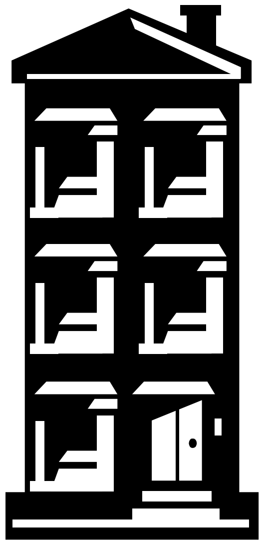
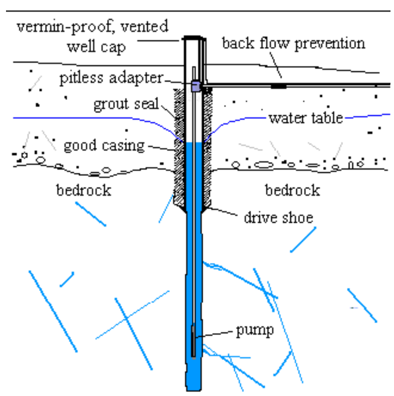


This OLDS House

Managing Your On-lot Drinking-Water (OLDS) System for Homeowners



In Partnership with
Pennsylvania Association of Conservation Districts
Pennsylvania Department of Environmental Protection
Penn State Cooperative Extension
York County Conservation District

Prepared by:
York County Conservation District
Conservation ♦ Stewardship ♦ Education

PREFACE

With country living comes responsibility...

Chances are that you have chosen to live in the country because you cherish the peace and quiet, the wide open spaces, and the beauty of nature. However, with this enjoyment and independence often comes responsibility. Most drinking water supply and sewage disposal in rural areas of York County is done on-lot. As a property owner, you are responsible for maintaining your drinking water well and septic systems. Understanding how they are built, work and how to keep them operating effectively and efficiently is good for your family's health, your household budget, and the environment. Replacing these systems can be expensive.

What you can do for failing well systems...

If you own one of the thousands of groundwater wells in this county, someday you may have problems with it. Drinking water (groundwater from the well) may stop flowing or become unusable on your property. Besides being unsightly, a nuisance, and the cause of health problems, failing groundwater well systems are often difficult and costly to fix. This booklet describes two proven methods that may be effective in restoring failing groundwater well systems: 1) water conservation and 2) groundwater protection. While the initial cost of either method may be slightly greater than the cost of reconstructing a system, both methods have benefits that will, in the long run, save money.

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UNDERSTANDING YOUR GROUND WATER WELL

Water Well Basics

A drinking water well uses groundwater as its source of water. Groundwater exists in the spaces, cracks and fractures in the underground soil and rock formations known as an aquifer. An aquifer is the part of the soil and rock that is saturated with water and can yield water to a well. How much water is available depends on the type of soil and rock below Earth's surface. For instance, some rock formations such as limestone can give large quantities of groundwater, while others like shale and diabase (a hard igneous rock) can yield only small amounts of water.

The groundwater table (or water table) is the top of the water-saturated zone. The water table level is usually maintained by rain water that seeps into the ground. As it soaks into the ground, the water flows toward a discharge point. Typically a nearby spring or stream. An average of 65 percent of all stream and river water in Pennsylvania comes from groundwater. This is known as base flow.

When precipitation decreases and/or water is unable to soak into the ground. From a drought, from paving or when the ground surface freezes in wintertime. Then the water table begins to drop. Over time, stream flows begin to decline as groundwater levels are lowered. The water table normally rebounds as winter ends and spring rains soak into the ground. If those rains don't come, the water table and stream levels drop. An increased demand on groundwater in an area, the decrease of precipitation due to a drought and/or a decrease in water recharge areas from paving, can all lower groundwater levels in a region.

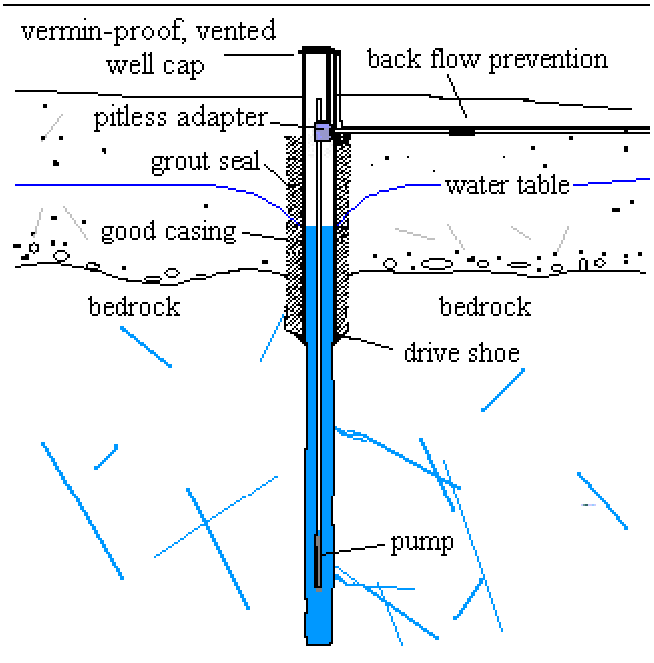


Figure 1. Typical Drinking Water Well

How does a well 'go dry'?
A well works by inserting a pump inside a drilled hole to bring water up and into a house through a pipe. If there is no groundwater available to enter the pump, it sucks air instead of water. When the tap is turned on, nothing comes out. In most cases, this is caused by the underground water table dropping below the level of the well pump.

How much water can my well provide?
When the well is drilled, the water well driller estimates the yield of a well. Wells that are estimated to yield 10 to 20 gallons a minute typically can easily meet all the requirements of a household, although lower yielding wells are generally adequate for most domestic purposes. Wells with lower yields may depend more on the storage capacity of the well. This is why wells with low yields are often drilled deeper to meet the needs of a home. The deep borehole serves as a 'storage tank'. The water level in a low-yielding well will drop faster than in a well that taps a geologic formation that has a lot of water. For this reason, it's helpful to know what your well's yield is. If you have a low-yielding well (less than 5-10 gallons a minute), you should be very careful of how much demand you place on the well.

How long will my well last?
The average life of a well is estimated at more than 20 years. However, over time, the yield of a well typically declines for various reasons. At some point, the well may need to be cleaned out or treated to restore its former condition.

What can I do to prevent my well from running dry?
Most importantly, practice water conservation. You can find water conservation tips on DEP's website at www.dep.state.pa.us (Keyword: .DEP drought.). Try to limit the demand on your well by spreading out your daily water-use activities such as bathing, watering the garden and dish and clothes washing as much as possible during the day and the week. If necessary, take laundry to a local Laundromat to conserve your well water supply.

Drinking Water Well Protection
Invest in water-efficient fixtures for faucets and showerheads, turn off water softeners and replace older toilets with newer, low flow models to save on water use. Take the time to repair any dripping faucets and leaking toilets. These seemingly small measures can save thousands of gallons per year in an average household and help to prevent your well from going dry.

How can I know that my well is running out of water?
This can be difficult to determine. Tap water that is muddy or murky in appearance or other changes in water quality can indicate that the well water level is getting low. Air that gets in the line may cause your spigots to cough and sputter as air comes through the line instead of water. Sometimes there will not be a sign until the submersible well pump is pumping air.

However, one certain way to determine if your well is running out of water is to measure the actual water level. This can be very difficult with a deep well, and you may want to call a water well driller. It's helpful to know how deep your well is, what depth the pump has been set, and what the water level is in the well. Knowing the yield of the well can also help you assess the stability of your water supply.

How can I find out information about my well?
When a well is drilled, the driller is required to provide information about the well to the state and to the well owner. If you do not have this information, in some cases the Commonwealth may have a record of the well. Contact the Bureau of Topographic and Geologic Survey at 717-702-2074. If you know the company that drilled your well, you may be able to contact it for a record.

I turned my water faucet on but nothing is coming out. What can I do?
If you're unfamiliar with your well, and you don't know the location where your water comes into your house, you should probably contact a water well driller, or someone who can find the cause of the loss of water. It could be that the electricity is off or a fuse has blown, since pumps and pressure tanks need electricity to work. The pump, pressure tank or the wiring to the pump can also fail. It also could be that the water level in the well has dropped below the pump.

Can a new well drilled in my neighborhood cause my well to go dry?
Possibly. Well owners have a right to a reasonable use of the groundwater beneath their land; however, as neighborhoods and communities expand, private water wells sometimes compete for the groundwater. If you suspect that a neighbor's private well is affecting yours, DEP can provide little help because water wells are essentially unregulated in Pennsylvania. Private water well conflicts highlight the need for good water planning when land developments are designed.

On a larger scale, if you suspect that your water well is being impacted by a large groundwater withdrawal and you live in central or eastern Pennsylvania, your river basin commission may be able to assist you. Both the Susquehanna and Delaware River Basin Commissions regulate large withdrawals of groundwater in wells used for many agricultural, municipal, industrial and other purposes. In order to withdraw large amounts of groundwater, entities must demonstrate that there is no significant impact on other water resources such as private wells.

Can I hire a tanker truck to pour water down my well?
This should not be done because you will get only as much water as you pour down the borehole. More importantly, you can damage the well's borehole and pump and/or introduce poor quality water from the container or tanker that will contaminate your well.

I have run out of water. Do I have to drill a new well?
After making sure that the well is out of water, you can explore several options before drilling a new well. First, can the well's pump be lowered? If you don't have a record of the well's construction details, a water well driller can determine the depth of the well and the pump. If there's room, the pump can be lowered deeper into the borehole. It's also possible that the well could be deepened without drilling a new well. However, for some situations, it may be as expensive to deepen a well as it is to drill a new well. For example, the well casing may have to be pulled out to allow the driller to drill a deeper hole. A driller may not be able to do this for a variety of reasons.

A procedure called hydrofracturing has been successfully used in 'tight' rock formations like metamorphic and igneous rocks. Using this method, a driller uses high-pressure pumps to open new fractures in sealed off parts of the borehole. This may be cheaper than drilling a second well, but it can be an involved procedure. You should talk to your drilling firm and ask about its experience with hydrofracturing if your well yield isn't adequate. This technique will not work if the water table has dropped below the pump.

Finally, it may be that a new, deeper well is the only solution. See the DEP guidelines on constructing new bedrock well at www.dep.state.pa.us (Keyword: .DEP private wells.). After a new well is installed, the abandoned well should be sealed to protect the aquifer and eliminate any physical hazard. Recommendations for sealing a well are available at the website on private wells.

How can I find a good well driller?
First, drillers must be licensed in Pennsylvania but that doesn't guarantee good service or practices. DEP recommends using a reputable driller and checking the references that they provide. Also, the National Ground Water Association certifies water well drillers. You can access the list of member drillers in your area at www.wellowner.org or by calling 800-551-7379. See tips on .Finding a Contractor. At http://www.wellowner.org/hto-whatis.htm. Check the yellow pages of your telephone book under .Water Wells. or 'Drillers'.

What can I do to make my well water safer?
Proper well construction will help to keep your water supply safe. Other ways include common sense care around the well. See our guidelines for installing wells in bedrock at www.dep.state.pa.us (Keyword: .DEP Private Wells.). Also, sample your well once a year for coliform bacteria. Consider sampling your water if the physical qualities (taste, odor, color, turbidity, etc.) suddenly change. Proper siting of the well can also help.

How can I learn more about groundwater and water resources?

- See the DEP web page on private wells atwww.dep.state.pa.us (Keyword: .DEP private wells. and .water resources.)
- See the Pennsylvania Geologic Survey's The Geology of Pennsylvania's Groundwater at http://www.dcnr.state.pa.us/topogeo/groundwater/groundwater.htm
- Check out EPA's publication EPA *The Water Sourcebooks* at http://www.epa.gov/safewater/kids/wsb/index.html
- Download the Water Resources Education Network publication *Groundwater - A Primer for Pennsylvanians* at http://pa.lwv.org/wren/pubs/primer.html
- Visit the Department of Conservation and Natural Resources. website at www.dcnr.state.pa.us/topogeo/
- Visit the Susquehanna River Basin Commission's website at www.srbc.net or call 717-238-0423
- Visit the Pennsylvania Groundwater Association's website at www.pgwa.org

Water Conservation Tips for Everyone

The average person each day uses about 62 gallons of water, with the majority of water used for clothes washing, toilet flushing and showering, followed by faucet use and leaky fixtures.

- Replace an old toilet with a new 1.6 gallon-per-flush model. This measure can save a typical household from 7,900 to 21,700 gallons of water per year;

- Save over 1,000 gallons per year by placing a plastic jug of water or commercial .dam. in older toilet tanks to cut down on the amount of water needed for each flush;

- Repair dripping faucets and leaking toilets (flapper valves are usually the cause). Repairs can save more than 10 gallons of water per person per day. A faucet dripping at one drop per second wastes 2,700 gallons per year;

- Wash clothes and dishes only when you have a full load. When replacing an older machine, consider high efficiency models, which use an average of 30 percent less water and 40-50 percent less energy, saving about 9 gallons per washing machine cycle and 7.5 gallons per dishwasher cycle;

- Install low-flow, water-efficient showerheads and faucets and save 1 to 7.5 gallons per minute. Taking a quick shower can save an average of 20 gallons of water; and

- Turn off the water when brushing teeth or shaving to save more than 5 gallons per day.

TYPES OF WELLS

There's a good chance that the average Joe who had to dig a well in colonial Pennsylvania probably did the work with his hands, a shovel, and a bucket. He would have kept digging until he reached the water table and water filled the bottom of the hole. Some wells are still dug by hand today, but more modern methods are available. It's still a dirty job, though!

Wells are extremely important to all societies. In many places wells provide a reliable and ample supply of water for home uses, irrigation, and industries. Where surface water is scarce, such as in deserts, people couldn't survive and thrive without ground

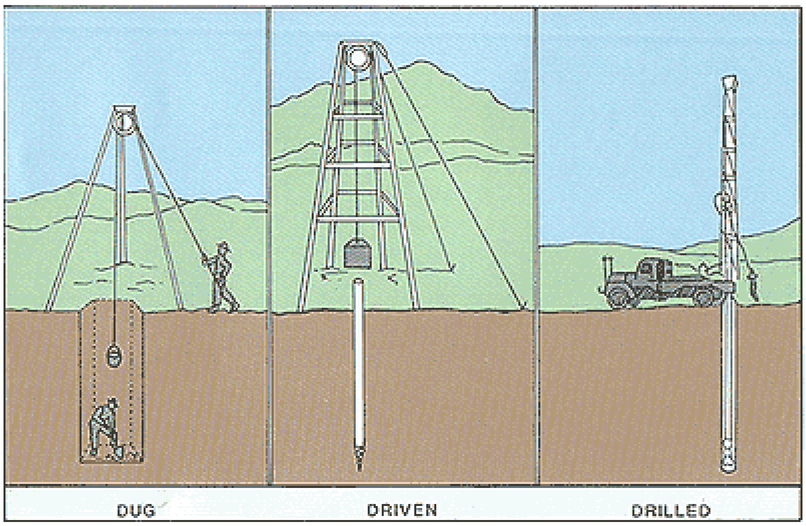


Figure 2. Types of Wells

Digging a well by hand is becoming outdated today (would YOU want to do it?). Modern wells are more often drilled by a truck-mounted drill rig. Still, there are many ways to put in a well -- here are some of the common methods.

Dug wells
Hacking at the ground with a pick and shovel is one way to dig a well. If the ground is soft and the water table is shallow, then dug wells can work. They are often lined with stones to prevent them from collapsing. They cannot be dug much deeper than the water table -- just as you cannot dig a hole very deep when you are at the beach... it keeps filling up with water!

Driven wells
Driven wells are still common today. They are built by driving a small-diameter pipe into soft earth, such as sand or gravel. A screen is usually attached to the bottom of the pipe to filter out sand and other particles. Problems? They can only tap shallow water, and because the source of the water is so close to the surface, contamination from surface pollutants can occur.

Drilled wells
Most modern wells are drilled, which requires a fairly complicated and expensive drill rig. Drill rigs are often mounted on big trucks. They use rotary drill bits that chew away at the rock, percussion bits that smash the rock, or, if the ground is soft, large auger bits. Drilled wells can be drilled more than 1,000 feet deep. Often a pump is placed at the bottom to push water up to the surface.

Water Levels in Wells
Ground-water users would find life easier if the water level in the aquifer that supplied their well always stayed the same. Seasonal variations in rainfall and the occasional drought affect the "height" of the underground water level. If a well is pumped at a faster rate than the aquifer around it is recharged by precipitation or other underground flow, then water levels around the well can be lowered. The water level in a well can also be lowered if other wells near it are withdrawing too much water. When water levels drop below the levels of the pump intakes, then wells will begin to pump air - they will "go dry."

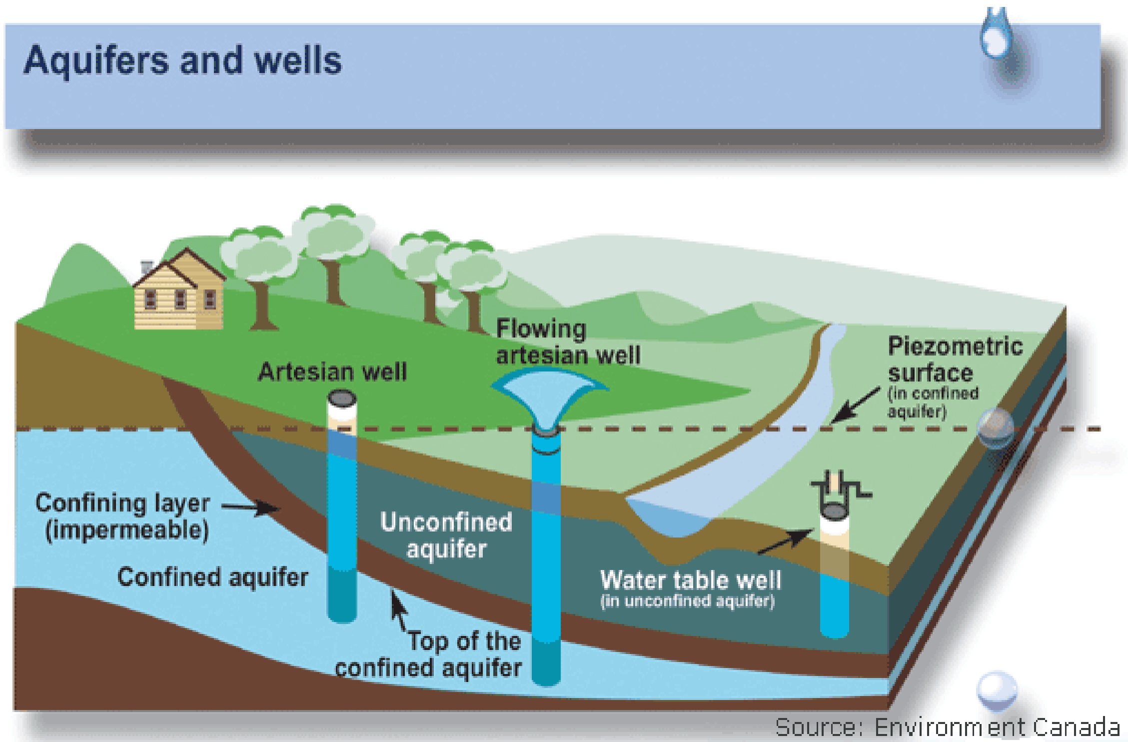


Figure 3. Aquifers and Wells

Information on this page is from Waller, Roger M., Ground Water and the Rural Homeowner, Pamphlet, U.S. Geological Survey, 1982

GROUND WATER QUALITY

Just because you have a well that yields plenty of water doesn't mean you can go ahead and just take a drink. Because water is such an excellent solvent it can contain lots of dissolved chemicals. And since ground water moves through rocks and subsurface soil, it has a lot of opportunity to dissolve substances as it moves. For that reason, ground water will often have more dissolved substances than surface water will.

Even though the ground is an excellent mechanism for filtering out particulate matter, such as leaves, soil, and bugs, dissolved chemicals and gases can still occur in large enough concentrations in ground water to cause problems. Underground water can get contaminated from industrial, domestic, and agricultural chemicals from the surface. This includes chemicals such as pesticides and herbicides that many homeowners apply to their lawns.

Contamination of ground water by road salt is of major concern in northern areas of the United States. Salt is spread on roads to melt ice and, with salt being so soluble in water, excess sodium and chloride is easily transported into the subsurface ground water. The most common water-quality problem in rural water supplies is bacterial contamination from septic tanks, which are often used in rural areas that don't have a sewage-treatment system. Effluent (overflow and leakage) from a septic tank can percolate (seep) down to the water table and maybe into a homeowner's own well. Just as with urban water supplies, chlorination may be necessary to kill the dangerous bacteria.

The U.S. Geological Survey is involved in monitoring the Nation's ground-water supplies. A national network of observation wells exists to measure regularly the water levels in wells and to investigate water quality.

Contaminants can be natural or human-induced
Naturally occurring contaminants are present in the rocks and sediments. As ground water flows through sediments, metals such as iron and manganese are dissolved and may later be found in high concentrations in the water. Industrial discharges, urban activities, agriculture, ground-water pumpage, and disposal of waste all can affect ground-water quality. Contaminants from leaking fuel tanks or fuel or toxic chemical spills may enter the ground water and contaminate the aquifer. Pesticides and fertilizers applied to lawns and crops can accumulate and migrate to the water table.

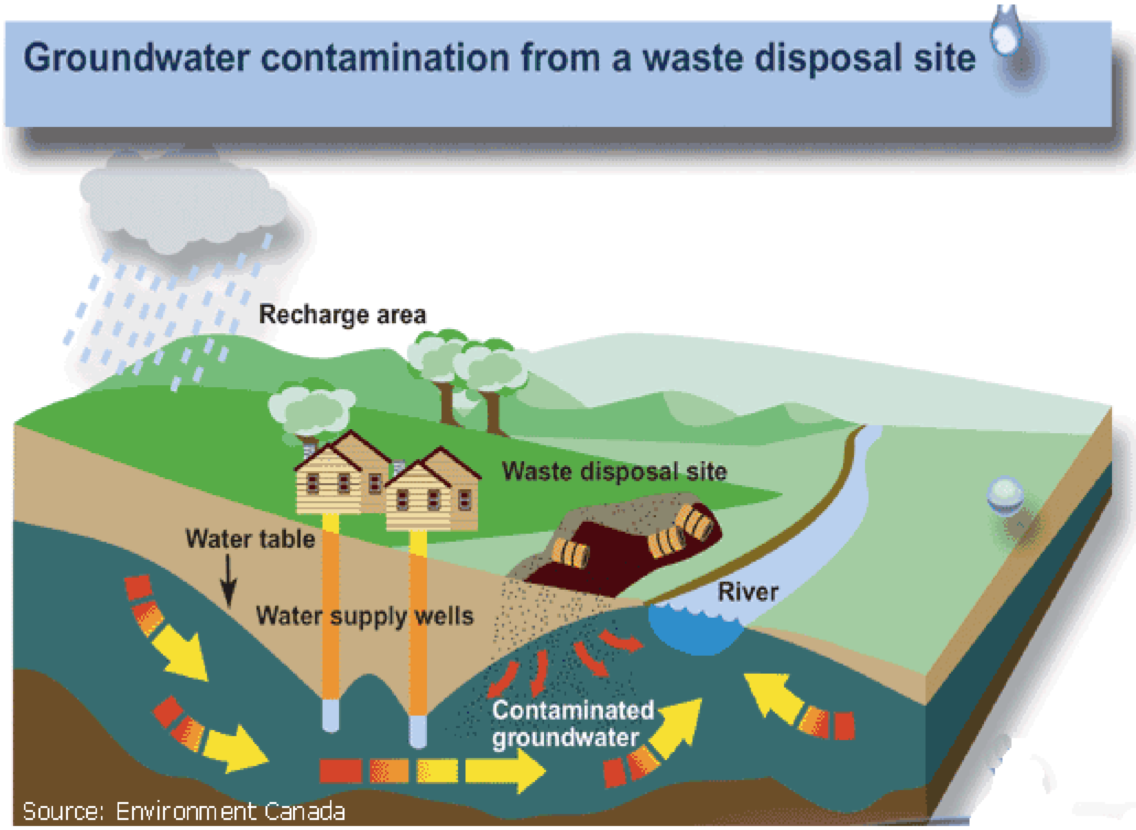


Figure 4. Sources of Groundwater Contamination

The physical properties of an aquifer, such as thickness, rock or sediment type, and location, play a large part in determining whether contaminants from the land surface will reach the ground water. The risk of contamination is greater for unconfined (water-table) aquifers than for confined aquifers because they usually are nearer to land surface and lack an overlying confining layer to impede the movement of contaminants. Because ground water moves slowly in the subsurface and many contaminants sorb to the sediments, restoration of a contaminated aquifer is difficult and may require years, decades, centuries, or even millennia.

Table 1. Inorganic contaminants found in ground water

Contaminant	Sources to ground water	Potential health and other effects
Aluminum	Occurs naturally in some rocks and drainage from mines.	Can precipitate out of water after treatment, causing increased turbidity or discolored water.
Antimony	Enters environment from natural weathering, industrial production, municipal waste disposal, and manufacturing of flame retardants, ceramics, glass, batteries, fireworks, and explosives.	Decreases longevity, alters blood levels of glucose and cholesterol in laboratory animals exposed at high levels over their lifetime.
Arsenic	Enters environment from natural processes, industrial	Causes acute and chronic

	activities, pesticides, and industrial waste, smelting of copper, lead, and zinc ore.	toxicity, liver and kidney damage; decreases blood hemoglobin. Possible carcinogen.
Barium	Occurs naturally in some limestones, sandstones, and soils in the eastern United States.	Can cause a variety of cardiac, gastrointestinal, and neuromuscular effects. Associated with hypertension and cardiotoxicity in animals.
Beryllium	Occurs naturally in soils, ground water, and surface water. Often used in electrical industry equipment and components, nuclear power and space industry. Enters the environment from mining operations, processing plants, and improper waste disposal. Found in low concentrations in rocks, coal, and petroleum and enters the ground and	Causes acute and chronic toxicity; can cause damage to lungs and bones. Possible carcinogen.
Cadmium	Found in low concentrations in rocks, coal, and petroleum and enters the ground and surface water when dissolved by acidic waters. May enter the environment from industrial discharge, mining waste, metal plating, water pipes, batteries, paints and pigments, plastic stabilizers, and landfill leachate.	Replaces zinc biochemically in the body and causes high blood pressure, liver and kidney damage, and anemia. Destroys testicular tissue and red blood cells. Toxic to aquatic biota.
Chloride	May be associated with the presence of sodium in drinking water when present in high concentrations. Often from saltwater intrusion, mineral dissolution, industrial and domestic waste.	Deteriorates plumbing, water heaters, and municipal water-works equipment at high levels. Above secondary maximum contaminant level, taste becomes noticeable.
Chromium	Enters environment from old mining operations runoff and leaching into ground water, fossil-fuel combustion, cement-plant emissions, mineral leaching, and waste incineration. Used in metal plating and as a cooling-tower water additive.	Chromium III is a nutritionally essential element. Chromium VI is much more toxic than Chromium III and causes liver and kidney damage, internal hemorrhaging, respiratory damage, dermatitis, and ulcers on the skin at high concentrations.
Copper	Enters environment from metal plating, industrial and domestic waste, mining, and mineral leaching.	Can cause stomach and intestinal distress, liver and kidney damage, anemia in high doses. Imparts an adverse taste and significant staining to clothes and fixtures. Essential trace element but toxic to plants and algae at moderate levels.
Cyanide	Often used in electroplating, steel processing, plastics, synthetic fabrics, and fertilizer production; also from improper waste disposal.	Poisoning is the result of damage to spleen, brain, and liver.
Dissolved solids	Occur naturally but also enters environment from man-made sources such as landfill leachate, feedlots, or sewage. A	May have an influence on the acceptability of water in

	measure of the dissolved "salts" or minerals in the water. May also include some dissolved organic compounds.	general. May be indicative of the presence of excess concentrations of specific substances not included in the Safe Water Drinking Act, which would make water objectionable. High concentrations of dissolved solids shorten the life of hot water heaters.
Fluoride	Occurs naturally or as an additive to municipal water supplies; widely used in industry.	Decreases incidence of tooth decay but high levels can stain or mottle teeth. Causes crippling bone disorder (calcification of the bones and joints) at very high levels.
Hardness	Result of metallic ions dissolved in the water; reported as concentration of calcium carbonate. Calcium carbonate is derived from dissolved limestone or discharges from operating or abandoned mines.	Decreases the lather formation of soap and increases scale formation in hot-water heaters and low-pressure boilers at high levels.
Iron	Occurs naturally as a mineral from sediment and rocks or from mining, industrial waste, and corroding metal.	Imparts a bitter astringent taste to water and a brownish color to laundered clothing and plumbing fixtures.
Lead	Enters environment from industry, mining, plumbing, gasoline, coal, and as a water additive.	Affects red blood cell chemistry; delays normal physical and mental development in babies and young children. Causes slight deficits in attention span, hearing, and learning in children. Can cause slight increase in blood pressure in some adults. Probable carcinogen.
Manganese	Occurs naturally as a mineral from sediment and rocks or from mining and industrial waste.	Causes aesthetic and economic damage, and imparts brownish stains to laundry. Affects taste of water, and causes dark brown or black stains on plumbing fixtures. Relatively non-toxic to animals but toxic to plants at high levels.
Mercury	Occurs as an inorganic salt and as organic mercury compounds. Enters the environment from industrial waste, mining, pesticides, coal, electrical equipment (batteries, lamps, and switches), smelting, and fossil-fuel combustion.	Causes acute and chronic toxicity. Targets the kidneys and can cause nervous system disorders.
Nickel	Occurs naturally in soils, ground water, and surface water.	Damages the heart and liver of

	Often used in electroplating, stainless steel and alloy products, mining, and refining.	laboratory animals exposed to large amounts over their lifetime.
Nitrate (as nitrogen)	Occurs naturally in mineral deposits, soils, seawater, freshwater systems, the atmosphere, and biota. More stable form of combined nitrogen in oxygenated water. Found in the highest levels in ground water under extensively developed areas. Enters the environment from fertilizer, feedlots, and sewage.	Toxicity results from the body's natural breakdown of nitrate to nitrite. Causes "bluebaby disease," or methemoglobinemia, which threatens oxygen-carrying capacity of the blood.
Nitrite (combined nitrate/nitrite)	Enters environment from fertilizer, sewage, and human or farm-animal waste.	Toxicity results from the body's natural breakdown of nitrate to nitrite. Causes "bluebaby disease," or methemoglobinemia, which threatens oxygen-carrying capacity of the blood.
Selenium	Enters environment from naturally occurring geologic sources, sulfur, and coal.	Causes acute and chronic toxic effects in animals--"blind staggers" in cattle. Nutritionally essential element at low doses but toxic at high doses.
Silver	Enters environment from ore mining and processing, product fabrication, and disposal. Often used in photography, electric and electronic equipment, sterling and electroplating, alloy, and solder. Because of great economic value of silver, recovery practices are typically used to minimize loss.	Can cause argyria, a blue-gray coloration of the skin, mucous membranes, eyes, and organs in humans and animals with chronic exposure.
Sodium	Derived geologically from leaching of surface and underground deposits of salt and decomposition of various minerals. Human activities contribute through de-icing and washing products.	Can be a health risk factor for those individuals on a low-sodium diet.
Sulfate	Elevated concentrations may result from saltwater intrusion, mineral dissolution, and domestic or industrial waste.	Forms hard scales on boilers and heat exchangers; can change the taste of water, and has a laxative effect in high doses.
Thallium	Enters environment from soils; used in electronics, pharmaceuticals manufacturing, glass, and alloys.	Damages kidneys, liver, brain, and intestines in laboratory animals when given in high doses over their lifetime.
Zinc	Found naturally in water, most frequently in areas where it is mined. Enters environment from industrial waste, metal plating, and plumbing, and is a major component of sludge.	Aids in the healing of wounds. Causes no ill health effects except in very high doses. Imparts an undesirable taste to water. Toxic to plants at high levels.

Table 2. Organic contaminants found in ground water		
Contaminant	Sources to ground water	Potential health and other effects
Volatile organic compounds	Enter environment when used to make plastics, dyes, rubbers, polishes, solvents, crude oil, insecticides, inks, varnishes, paints, disinfectants, gasoline products, pharmaceuticals, preservatives, spot removers, paint removers, degreasers, and many more.	Can cause cancer and liver damage, anemia, gastrointestinal disorder, skin irritation, blurred vision, exhaustion, weight loss, damage to the nervous system, and respiratory tract irritation.
Pesticides	Enter environment as herbicides, insecticides, fungicides, rodenticides, and algicides.	Cause poisoning, headaches, dizziness, gastrointestinal disturbance, numbness, weakness, and cancer. Destroys nervous system, thyroid, reproductive system, liver, and kidneys.
Plasticizers, chlorinated solvents, benzo[a]pyrene, and dioxin	Used as sealants, linings, solvents, pesticides, plasticizers, components of gasoline, disinfectant, and wood preservative. Enters the environment from improper waste disposal, leaching runoff, leaking storage tank, and industrial runoff.	Cause cancer. Damages nervous and reproductive systems, kidney, stomach, and liver.

Table 3. Microbiological contaminants found in ground water		
Coliform bacteria	Occur naturally in the environment from soils and plants and in the intestines of humans and other warm-blooded animals. Used as an indicator for the presence of pathogenic bacteria, viruses, and parasites from domestic sewage, animal waste, or plant or soil material.	Bacteria, viruses, and parasites can cause polio, cholera, typhoid fever, dysentery, and infectious hepatitis.

Table 4. Radiological contaminants found in ground water		
Gross alpha-particle activity	A category of radioactive isotopes. Occurs from either natural or man-made sources including weapons, nuclear reactors, atomic energy for power, medical treatment and diagnosis, mining radioactive material, and naturally occurring radioactive geologic formations. Primary concern is natural sources, which are ubiquitous in the environment (Durrance, 1986); secondary concern is man-made sources.	Damages tissues and destroys bone marrow.
Combined radium-226 and radium-228	Enters environment from natural and man-made sources. Historical industrial-waste sites are the main man-made source.	Causes cancer by concentrating in the bone and skeletal tissue.
Beta-particle and photon radioactivity	A category of radioactive isotopes from either natural or man-made sources including weapons, nuclear reactors, atomic energy for power, medical treatment and diagnosis, mining radioactive material, and naturally occurring radioactive geologic formations. Primary concern is man-made sources because of widespread use (Durrance, 1986); secondary concern is natural sources.	Damages tissues and destroys bone marrow.

Table 5. Physical characteristics of ground water		
Turbidity	Caused by the presence of suspended matter such as clay, silt, and fine particles of organic and inorganic matter, plankton, and other microscopic organisms. A measure how much light can filter through the water sample.	Objectionable for aesthetic reasons. Indicative of clay or other inert suspended particles in drinking water. May not adversely affect health but may cause need for additional treatment. Following rainfall, variations in ground-water turbidity may be an indicator of surface contamination.
Color	Can be caused by decaying leaves, plants, organic matter, copper, iron, and manganese, which may be objectionable. Indicative of large amounts of organic chemicals, inadequate treatment, and high disinfection demand. Potential for production of excess amounts of disinfection byproducts.	Suggests that treatment is needed. No health concerns. Aesthetically unpleasing.
pH	Indicates, by numerical expression, the degree to which water is alkaline or acidic. Represented on a scale of 0-14 where 0 is the most acidic, 14 is the most alkaline and 7 is neutral.	High pH causes a bitter taste; water pipes and water-using appliances become encrusted; depresses the effectiveness of the disinfection of chlorine, thereby causing the need for additional chlorine when pH is high. Low-pH water will corrode or dissolve metals and other substances.
Odor	Certain odors may be indicative of organic or non-organic contaminants that originate from municipal or industrial waste discharges or from natural sources.	
Taste	Some substances such as certain organic salts produce a taste without an odor and can be evaluated by a taste test. Many other sensations ascribed to the sense of taste actually are odors, even though the sensation is not noticed until the material is taken into the mouth.	

Some information on this page is from Waller, Roger M., Ground Water and the Rural Homeowner, Pamphlet, U.S. Geological Survey, 1982

GROUND WATER AQUIFERS

One of our most valuable resources is the water beneath our feet - something you can't see and may not even know is there! As you may have read, most of the void spaces in the rocks below the water table are filled with water. But rocks have different porosity and permeability characteristics, which mean that water does not move around the same way in all rocks.

When a water-bearing rock readily transmits water to wells and springs, it is called an aquifer. Wells can be drilled into the aquifers and water can be pumped out. Precipitation eventually adds water (recharge) into the porous rock of the aquifer. The rate of recharge is not the same for all aquifers, though, and that must be considered when pumping water from a well. Pumping too much water too fast draws down the water in the aquifer and eventually causes a well to yield less and less water and even run dry. In fact, pumping your well too fast can even cause your neighbor's well to run dry if you both are pumping from the same aquifer.

In the diagram below, you can see how the ground below the water table (the blue area) is saturated with water. The "unsaturated zone" above the water table (the greenish area) still contains water (after all, plants' roots live in this area), but it is not totally saturated with water. You can see this in the two drawings at the bottom of the diagram, which show a close-up of how water is stored in between underground rock particles.

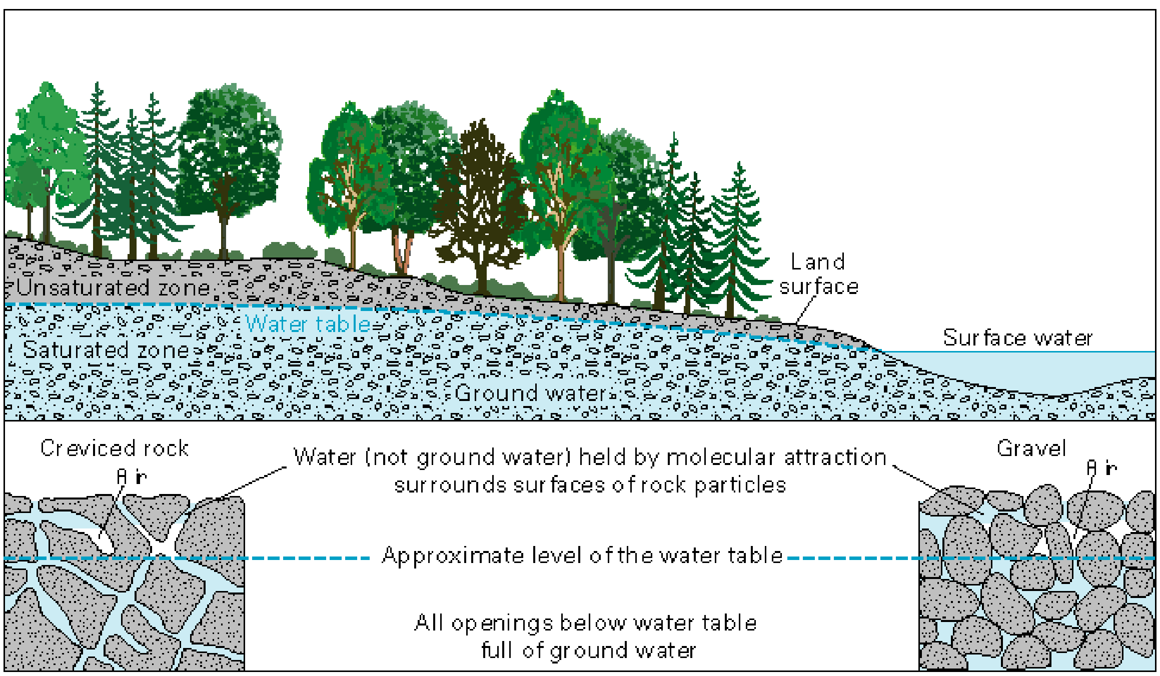


Figure 5. Typical Surface Groundwater Aquifer

Sometimes the porous rock layers become tilted in the earth. There might be a confining layer of less porous rock both above and below the porous layer. This is an example of a confined aquifer. In this case, the rocks surrounding the aquifer confine the pressure in the porous rock and its water. If a well is drilled into this "pressurized" aquifer, the internal pressure might (depending on the ability of the rock to transport water) be enough to push the water up the well and up to the surface without the aid of a pump, sometimes completely out of the well. This type of well is called artesian. The pressure of water from an artesian well can be quite dramatic.

Here's a little experiment to show you how artesian pressure works. Fill a plastic baggie with water, put a straw in through the opening, tape the opening around the straw closed, DON'T point the straw towards your teacher, and then squeeze the baggie. Artesian water is pushed out through the straw.

Some information on this page is from Waller, Roger M., Ground Water and the Rural Homeowner, Pamphlet, U.S. Geological Survey, 1982

GROUND WATER DEPLETION

Ground water is a valuable resource both in the United States and throughout the world. Where surface water, such as lakes and rivers, are scarce or inaccessible, ground water supplies many of the hydrologic needs of people everywhere. In the United States it is the source of drinking water for about half the total population and nearly all of the rural population, and it provides over 50 billion gallons per day for agricultural needs. Ground-water depletion, a term often defined as long-term water-level declines caused by sustained ground-water pumping, is a key issue associated with ground-water use. Many areas of the United States are experiencing ground-water depletion.

Excessive pumping can overdraw the ground-water "bank account"

The water stored in the ground can be compared to money kept in a bank account. If you withdraw money at a faster rate than you deposit new money you will eventually start having account-supply problems. Pumping water out of the ground faster than it is replenished over the long-term cause’s similar problems. The volume of ground water in storage is decreasing in many areas of the United States in response to pumping. Ground-water depletion is primarily caused by sustained ground-water pumping. Some of the negative effects of ground-water depletion:

- drying up of wells
- reduction of water in streams and lakes
- deterioration of water quality
- increased pumping costs
- land subsidence

What are some effects of ground water depletion?

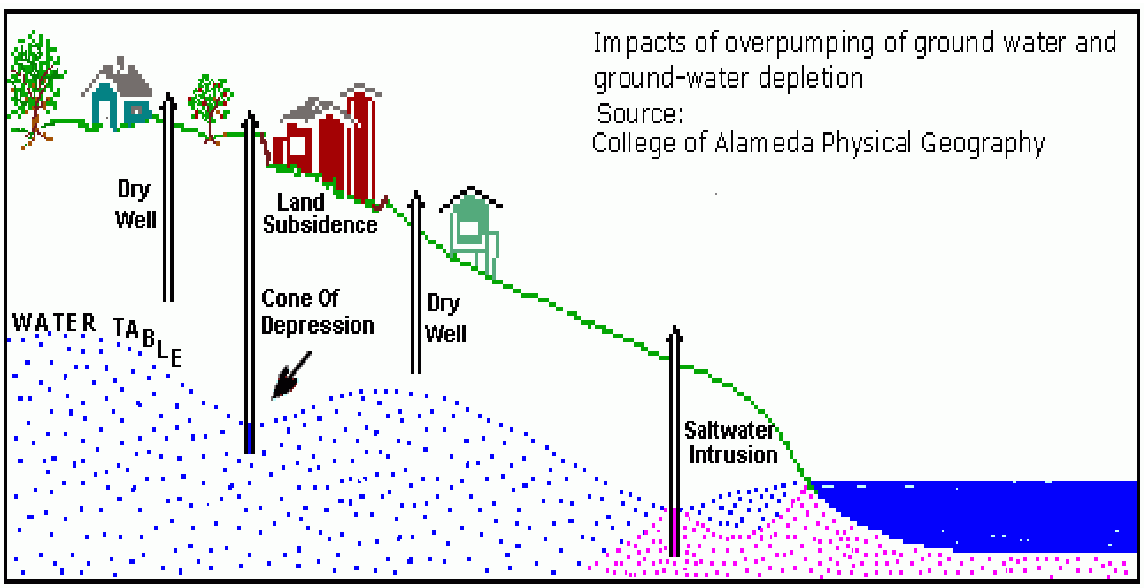


Figure 6. Effects of Groundwater Depletion

Pumping ground water at a faster rate than it can be recharged can have some negative effects of the environment and the people who make use of the water:

Lowering of the water table
The most severe consequence of excessive ground-water pumping is that the water table, below which the ground is saturated with water, can be lowered. For water to be withdrawn from the ground, water must be pumped from a well that reaches below the water table. If ground-water levels decline too far, then the well owner might have to deepen the well, drill a new well, or, at least, attempt to lower the pump. Also, as water levels decline, the rate of water the well can yield may decline.

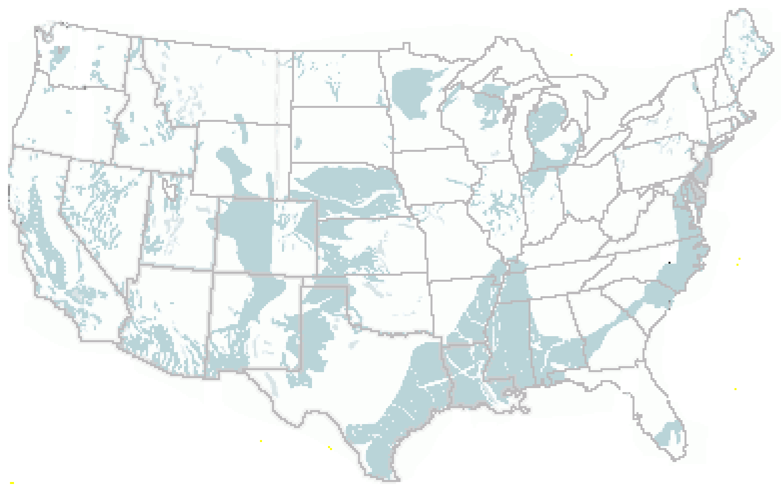
Increased costs for the user
As the depth to water increases, the water must be lifted higher to reach the land surface. If pumps are used to lift the water (as opposed to artesian wells), more energy is required to drive the pump. Using the well can become prohibitively expensive.

Reduction of water in streams and lakes
There is more of an interaction between the water in lakes and rivers and ground water than most people think. Some, and often a great deal, of the water flowing in rivers come from seepage of ground water into the streambed. Ground water contributes to streams in most physiographic and climatic settings. The proportion of stream water that comes from ground-water inflow varies according to a region's geography, geology, and climate. Ground-water pumping can alter how water moves between an aquifer and a stream, lake, or wetland by either intercepting ground-water flow that discharges into the surface-water body under natural conditions, or by increasing the rate of water movement from the surface-water body into an aquifer. A related effect of ground-water pumping is the lowering of ground-water levels below the depth that streamside or wetland vegetation needs to survive. The overall effect is a loss of riparian vegetation and wildlife habitat.

Land subsidence
The basic cause of land subsidence is a loss of support below ground. In other words, sometimes when water is taken out of the soil, the soil collapses, compacts, and drops. This depends on a number of factors, such as the type of soil and rock below the surface. Land subsidence is most often caused by human activities, mainly from the removal of subsurface water.

Deterioration of water quality
One water-quality threat to fresh ground-water supplies is contamination from saltwater saltwater intrusion. All of the water in the ground is not fresh water; much of the very deep ground water and water below oceans is saline. In fact, an estimated 3.1 million cubic miles (12.9 cubic kilometers) of saline ground water exists compared to about 2.6 million cubic miles (10.5 million cubic kilometers) of fresh ground water (Gleick, P. H., 1996: Water resources. In Encyclopedia of Climate and Weather, ed. by S. H. Schneider, Oxford University Press, New York, vol. 2, pp.817-823). Under natural conditions the boundary between the freshwater and saltwater tends to be relatively stable, but pumping can cause saltwater to migrate inland and upward, resulting in saltwater contamination of the water supply.

Where does ground-water depletion occur in the United States?



Areas where subsidence has been attributed to ground-water pumpage (Land Subsidence in the United States, USGS Circular 1182)

Figure 7. Groundwater Depletion Areas of United States

Ground-water depletion has been a concern in the Southwest and High Plains for many years, but increased demands on our ground-water resources have overstressed aquifers in many areas of the Nation, not just in arid regions. In addition, ground-water depletion occurs at scales ranging from a single well to aquifer systems underlying several states. The extents of the resulting effects depend on several factors including pumpage and natural discharge rates, physical properties of the aquifer, and natural and human-induced recharge rates.

Sources and more information

- *Ground-Water Depletion Across the Nation, USGS Fact Sheet 103-03*
- *Sustainability of Ground-Water Resources, USGS Circular 1186*

FREQUENTLY ASKED QUESTIONS ABOUT GROUND WATER WELLS IN PENNSYLVANIA

Do I have to have a permit to install a new well?
The Commonwealth of Pennsylvania does not regulate the construction of or water quality in private wells. However, a few municipalities in Pennsylvania require permits. You should contact your local municipality.

I'm buying a house with a well. Should I test the water? What should I have the laboratory test for?
Testing the water is the only way to know for sure that the water is safe to drink. Pennsylvania does not require testing of private wells, although some county or other local governments may. In addition, financial institutions may require certain water analyses for properties to be sold.

DEP recommends you test your well yearly. At a minimum, have your water tested for coliform bacteria. Nitrates and lead are other common contaminants. Lead can be present from older plumbing systems. These are some of the most common potentially harmful contaminants in private wells. Iron and hydrogen sulfide are common contaminants that cause mainly aesthetic problems; most water can be successfully treated. See DEP's publication, *Citizens Guide on Home Drinking Water Treatment Devices* on DEP's website at www.dep.state.pa.us, Keyword: 'DEP Drinking Water'. Keep in mind, however, that neither DEP nor the U.S. Environmental Protection Agency (EPA) certifies or endorses treatment devices. So you should beware of sellers who say their units are DEP or EPA-certified.

Will the Commonwealth pay for any water quality tests?
Because private water wells are not regulated, DEP does not typically sample private wells unless there is some nearby potential or suspected contamination problem from a regulated facility. It is the responsibility of the well owner to ensure a safe drinking water supply. In general, you should work with a private laboratory to have your water tested.

I had my well water tested and the results are positive for coliform bacteria. Is this harmful?
For bacteria, the results for safe water well should be zero. Drinking water with any coliforms is potentially harmful. This is because *E.coli* is a significant member of the total coliform group of bacteria. The presence of coliform organisms raises a red flag that there could be disease-causing coliforms such as *E.coli*. Also, false positives or sampling errors can occur when water is sampled and analyzed for bacteria. For this reason, we suggest re-sampling.

What do I do if my well has coliform bacteria in it?
Harmful bacteria will be killed by boiling the water. A rapid boil for a minute makes the water safe for drinking. If you're a handy person, you may want to consider your own treatment of the well. A procedure is described under the DEP fact sheet, .Disinfection of Home Wells and springs. Available on DEP's website. However, this procedure should not be considered a permanent solution for a water source that is continuously exposed to bacteria because of poor well construction or contaminated groundwater. It's a good idea to

sample the well again in a month or two after any treatment. If you do find bacteria again, treatment systems for this problem can be installed. Treatment methods like ultraviolet light and chlorination systems will kill the bacteria and any viruses.

What do my water test results mean?
Although there are no standard levels for private wells in Pennsylvania, you can compare your results with maximum and secondary contaminant levels for public drinking water supplies. These values are available on DEP's website.

Should I worry about methane gas in my well?
In some areas of Pennsylvania (especially areas of coal mining and gas well activity), stray methane gas in the subsurface may be a concern that should be taken seriously. Under certain conditions, methane can migrate to private water supply wells and ultimately into a house or structure. Unmitigated, methane can build to explosive concentrations. A proper well vent allows methane to vent to the atmosphere, rather than build up to explosive levels. Since these problems can occur in wells where methane was previously not a concern, it should be routine that all wells are properly vented as a precaution. For proper well venting, you may want to contact an environmental consultant or local well driller.

The risk of an explosion from stray methane varies from location to location based on site-specific conditions. For example, in 1997, a methane explosion destroyed a home in Greene County. Methane gas had migrated through improperly vented water well into the house.

Does it make a difference what kind of well cap you have?
Most well caps in Pennsylvania are loose-fitting caps that sit on top of the casing. A good well cap will protect the well from sources of contamination at the well top. Well caps should be weather tight and vermin-proof, and provide venting while being tightly secured to the well casing. A tight cap prevents insects from entering the well and falling into the water. A screened vent allows air into the well and keeps the well pressure equalized. These caps will typically cost less than $50, depending on the type and who installs it.

We have a lot of earwigs around our well cap. Should we be concerned?
Even if the well is grouted around the casing in a properly constructed well, insects like earwigs may seek sources of moisture and provide a source of coliform bacteria to the well. Earwigs can enter the top of the cap (which is typically a loose fitting steel cap) and be a source of bacteria to the well water. Because they are scavengers, earwigs can carry coliform bacteria into the well. We recommend a well cap that seals the well but has a screened vent. A makeshift solution is to cover the well top with nylon stockings secured with duct tape.

What else can I do to make my well water safer?
Proper well construction will help to keep your water supply safe. Other ways include common sense care around the well. See our guidelines for installing wells in bedrock on DEP's website. Also, sample your well once a year for coliform bacteria. Consider sampling your water if the physical qualities (taste, odor, color, turbidity, etc.) change suddenly. Proper siting of the well can also help.

Where should I site my well?
Wells should be sited at least 100 feet away from sources of contamination such as septic system leach fields, roads, fuel tanks and barnyards. Ideally, the well will be uphill from these pollution sources. Combining these isolation distance guidelines with sound construction practices will go a long way toward protecting the groundwater quality and the user's health.

Should I hire a water witcher to site my well?
There is no scientific evidence that 'water witching', using a forked stick or metal rods to locate 'underground streams of water' works. First, water is typically found in the small fractures, bedding planes and pore spaces in sediments and rocks. Underground streams are rare and occur only in limestone areas (or in old deep-mined areas of coal).

Our new well produces less than a gallon a minute. Is there anything we can do?
Most wells in Pennsylvania produce more than one gallon a minute; however, nearly all rock types can have areas where there are few fractures and consequently low yields.

A deeper well can store water that allows the homeowner to cope with a low-yielding well. Other methods of storing water can be used.

Also, a procedure called hydrofracturing has been successfully applied in .tight. Formations like metamorphic and igneous rocks. Using a packer to seal off zones of a well, a driller uses high-pressure pumps to inject water and open new fractures. These fractures can 'heal', so sand is sometimes added to keep the fractures open.

Hydrofracturing is cheaper than drilling a second well, but it can be an involved procedure. You should talk to your drilling firm and ask about its experience with hydrofracturing if your well yield isn't adequate. However, there is no state requirement for a minimum quantity of water from a private well.

What do I do if my well goes dry?
First, before your well goes dry, develop good water conservation habits. Water conservation tips are available on DEP's website. If your well does go dry, contact a water well driller. Perhaps your pump could be lowered, or the well deepened. Sometimes though, a new well will have to be drilled.

We just drilled a new well and the water smells like rotten eggs. What is going on?
The smell is most likely hydrogen sulfide gas - a fairly common, mostly natural contaminant that occurs in groundwater. It is often associated with certain rock formations like black shales that can have high sulfur content. It does not usually pose a health threat, but it can be a terrible nuisance. It also can be corrosive to metals. Higher concentrations can cause a laxative affect and produce a bitter taste.

Hydrogen sulfide in a well can appear and disappear, but will probably need to be dealt with when its odor is present. Proper treatments can typically control the problem. We would recommend getting your well tested for hydrogen sulfide. The treatment method typically depends on the concentration of hydrogen sulfide. Concentrations up to 6 milligrams per liter (mg/L) can be removed by an oxidizing filter. A new method for treating hydrogen sulfide uses catalytic carbon. Chlorination shock treatment of a well can sometimes be effective if bacteria are causing the production of the hydrogen sulfide gas. For public water supplies, the safe drinking water standard for sulfate is 250 mg/L. This concentration is a secondary maximum contaminant level (for contaminants that affect the taste, color or odor of water).

My water has a very low pH. Is this dangerous?
A pH value is a measure of the hydrogen ion concentration of a substance. Lower values indicate increasing acidity, whereas higher values indicate increasing alkalinity. A low pH is typically not something that needs to be corrected. In Pennsylvania, most groundwater has a pH between 5 and 9. However, the pH of precipitation is typically between 4.0 and 4.7. Soft drinks can have a much lower pH (3). Stomach acids have a very low pH value (2). A low pH has no particular health risk in itself.

EPA has listed pH to be a secondary contaminant, with an acceptable range of 6.5 to 8.5. Secondary contaminants are mainly aesthetic in nature and not health-related. However, the corrosiveness of water generally increases with a decreasing pH. Corrosive water can leach lead from old lead pipes, lead-soldered joints or brass or bronze plumbing fixtures. The presence of lead is a problem that should be corrected. If you have an older house, you may want to test your water for lead. You may be able to purchase a pH neutralizer from a water treatment company to adjust the pH. If you have plastic, non-corrosive pipes, then no action is needed.

Are roadside spring's good sources of water?
Most springs, including roadside springs, are not tested unless they are part of a public water system. Without any information, the user of water from springs should consider their potential problems. Shallow springs often have bacteria and other contaminants present.

We found an old abandoned well on our property. Is this a problem?
There are tens of thousands of abandoned wells across Pennsylvania. Abandoned wells should be properly sealed. Besides the obvious physical hazard, old wells can spread contaminants to different areas of the aquifers. The property owner could be held liable for contamination that an old well causes or spreads.

How do I seal an old well?
Contact a licensed water well contractor. In most cases, this is a job for a driller who can remove old equipment from the well and seal the borehole from the bottom up. See the guidelines for well abandonment on DEP's website.

I know there used to be a well on my property. How can I find it?
Look for any evidence of an old well: windmills, small buildings or vaults. Plumbing fixtures, pipes and pits can also mark a well's location. Old property plans and deeds may show the location of a well.

What laws protect groundwater quality in Pennsylvania?
Although Pennsylvania does not have specific groundwater protection statutes, the Clean Streams Law provides a framework for managing and protecting the groundwater quality in

the waters of the Commonwealth. The Act states that .... "the waters of the Commonwealth shall be construed to include any and all rivers, streams, creeks, rivulets, impoundments, ditches, and other bodies or channels of conveyance of surface and underground (emphasis added) water, or parts thereof, whether natural or artificial, within or on the boundaries of the Commonwealth." The Clean Streams Law protects the waters of the Commonwealth from pollution. Many other laws protect the groundwater through the regulation of specific activities that can pollute ground water.

Where can I have my water tested?

Contact a DEP regional office for a list of commercial certified drinking water laboratories in Pennsylvania, or look up 'Water Testing' or 'Laboratories' in the yellow pages of the telephone listings.

GUIDELINES FOR INSTALLING WATER WELLS

Introduction
This fact sheet contains guidelines for homeowners and contractors on the construction and maintenance of private wells. The guidelines cover construction of open rock wells in fractured rock aquifers.

Open rock wells are the most common type of private water well in Pennsylvania. The typical well has a steel casing set in bedrock with a borehole that taps groundwater in the fractures of the rock.

Additional construction precautions beyond those listed in this fact sheet may be warranted for some wells. Water well constructed without any precautions may be adequate; however, the use of these guidelines will provide better protection of the well owner's water supply. Proper well siting and construction are probably the most effective steps a homeowner can take to protect a private well.

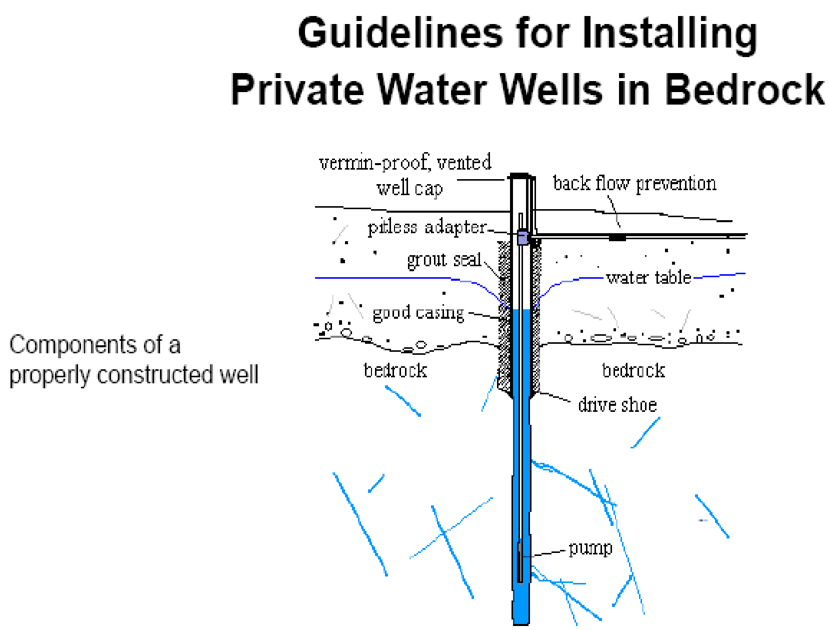


Figure 8. Cross-section View for Installing Bedrock Wells

Background
Private water supplies are unregulated in Pennsylvania. Consequently, homeowners who have their own private water supplies in Pennsylvania are not protected by any regulations or standards.

When a new well is drilled, no state requirements for construction materials, yield or quality apply. State law does require drillers to have a valid rig permit and a Water Well Drillers License. They must also give the state and homeowner a copy of the Water Well Completion report. This report describes where, when and how the well was constructed.

A few local and county governments have adopted standards for private water supplies (i.e. Chester and Montgomery counties). Mortgages associated with federal housing may require certain water analyses for the well. Other lending institutions also may have sampling requirements. But for the most part, private well owners must take responsibility for their own water quality and for maintaining their well.

Reasons for Concern
Almost half of Pennsylvanians get their water supply from groundwater. Although some areas have inadequate amounts of groundwater, sufficient water supplies for a single family home occur just about everywhere in Pennsylvania.

The old saying "you never miss the water til the well runs dry "is true. Except in severe drought, dry wells don't happen often in Pennsylvania. What could be said more often is that 'you never miss the well until you have contaminated water'.

In the past, groundwater was thought to be protected from contamination by the soil layer. We now know that is not necessarily true. Water can pass through the soil with limited filtering of contaminants in many areas (for example, in areas with shallow bedrock, limestone with sinkholes or high water tables). In addition, poor well Components of a properly constructed well construction is increasingly the prime suspect in the presence of bacterial contamination.

Coliform bacteria are a noted contaminant of concern by the U.S. Geological Survey (USGS). In a 1996 study of the Lower Susquehanna River Basin, the USGS found that 'nearly 70 percent of the [146] wells sampled had total coliform present and thus were not suitable for drinking without treatment.' The USGS concluded that poor well construction can allow contaminated surface or shallow groundwater to directly enter the well. Complicating this threat is the fact that microbial contamination can be sporadic and often does not affect taste, appearance, or odor of the water.

A properly constructed well minimizes the threat of contamination entering the well, and keeps people healthy who otherwise might get sick from their own well water.

What Can You Do?
As a first defense, wells should be sited at least 100 feet away from sources of contamination such as septic system leach fields, roads, fuel tank and barnyards. Ideally, the well will be uphill from these pollution sources. Combining these isolation distance guidelines with sound construction practices will go a long way toward protecting the groundwater quality and the user's health.

The homeowner can require the driller to construct a well that protects the water supply. This is slightly more expensive than a traditional well with no such features. However, the increased cost of constructing a .sanitary well may be offset by savings associated with better health of users and protection of the water source, or by preventing the need for costly treatment equipment in the future.

Recommended Construction for Open Rock Wells

Casing . Drillers typically install a steel casing to keep the loose rock and soil from collapsing into the well. Properly installed casing also should keep shallow groundwater and surface water from entering the well. This water is likely to be contaminated and often enters the well by flowing down the outside of the casing. The casing should be new and meet ASTM (American Society of Testing and Materials) standards. Casing should be at least 20 feet in length *and* extend at least five feet into sound bedrock. Finally, the casing should extend at least 12 inches above land surface, more if the area is subject to water accumulations that might enter the well.

Drive shoe. In most cases, a drive shoe should be used to protect the casing from cracking and splitting during installation into bedrock.

Pitless Adapter. This device diverts water laterally below the frost line from the well to a storage tank. It allows the well casing to extend above the ground surface. The pitless adapter should be manufactured by a reputable company and installed so that it is watertight.

Casing Grout. When a casing is installed down a hole, an annular space is created between the wall of the boring and the casing (see figure). If not properly sealed, the annular space becomes an avenue for pollution to move into the water supply. To remove this threat, the annular space should be filled with a watertight sealant, such as a cement-based grout, or a grout and clay mixture. The grout prevents contaminated surface water from seeping down along the casing directly into the groundwater. To ensure a watertight seal, the annular space should be filled from bottom to top. This is typically done by placing a pipe in the annular space and pumping the sealant as the pipe is withdrawn. The annular space should be grouted from the casing bottom to at least the base of the pitless adapter. For long casing lengths, the driller should grout at least 30 feet of casing to the pitless adapter.

It is recommended that the driller construct the well in two steps. The first step is the drilling of the hole into firm bedrock, and installing and grouting the casing. The second step would be to drill the hole to the desired depth (after allowing the grout to cure).

There may be instances where grouting could be effectively done after completing all the drilling. In either case, care should be given to make certain the casing seals off shallow water, and that grout is not placed into the open rock portion of the well.

Development, Yield and Disinfection

The driller should develop the well by cleaning out the fine material. The driller typically estimates the well's yield at this time. A two- to four-person household typically requires 125-250 gallons of water per day. After the development, the driller should disinfect the well to kill any organisms that may be introduced during the construction. The driller must provide a copy of the well construction record to the owner, who should keep it as a permanent record. Information on the well depth, water level (with no pumping), well yield and the depth of the pump should be included. The well should be topped with a vermin-proof, vented cap that can be locked.

Testing the Water Quality

The water may *look fine,* but could have undesirable substances. Sanitary well construction is no guarantee of safe water quality. If the aquifer is contaminated, then the construction of the well won't help. For this reason, the water should be tested yearly for total coliform bacteria and nitrates. In addition, the well owner may want to test for additional substances.

Common undesirable substances in groundwater include coliform bacteria, nitrates, hydrogen sulfide and excess iron, manganese, lead and turbidity. Volatile organic compounds and petroleum products are released to the groundwater from such sources as spills and underground storage tanks. It is recommended that a DEP certified laboratory for drinking water be used for the analysis. A list of certified laboratories can be obtained from a DEP regional office or website. An annual check on the water and the well is a good idea.

After the Well is Drilled

The well owner can take precautions to prevent problems by establishing their own wellhead protection areas… This involves keeping potential contaminants away from the well.

- Keep livestock or the family pet away from the well.
- Do not dispose of waste into basement or garage floor drains.
- Take used oil to a recycling center. Never dump it on the ground. Yes, the oil may have initially come out of the ground, but it wasn't from a drinking water well.
- Mix pesticides or paints over a sidewalk or concrete pad, away from the well; apply fertilizers and pesticides with caution.
- Be careful where you dispose of waste or where you wash equipment.
- Don't allow back-siphonage from a container or tank into a well; install a backflow preventer or keep hoses out of mixing containers or tanks.
- Properly dispose of household chemicals and refuse.
- Sinkholes are probably the worst place to put trash. Usually, a sinkhole is a direct connector to groundwater.
- Properly seal old abandoned wells.
- And remember, water drawn from a well most likely originated nearby as rainfall or snowmelt. Good land use practices can pay off with good water quality.

DISINFECTION OF WELLS AND SPRINGS

Editor's Note: The disinfection procedure described below is only a temporary measure for use by homeowners to treat for bacteriological contamination (not including the organisms that cause giardiasis or cryptosporidiosis) and may not be used by public water suppliers. It should not be considered a permanent correction for a home groundwater source that is continuously exposed to microbiological contamination due to improper location and/or construction.

Disinfection of a home groundwater source should be performed under any of the following conditions:

- After completing construction of a new well or spring supply;
- When repair or reconstruction of a well or spring, pumps or attached piping is completed;
- If the well or spring has been temporarily flooded or subjected to another temporary source of bacteriological contamination;
- Upon receipt of a laboratory report indicating an unsatisfactory bacteriological analysis of the well or spring supply

MATERIALS NEEDED

You will need a two-gallon or larger bucket, a length of garden hose long enough to reach as far as possible into the home water source, a funnel that fits into the end of the garden hose, and a suitable quantity of a liquid or granular chlorinating compound.

Chlorinating compounds are sold at grocery, hard-ware, plumbing, and swimming pool supply stores under various trade names. You should look for one of the following:

1. Liquid Forms
   - Unscented laundry bleach containing five to six percent sodium hypochlorite
   - Sodium hypochlorite solution containing five to 14 percent sodium hypochlorite

NOTE: Do not use laundry bleach containing scent additives. These additives should not be consumed. Since liquid laundry bleach weakens with time, obtain a fresh supply rather than using old laundry bleach you may have at home.

2. Granular Forms
   - Swimming pool granules containing 65 to 70 percent calcium hypochlorite
   - Calcium hypochlorite granules (65 to 70 percent)

NOTE: Do not use stabilized chlorine products that are meant for swimming pools or non-chlorinated "pool shock" products. These products are not intended for disinfecting wells or springs. There are fast dissolving pellets containing chlorine that are specifically made for disinfecting wells. This should not be confused with the larger stabilized chlorine pellets (one to three inches in diameter) that should not be used. Please check the product label.

Chlorinating products must be handled in accordance with the manufacturer's directions. Failure to follow instructions could cause bodily injury. Wearing eye and body protection during the procedure is strongly recommended. Do not drink well water containing high levels of chlorine. The water should be tested for bacteria after the disinfection procedure has been completed. Until tested and found potable, bring the water to a rolling boil for at least one minute before consuming or using for food preparation.

PROCEDURE

1. First, remove any cover over the well casing or spring vault to allow access to the water source.

2. Then, add the appropriate amount of chlorinating compound (see below) to three or four buckets of water (6 to 10 gallons total) and mix thoroughly.
   - For liquid chlorinating products with 5 to 6 percent available chlorinating chemical, use about 1½ quarts of the chlorinating product.
   - For liquid chlorinating products with more available chlorinating chemical, reduce the amount used. For example, for products with 10 percent, use about ¾ quart or for products with 14 percent, use about ½ quart of the chlorinating chemical.
   - For granular chlorinating chemicals with 65 to 70 percent available chlorinating chemical, use about 4 ounces (10 tablespoons) of the chlorinating product.
   - The process of mixing the appropriate amount of chlorinating product with six to ten gallons of water is important for the following reasons:
     - It helps to mix the disinfectant evenly through the water in the well and force the disinfectant into the surrounding water-bearing rocks.
     - It prevents the concentrated chlorinating chemical from corroding the metal pump and other metal parts of the well.

3. These amounts of chlorinating products will disinfect about 150 gallons of water to 100 - 150 parts per million (ppm). That corresponds to 100 feet of water in a 6-inch diameter well, a spring vault with inside dimensions of 5 feet long by 5 feet wide and a water depth of 1 foot, or a dug well with an inside diameter of 5 feet and a water depth of 1 foot. If your well or spring holds more or less water, the amount of chlorinating product should be increased or decreased proportionately.

4. Place one end of the garden hose into the well or spring (remove the pump, if necessary) so that the hose is as far into the well or spring as possible.

5. Place the funnel into the other end of the hose and, with help, pour the contents of each bucketful of diluted chlorinating product through the hose while alternately rising and lowering the hose to disperse the disinfectant throughout the water supply.

6. When the appropriate amount of disinfectant has been added to the water supply, do the following:
   - If the water source has no pump, close the cover over it.
   - If the water source has a pump or is piped to a house or other outlets, draw the chlorinated water through all the fixtures and outlets until the smell of chlorine is noticed, so that all of the piping and fixtures are disinfected. After the odor is noticed, turn off the water at the fixture or valve outlet.
   - In some cases involving wells, running the water from fixtures may not produce a chlorine odor quickly. In those cases, it may be necessary to run the water from an outside faucet through a garden hose and back into the well to further mix the chlorinating chemical into the well water.

7. The chlorinating solution should remain in the entire water supply system for at least four hours and preferably overnight. The water should be pumped out after that period until no odor of chlorine remains at the fixtures and outlets. Please avoid discharging water containing detectable amounts of chlorine into storm drains, waterways, ponds, creeks, etc. Fish and aquatic animals are very sensitive to very low levels of chlorine and can be killed.
8. Once the water source is chlorine-free, wait an additional 2-5 days and then resample for bacteria. If total coliform organisms are present, the water should not be consumed unless it is brought to a rolling boil for at least one minute. If total coliform organisms are not found, the water is considered bacteriologic ally potable. However, the well or spring should be sampled for bacteria at least annually.

9. If the well or spring continues to be contaminated after disinfection and sampling or is found to be contaminated as the result of a future sample, the construction or location of the water supply should be re-evaluated.

BIBLIOGRAPHY

1. Disinfection of Home Wells and Springs Fact Sheet, PADEP.
2. Frequently Asked Questions About Private Water Wells in Pennsylvania Fact Sheet, PADEP.
3. Guidelines for Installing Private Water Wells in Bedrock Fact Sheet, PADEP.
4. Pennsylvania Department of Environmental Protection web site. www.dep.state.pa.us
5. Understanding Your Drinking Water Well Fact Sheet, PADEP.
6. Water resources information on: www.sfr.cas.psu.edu/water.
7. United States Geologic Survey, Water Science web site http://ga.water.usgs.gov/edu/earthgwwells.html

APPENDICES

A. Commercial Water Testing Services

B-H Labs, 978 Loucks Mill Road, York, PA (717) 852-1600
Labs Inc., 409 North Avenue, East Berlin, PA (717) 259-6550
Lancaster Labs, 2425 New Holland Pike, Lancaster, PA (717) 656-2300
Water Supply Management, 150 Roosevelt Avenue, York, PA (717) 771-4481

B. Offices of Pennsylvania Department of Environmental Protection

Department of Environmental Protection
Bureau of Water Supply and Wastewater Management
Division of Wastewater Management
P.O. Box 8774
Harrisburg, PA 17105-8774
(717) 787-8184

South-central Region
909 Elmerton Ave.
Harrisburg, PA 17110
Main Telephone: 717-705-4700
24-Hour Emergency: 1-877-333-1940
Counties: Adams, Bedford, Berks, Blair, Cumberland, Dauphin, Franklin, Fulton, Huntingdon, Juniata, Lancaster, Lebanon, Mifflin, Perry and York

C. Other Contacts

1. Thomas R. McCarty, Ph.D., Multi-County Agent, Penn State Cooperative Extension, 110 Claremont Road, Carlisle, PA 17013-8802. Phone: (717) 240-6500. Fax: (717) 240-6548.
2. Gary R. Peacock, Watershed Specialist, York County Conservation District, 118 Pleasant Acres Road, York, PA 17402. Phone: (717) 840-7430. Fax: (717) 755-0301. E-mail: yorkccd@yorkccd.org. Internet: www.yorkccd.org.

D. PennVEST Financing [Reserved]

E. Alternative Drinking-Water Systems [Reserved]

York County Conservation District

Who are we?

The York County Conservation District is the county government office that handles environmental concerns. The District was founded in 1938 when 554 farmers from 18 townships signed a petition. Since the beginning, the office has been citizen directed. Education has been consistently labeled as a priority area of focus. The education office officially began in November 1996 although the District has been active in education programs for more than 15 years.

Our mission

The York County Conservation District commits to being an innovative leader, assisting and educating the public to make the best choices for conserving and preserving our natural resources.

Contact Information

York County Conservation District

118 Pleasant Acres Road

York, PA 17402

Telephone: 717-840-7430

FAX: 717-755-0301

Email: mailto:yorkccd@yorkccd.org

Web: www.yorkccd.org