***
*3015 Peters Creek Rd.*
*P. O. Box 7017*
*Roanoke, VA 24019*
*(540) 562-3666*
*FAX: (540) 562-3680*

***Northern Regional Office***
*1549 Old Bridge Road*
*Woodbridge, VA 22192*
*(703) 490-8922*
*FAX (703) 490-6773*

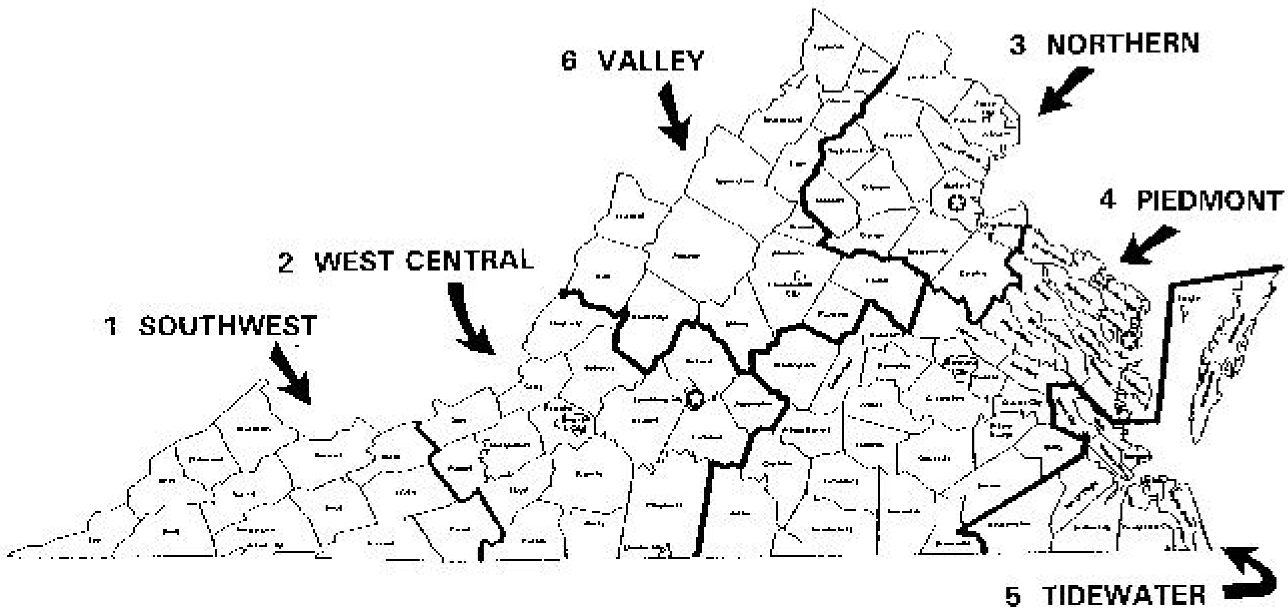
***Piedmont Regional Office***
*4900 Cox Road*
*P. O. Box 6030*
*Glen Allen, VA 23058*
*(804) 527-5020*
*FAX: (804) 527-5247*

***Tidewater Regional Office***
*287 Pembrook Office PK.*
*Pembroke II, Suite 310*
*VA Beach, VA 23462*
*(804) 552-1840*

*FAX: (804) 552-1849*

***Valley Regional Office***
*116 N. Main St.*
*P. O. Box 268*
*Bridgewater, VA 22812*
*(540) 828-2595*
*FAX: (540) 828-4016*

**Figure 12. Department of Environmental Quality Regions and Regional Offices.**




*A Guide to Private Wells* is a publication of the Virginia Water Resources Research Center at Virginia Polytechnic Institute and State University.