The Private Well Class

FREE ONLINE TRAINING *for* HOMEOWNERS WITH WATER WELLS

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Welcome to The Private Well Class. This is a self-paced email class delivered in 10 weekly lessons. Each lesson has been designed to take just 15 minutes of your time to read. To extend your learning, we have a series of three live web trainings ("webinars") you can register to attend. We'll be repeating this series through August. Let's get started with this week's lesson!

Class Pre-Test

To assess your current knowledge, we'd like to invite you to complete our short class pre-test. While scores are recorded for us, your individual participation is anonymous and not tracked.

Click here to take the pre-test.

Lesson 1 - The Science of Groundwater

Why this lesson is important: Knowing the geology of your well provides you with an understanding of possible sources of contamination, as well as how much water your well might be able to pump. It puts the science behind why some wells might run out of water, why others have plenty of water, why some wells are less likely to get contaminated and why others are more susceptible to water quality problems.

The Hydrologic Cycle

Water is ever moving. Water moves by many processes, including precipitation, evaporation, runoff, infiltration, plant uptake, percolation, and transpiration (Figure 1). The water you are drinking today has likely been through the hydrologic cycle countless times in the past. It's been in the oceans, on a different continent—someone else might've even drunk it before. It's a continuous, ever changing cycle.

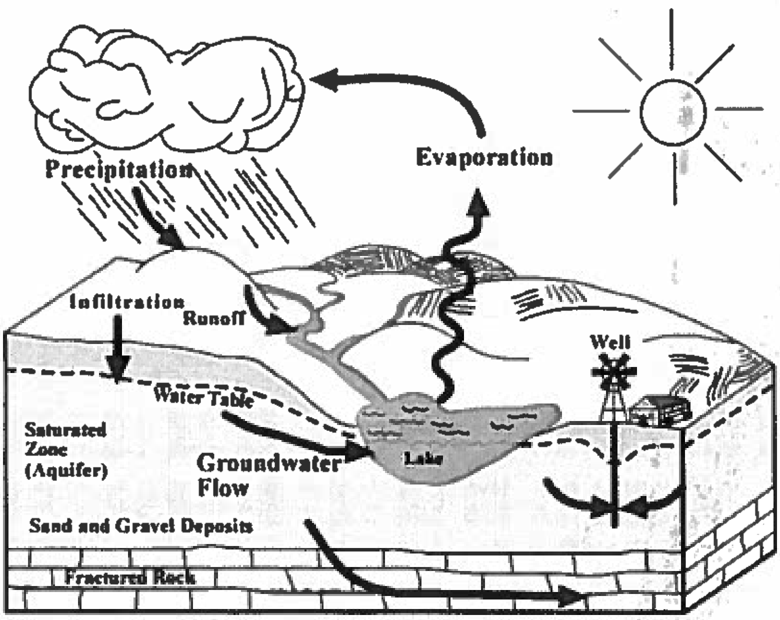


Figure 1 - The Hydrologic Cycle. Source: Minnesota Department of Health

The water in the ground today infiltrated into the ground from the surface. What wasn't used by plants or held in the soil, migrated down through the soil zone to the water table to become groundwater. As groundwater, it is held in the open spaces (pores and fractures) between soil particles and rock. The water table is the point where the pore spaces are completely filled (saturated) with water (Figure 2).

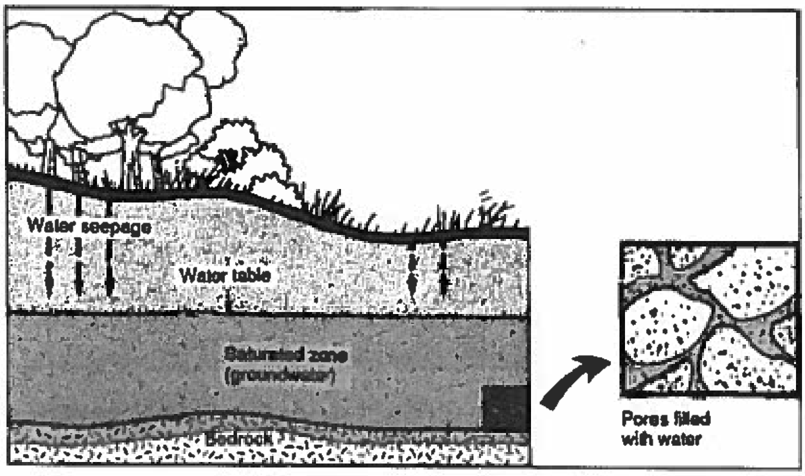


Figure 2 - The Water Table. Source: New York State Water Resources Institute.

It doesn't stop there though. Because water flows downhill, pressure from water above "pushes" water through the ground to areas of lower pressure, both horizontally and vertically. It can continue to migrate downward through different geologic units, or move horizontally through a single geologic material to a point of discharge. In the hydrologic cycle, this is generally a low point on the landscape where water can discharge to a lake, stream, or ocean (Figure 3). Then it starts the cycle all over again. As shown in Figure 3, sometimes water can spend thousands of years in the ground before making its way back to the surface.

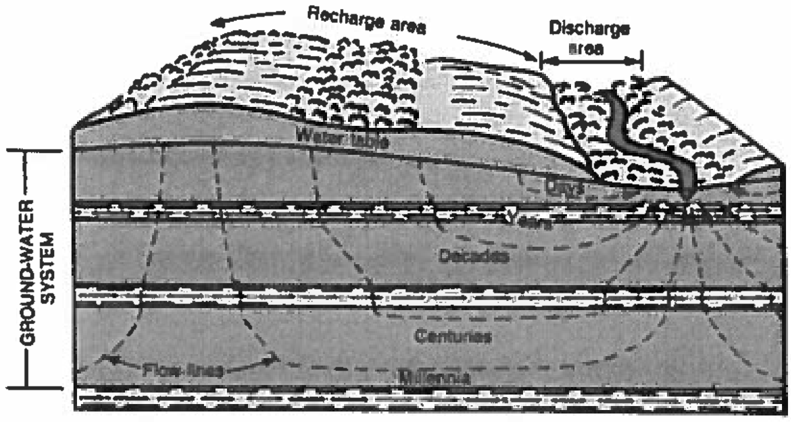


Figure 3 – Recharge. Source: USGS.

Groundwater recharge is typically, but not always, a local process whereby the rainfall that infiltrates into the ground eventually makes it into the geologic formations below where it is stored in the pore spaces between soil materials (unconsolidated sands, silts, and clays) or in open crevices and fractures in bedrock (consolidated material). Your well taps into these geologic units and allows you to pump water to your home.

Aquifers

An *aquifer* is a geologic unit, either unconsolidated sand and gravel or consolidated bedrock, that can provide useable quantities of water to a well. That means that there has to be both sufficient water available in the aquifer for the well to pump (porosity) and that water has to be able to flow through the aquifer easily enough to supply the well as it is pumped (permeability). The geologic units that slow the movement of water are called confining layers, or *aquitards*. There can be multiple aquifers and aquitards at a single location as shown in this example from Eastern Texas (Figure 4).

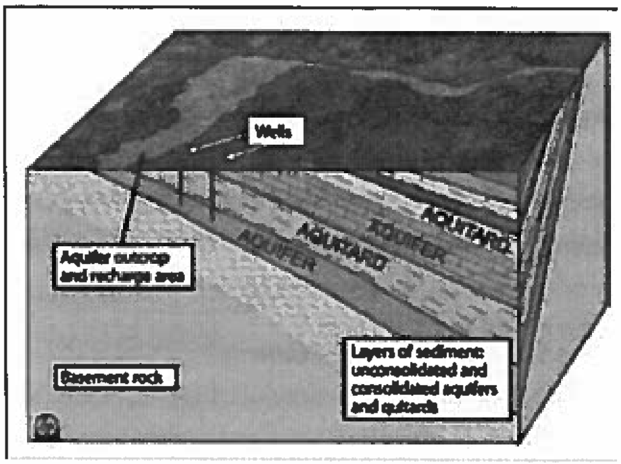


Figure 4 – Example of Multiple Aquifers and Aquitards. Source: Texas A&M AgriLife Extension.

Porosity is a measure of the relative volume of pore space per unit volume of geologic unit. So, an aquifer with a porosity of 25% means that 25% of the total space it occupies is void space, full of air or water. Porosity can vary greatly. A sand and gravel aquifer for instance, can have a porosity of 20-30%. Clay can even have higher porosity, upwards of 50%. Bedrock can be highly fractured and creviced giving it an overall moderate porosity, or it can be almost solid throughout with a porosity of only a few percent. If your well is in a geologic unit with low porosity, you might have limited water availability. In many bedrock aquifers, if a well doesn't go through multiple or large fractures or crevices, water availability can be limited to just a few gallons a minute or less.

How easily water can flow through an aquifer also determines its ability to provide water to a well. This is defined as an aquifer's *permeability*. Large grained unconsolidated deposits, like sands and gravels, have high permeability, meaning that water can flow between the grains easily to a well. But as the particles get smaller, it gets harder and harder for water to move through them, lowering the permeability. So, really small particles, like clays and silts, may have high porosity (up to 50% water by volume), but because it's so hard for the water to move around the particles to a well, geologic units made up of clay and silt are generally considered to be aquitards. This concept is important because a well generally draws water from an area of the aquifer around the well. If water can't get to the well freely, it will limit the pumping rate, and pumping at too high a rate will draw down the water in a well to the pump intake, interrupting the water supply.

In bedrock aquifers, most of the water is stored in fractures and crevices, the rock itself isn't very porous and doesn't hold much water in the rock material itself. One exception to this is sandstone, which not only has fractures and crevices, but also can hold water in the rock itself where not completely cemented. To be an aquifer, a bedrock unit has to have sufficient fracturing and crevices, as well as connections between those openings, to supply sufficient water to a well.

(Figure 5) describes the typical permeability for the major types of aquifer materials. As you can see, sands and gravels can allow water to move through them at a rate of as much as 3000 feet a day, while some clays can restrict movement of water almost completely. This isn't to say that water does move through some aquifers that fast, but it says that's the upper limit. High permeability also means that a well can be pumped at a higher rate with less drawdown (i.e. lowering of the local water table) compared to a well in an aquifer with lower permeability.

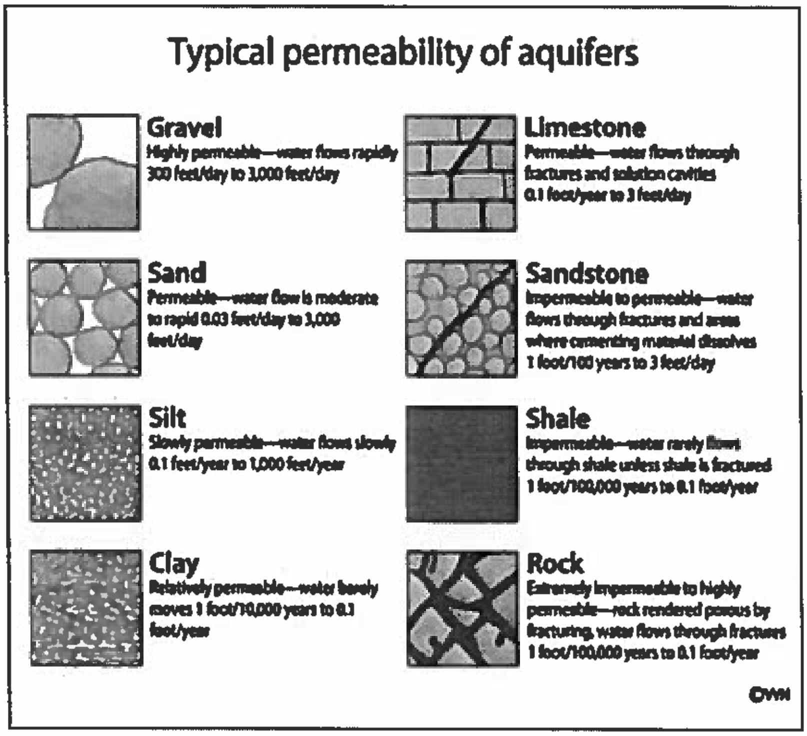


Figure 5 – Typical Permeability of Aquifers. Source: Texas A&M AgriLife Extension.

One more point about recharge. Sometimes in deeper aquifers, the area that recharges the aquifer can be some distance away from your well. (Figure 4) shows a good example of this. The aquifer shown in blue is being recharged in the area on the left where the unit comes to the surface. If you had a well in that aquifer, but it was on the right side of the figure, not only would you be drilling a deeper well to reach the aquifer, but the water for your well would be coming from the recharge area, moving through the aquifer from left to right. There is no scale on this figure, but the distance could either be a mile from the left to right side of the figure, or it could be a few hundred miles.

The aquifer you get your water from and how that aquifer is recharged will tell you a lot about your water supply. Like other natural resources, the groundwater available to you is dependent on your local conditions, mainly the geology of your location. In some cases, you might have options where multiple aquifers are available, but for many there may only be one choice. The groundwater basics shown in (Figure 6) demonstrate an example of possible multiple aquifers.

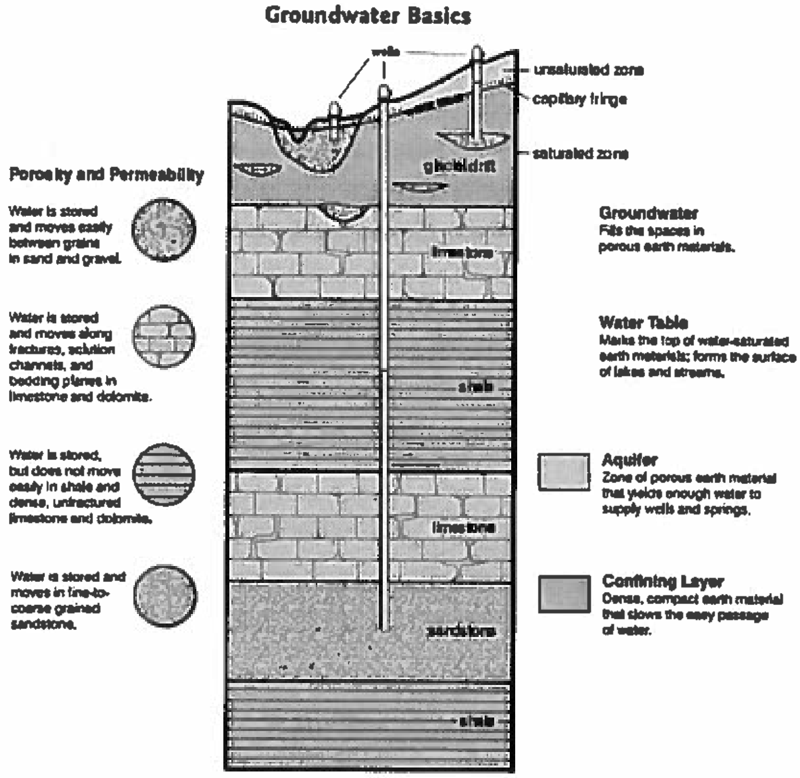


Figure 6 – Groundwater Basics. Source: Iowa Department of Natural Resources.

For some well owners, there is no "real" aquifer available for water supply, there are no sand and gravel aquifers, nor are there dependable bedrock aquifers. It could be that the groundwater in deeper geologic units isn't potable, in other words is unfit to drink. An example of this would be a bedrock aquifer that contains saltwater. In cases like that, the only groundwater option might be a shallow dug or bored well. These wells are meant to be storage reservoirs, collecting water from near surface infiltration and/or thin lenses of sand in areas that are otherwise mostly clay or silt based geology.

Additional Steps

To find out more about the aquifer that supplies your well, talk with your state agencies that maintain the well logs in your state and those that conduct geologic mapping projects for your state. In most cases, that will be the state Geological Survey, state Department of Health, and/or state Department of Natural Resources. In some states, those responsibilities belong to different agencies, like the Water Development Board in Texas, for example. A call to your local or county health department or Cooperative extension service should provide you with the contacts you need. You can also Google "[your state] well logs" to find the agencies that store well logs or have them available. Your state has spent years mapping aquifers to better understand how much water might be available, as well as what possible water quality issues there might be. It's worth your time to find out whom in your state or area has the knowledge to assist you; they will be glad to help. If you have problems finding the correct agency, let us know and we will try to help.

The best source of information about your well is probably your well log and your driller. Your driller can explain your geology to you, or you can ask the state folks to do the same. If you don't have your log, then your state agency can help you find it, if it is on file, or you can contact your driller and request a copy. If you contact your state to find your log, you will need to know the legal description of the well location, and/or possibly the latitude and longitude. It's also important to know the depth. If your well is old, or there is no log, then they can use nearby logs to give you information about the geology of the area.

If you know very little about your well, especially the depth, then it's important and worth the effort and expense to have a professional contractor (driller or pump installer) come out and collect that information for you about your well. If you don't know how deep your well is, you have no idea where your well water is coming from, where your pump is set, or any other information that you might need if you have a problem with the water supply from your well. The National Ground Water Association has a page where you can look up information about nearby contractors.

Additional Resources

Visit our Resources area at The Private Well Class for a list of resources used to develop this content and materials for further reading.

ERA Cristopher Creek

Subject: FW: [Private Well Class] Lesson 2

From

The Private Well Class
FREE ONLINE TRAINING *for* HOMEOWNERS WITH WATER WELLS

Welcome back to The Private Well Class. **Are you enjoying the class so far?** Make sure to like The Private Well Class on Facebook for additional water information and homeowner tips.

Lesson 2 - Groundwater and Well Contamination

Why This Lesson is Important: Now that we have an idea of how water is stored in the ground, and how the geology affects its movement and availability, we are going to look at how it moves to your well and what can happen as it does. In particular, we'll discuss how water level, flow, and water quality can be affected when pumping a well. You'll also learn how contaminants can move with groundwater or be affected by groundwater flow and pumping. This lesson will give you the background to understand how pumping your well can influence groundwater flow and introduces the value of source water protection.

Groundwater Flow

Water flows naturally in a groundwater system based on the hydraulic pressure put on the system. The flow can be horizontal though a geologic unit or vertical through several different geologic units, or sometimes some of both. In Lesson 1, Figure 1 was used to show how water moves naturally though a groundwater system. The thin layers with horizontal dashes in Figure 1 represent confining layers (aquitards) that separate the aquifers shown in blue. As you can see on the figure, because the high point of the water table is near the left edge, water is flowing downward from the high point toward areas of lower water levels in both directions (lower levels = less pressure).

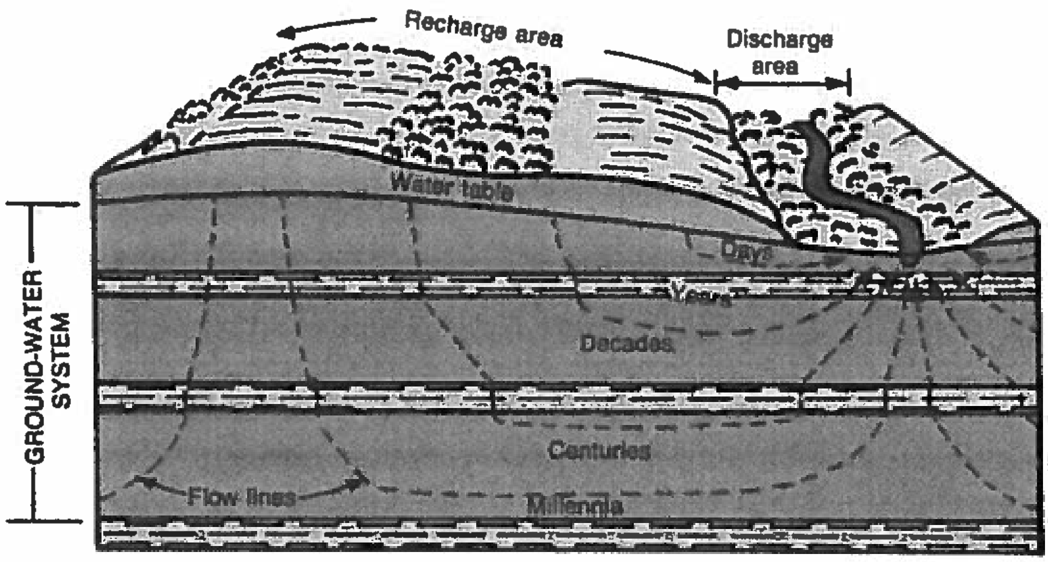


Figure 1 - Recharge and Groundwater Flow. Source: USGS.

If separated by confining layers, water levels in different aquifers at a single location can be very different. When an aquifer has the water table as its upper saturated surface, that aquifer is called a water table aquifer. The aquifer isn't completely saturated; there is air in the pore spaces in the aquifer material above the water table. The water level in a water table well will be at the water table elevation, which is below the top of the aquifer.

When an aquifer is below a confining unit, the situation is different. The water level in a well in a confined aquifer can be above the top of the aquifer. This happens when the confined aquifer is getting recharge from a location with a much higher water level. Figure 2 shows a simple system with both a water table well in a shallow aquifer and two deeper wells in a confined aquifer. The pressure on the system at the deep well labeled the "artesian well" forces water up into the well to nearly the same elevation as at the recharge area (dashed line). When the water level in a well rises above the top of the aquifer, it is under artesian conditions. If it rises so high that it overtops a well, it is called a flowing artesian well (labeled). The term "piezometric level" in Figure 2 refers to the elevation that water will rise to in a well due to the liquid pressure of the water in the aquifer.

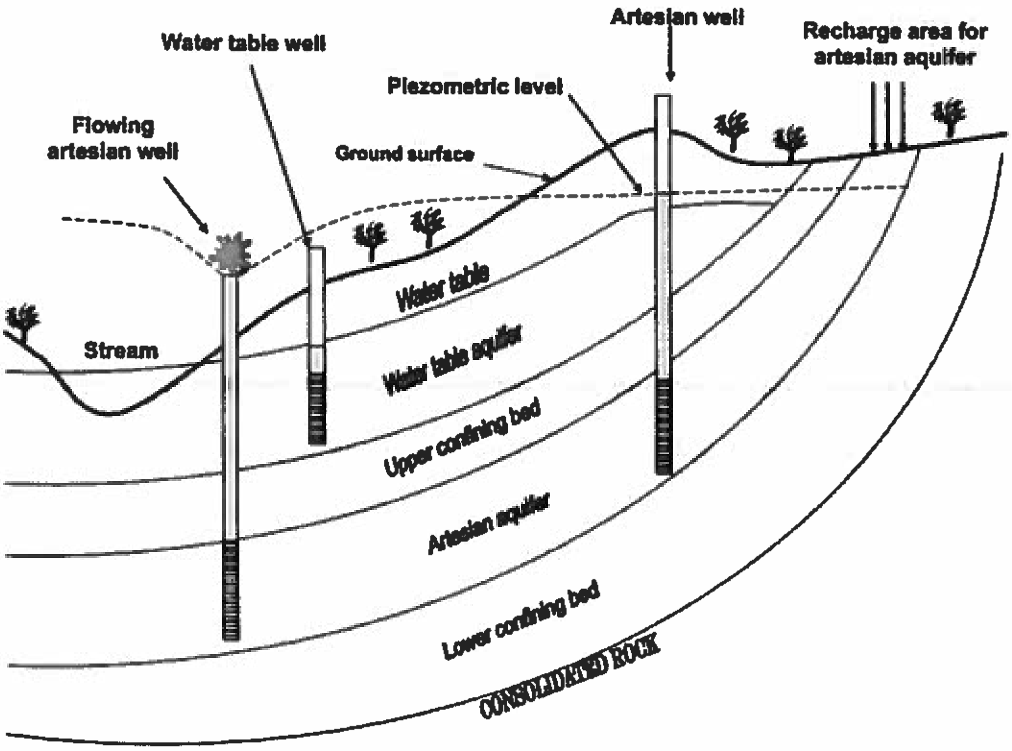
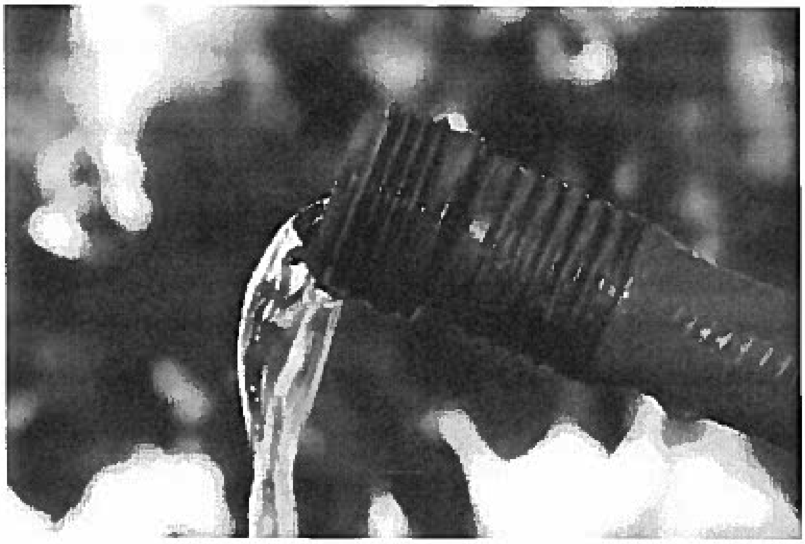


Figure 2 - Example of a Confined Aquifer System. Source: Michigan Dept of Environmental Quality.

Here is an analogy that will hopefully help make this clearer. Consider a garden hose lying in your back yard. It has some water in it that you need to drain out so you can put it away. What do you do? You lift up one end and water runs out the other. Even if the other end of the hose is resting on a fence so that it is a few feet above the ground, as long as you lift up one end higher, water will be forced out of it. If you keep adding water to the end you are holding, it causes water to come out the other end, because it is at a higher elevation (at a higher pressure). You could accomplish the same thing by blowing on the end of the hose. You are increasing the pressure in the hose on one end, which forces water to come out the other, or in our case rise up in the well.



Why is this important? In some areas, well owners have never had a pump in their well because their well flows naturally. In other areas, heavy rains or flooding can cause wells to start flowing. Conversely, drought conditions like we had in many parts of the US in 2012 can reduce recharge to the aquifer, which reduces the pressure head, which can cause some flowing wells to stop flowing. Understanding how the water level in your well can change because of natural factors will help you understand how your well works and if there are any risks of contamination. For example, during different seasons of the year, recharge can be different. In cold climates, there is virtually no infiltration when the ground is frozen, for instance, which limits recharge.

For another example, look at the water table well in Figure 2. The water level in the well is clearly higher than the level of the stream (the solid line labeled "water table"). That means that groundwater flow in the water table aquifer is from right to left, from the well toward the stream. But what happens after heavy rainfall and the stream elevation rises? It's very possible that the flow direction could be reversed, short term, and water would flow from the stream into the aquifer and toward the well. This is important to understand if you have a shallow well that is close to a surface water body. Surface waters have bacteria and organisms that can pose a health risk. Though the ground can act as a natural filter, if the well is close, it may not have a chance to do so. Understanding the flow near and to your well is critical when it could potentially be affected by surface water sources.

Pumping and Groundwater Flow

When your well pump kicks on and starts drawing water from your well, the water level in your well drops, creating a water pressure difference between the water in your well and the water in the surrounding aquifer. Water flows into your well to replenish the withdrawn water. How fast water can move to your well affects how much the water level drops in your well. This drop is called the drawdown in your well. As water flows into your well, it lowers the water level in the surrounding aquifer as well, creating a cone-shaped area of lower water levels around your well. This is called the cone of depression. Figure 3 shows a pumping well with 3 additional wells to the right. The water table surface is shaped like a cone pointing downward with your well at the center. In this example, the two wells closest to the pumping well are in the cone of depression, but the third well is not. The size and extent of the cone of depression depends on the pumping rate, permeability, and available water in the aquifer.

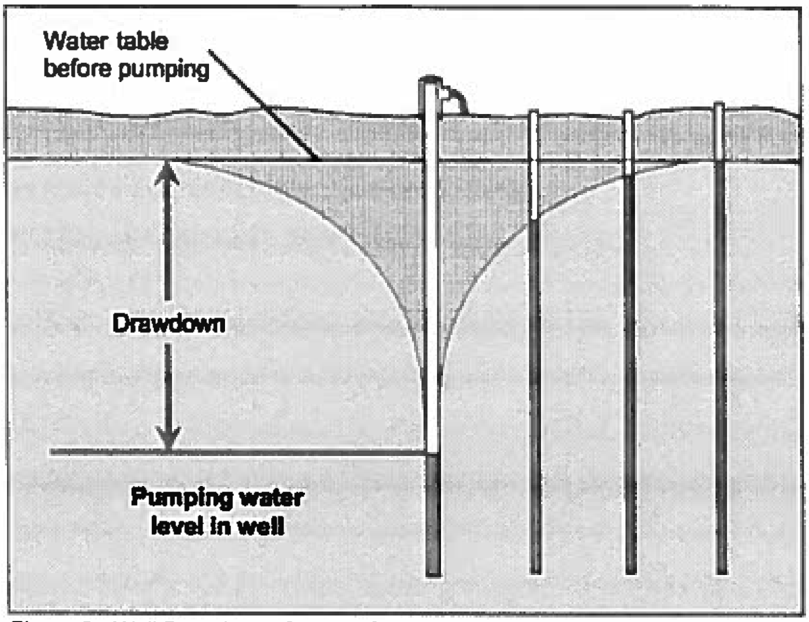


Figure 3 - Well Drawdown. Source: Oregon Water Resources Department.

Pumping can have significant effects on groundwater flow. Referring back to Figure 2, if we were to pump the water table well at a high enough rate, we could reverse the flow in the aquifer, causing water from the stream to flow into the aquifer and toward the well. There are many other situations where this is important. Wells and aquifers near an ocean could induce salt water migration into the aquifer if the water levels drop too much. Lowering water levels in a well could induce flow from a shallower or deeper aquifer that has differing water quality. Though these are important considerations, in most cases normal household use won't result in pumping your well hard enough to cause significant changes in flow, except for very near your well.

Groundwater Flow and Contamination

Water is a natural solvent, and because it is, all groundwater generally has dissolved minerals and other constituents in it. These added minerals are what can give it a particular taste, color, or, in some cases, odor. This is why some people feel their well water tastes better than (treated) "city water". However, water's ability to dissolve material also means that water can sometimes "pick up" contaminants from the surface and transport them down into your groundwater system. In other cases, liquid contaminants at the surface can infiltrate directly into a groundwater system and, depending on their density, sit on top of the water table (less dense than water), or create a pool of contaminant at the bottom of an aquifer (more dense than water) (Figure 4). The problem with groundwater contamination is that we have learned the hard way that it's much cheaper to protect groundwater in the first place than it is to try to remove the contaminant from the aquifer. Many communities and individual well owners have had to abandon their wells because their source aquifer became contaminated and it's too expensive to treat or clean up.

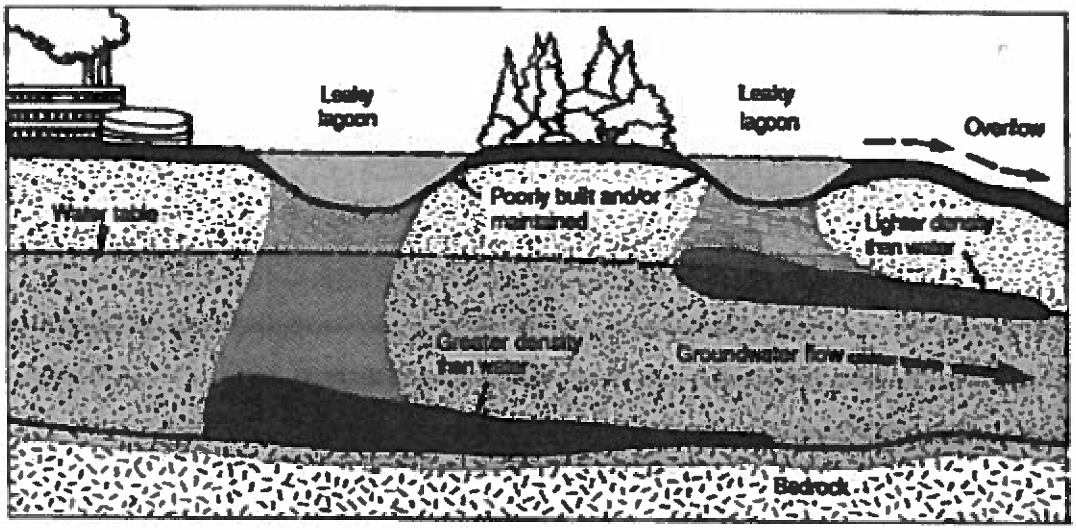


Figure 4 - Contaminant Movement. Source: New York State Water Resources Institute.

We're going to deal with the issue of groundwater contaminants several times in this class. For Lesson 2, today, we are going to limit the discussion to some common sources of contamination. Later, in Lesson 8, we will talk about source water protection and how to help prevent these things from getting in your well. In Lesson 10, we'll talk about what you can do if you have any of these contaminants in your well.

The permeability of the soil and shallow earth materials will affect surface infiltration of both water and contaminants (Figure 5). That said, creating a dump for waste allows contaminants to infiltrate over time, so whether slow or not, eventually it will contaminate the ground water system. Again, the message is to be smart with waste materials, always dispose of them properly. If you aren't sure what to do, call the manufacturer or your local health department for advice on disposing of materials that could become a groundwater contaminant.

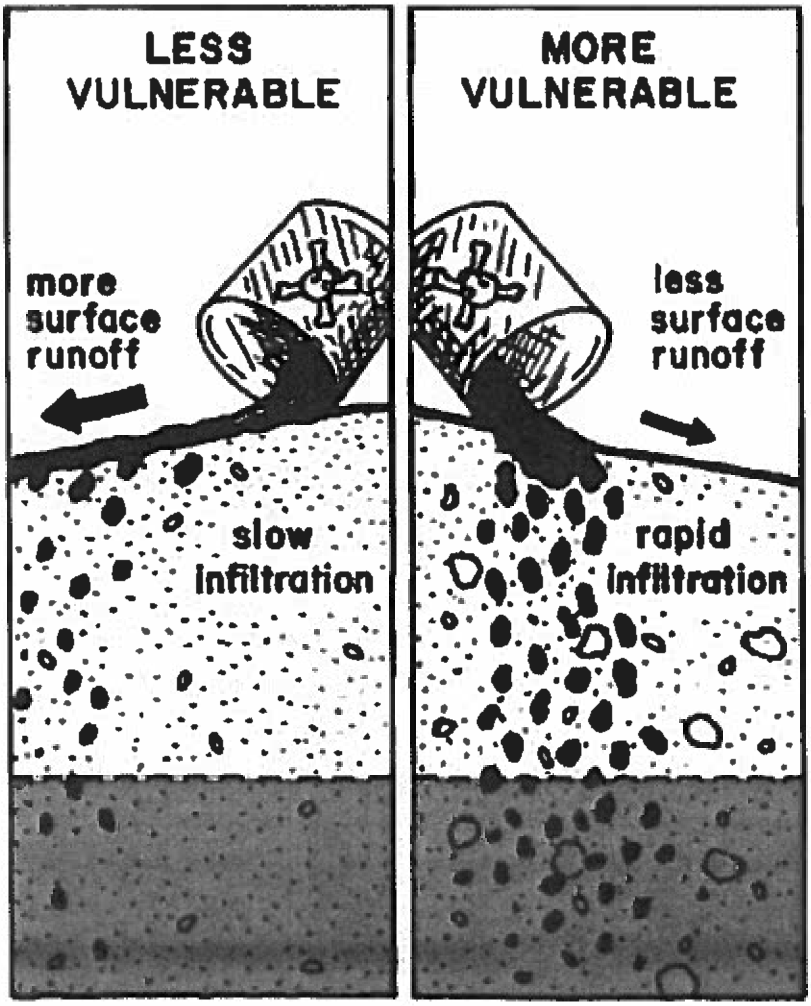


Figure 5 - Surface Vulnerability. Source: New York State Water Resources Institute.

Contaminants that can get into groundwater are of two types, naturally occurring and anthropogenic. Anthropogenic simply means the result of human activities. Both natural and anthropogenic contaminants fall into two categories, nuisance or of possible health risk. We care about both. Nuisance contaminants like iron can cause staining and sediment can cause taste problems or possibly pump wear, for example. Those that that pose a health risk speak for themselves and we all need to be concerned about ensuring our well water is free of any unwanted constituent.

Naturally Occurring Contaminants

The problem with naturally occurring contaminants is that if they are in the ground and part of the groundwater system, there isn't a lot you can do. In Wisconsin, for example, they have identified a certain bedrock layer that is especially high in arsenic and now require new wells to be sealed from that geologic unit. It's just there, in some cases, and the only solutions are to not use it or treat the water if feasible or the only option. Many naturally occurring contaminants are nuisance, rather than health risk based. Iron, Chloride, Sulfur, Manganese, and Hardness are all examples. But, some have health risks too, including Arsenic, Barium, Chromium, Nitrate, Selenium, Radium, and Uranium. For more details on these and other naturally occurring contaminants, contact your local health department, cooperative extension, or state water resources agency. They will be able to tell you which, if any, of these contaminants are prevalent in your area. The USEPA has a page that allows you to click on your state to find private well info, especially contacts.

An excellent description of types of groundwater contamination can be found in the Groundwater

Contamination bulletin available from the New York State Water Resources Institute and Cornell Cooperative Extension. I highly recommend you take a look at it.

Next Steps

The message for everyone is common sense. Whether you are on a farmstead or in a rural subdivision, or in a community that uses private wells, consider what practices you might be doing that can affect the infiltration of contaminants into your source aquifer. For example, in Figure 6, the landowner is burying all of his waste so it won't be a problem anymore.

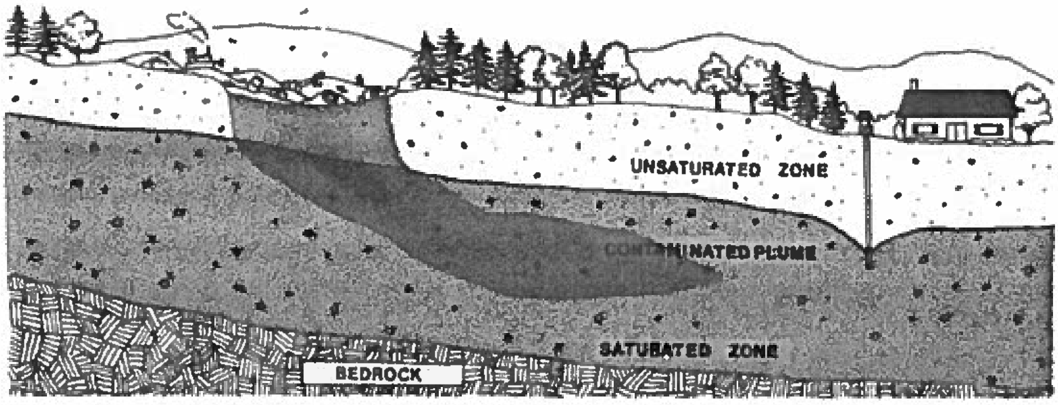


Figure 6. Source: Cornell Cooperative Extension.

Additional Resources

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If you have trouble viewing this email, click here to read it on the web.

Lesson 3 - Well Construction, Well Types, Importance of Location

Why This Lesson is Important: Knowing what kind of well you have and how it was constructed are important things to understand when considering well contamination problems and risks. Knowing how water gets into your well and from what source will help you understand what you need to do to protect your groundwater source and your well from outside influences.

Understanding Your Situation

Location and geology will dictate and likely limit the well type you can have at your location for an adequate water supply. We are assuming you have a well already, but understanding your geology and what makes a good well location might shed light on why your well is where it is, the type it is, and the depth it is. It will also give you an idea if you have other options for water supply.

In Lesson 1, we went through the basics related to geology and your well. The important points for the current lesson are whether you have an aquifer beneath your property---not everyone does---and what type of aquifer it might be. You could be fortunate enough to have choices. At many locations throughout the country, there are multiple aquifers that vary with depth (near the ground surface to several thousand feet below the ground surface), thickness (from a few feet to hundreds of feet thick), water quality (this can vary in many ways), and geologic makeup (sand, gravel, dolomite, sandstone, and limestone are the most common aquifers). Knowing whether you have choices and options, and understanding the makeup of the aquifer that supplies your well, are just good management. See Lesson 1 for details on how to find information on the geology at your well.

Well Types and How They're Drilled

There are three well types that we are going to describe in this lesson: One type is drilled bedrock wells that are open to an aquifer. The second is drilled or driven wells completed in a sand and gravel aquifer. The third is large diameter dug or bored wells that allow shallow infiltration and storage when an adequate aquifer might not be available. As mentioned, the well types are classified by the type of geologic material they are getting water from. We will go through each type in more detail in the following sections.

Drilling is a common modern method of creating all three kinds of well we discuss. A well is drilled by literally boring a hole in the ground, removing the earth materials, and placing a casing in the borehole. Drilled wells for household use are generally 4-6 inches in diameter and the casing is made of steel or PVC. A large diameter dug or bored well is generally 2-4 feet in diameter and the casing is generally concrete tile, brick, or sometimes even stone. Keep in mind that there are a number of different drilling methods that can be used to drill a borehole. If you are interested in knowing more about drilling methods, such as cable tool, bucket auger, or reverse circulation rotary, the National Ground Water Association has videos that demonstrate how the different methods work on their wellowner.org webpage under "Types of Wells".

Drilled Bedrock Wells

Figure 1 is a diagram of a drilled bedrock well. For a well finished in bedrock, the casing extends from just above land surface to a short distance into the bedrock where the casing is "seated" into the rock to keep it in place. The borehole continues down into the bedrock aquifer for some distance below the casing. Because bedrock is "solid", the rock itself acts as the well casing below where the surface casing is seated. The borehole intercepts fractures in the bedrock, which provide water to the well when it is pumped.

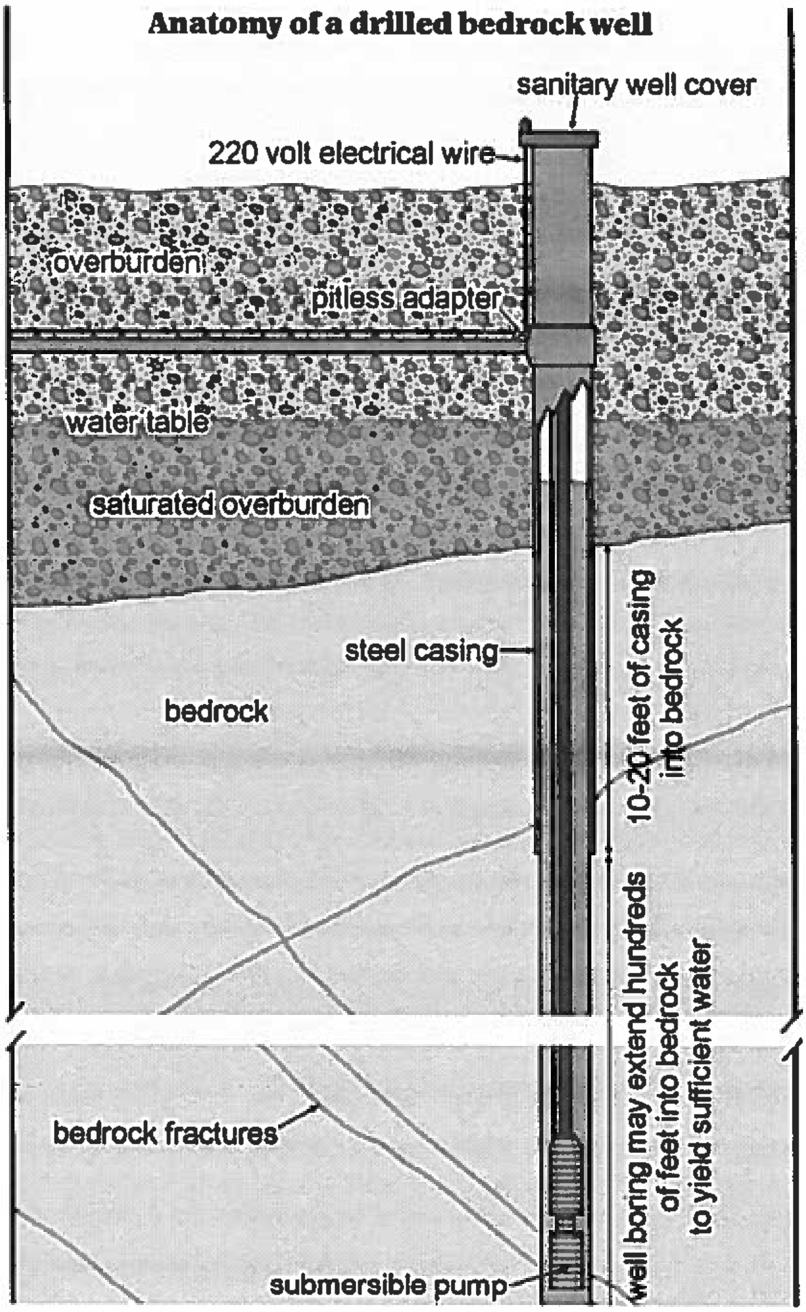


Figure 1 - Typical Drilled Bedrock Well. Source: Maine Department of Agriculture, Conservation, and Forestry.

Sand and Gravel Wells

Figure 2 is a diagram of a drilled sand and gravel well. Because this type of well is finished in a sand and gravel aquifer, which isn't solid and will cave in, it requires the well to be completely cased. Sand and gravel wells differ in basic construction from bedrock wells by having a screen at the bottom of the well. The screen allows water through, but keeps the sand and gravel out of the well. A well screen is generally made of woven steel wire, formed in the shape of a pipe or casing, that has openings based on the size of the sand and gravel grains in the aquifer. This way, the screen keeps the sand out of the well, but water can flow through. Figure 3 is a picture of a typical well screen. A specific size of coarse sand or gravel is placed around the well screen in the well bore to help keep the finer sand in the aquifer from entering the well, called the gravel pack.

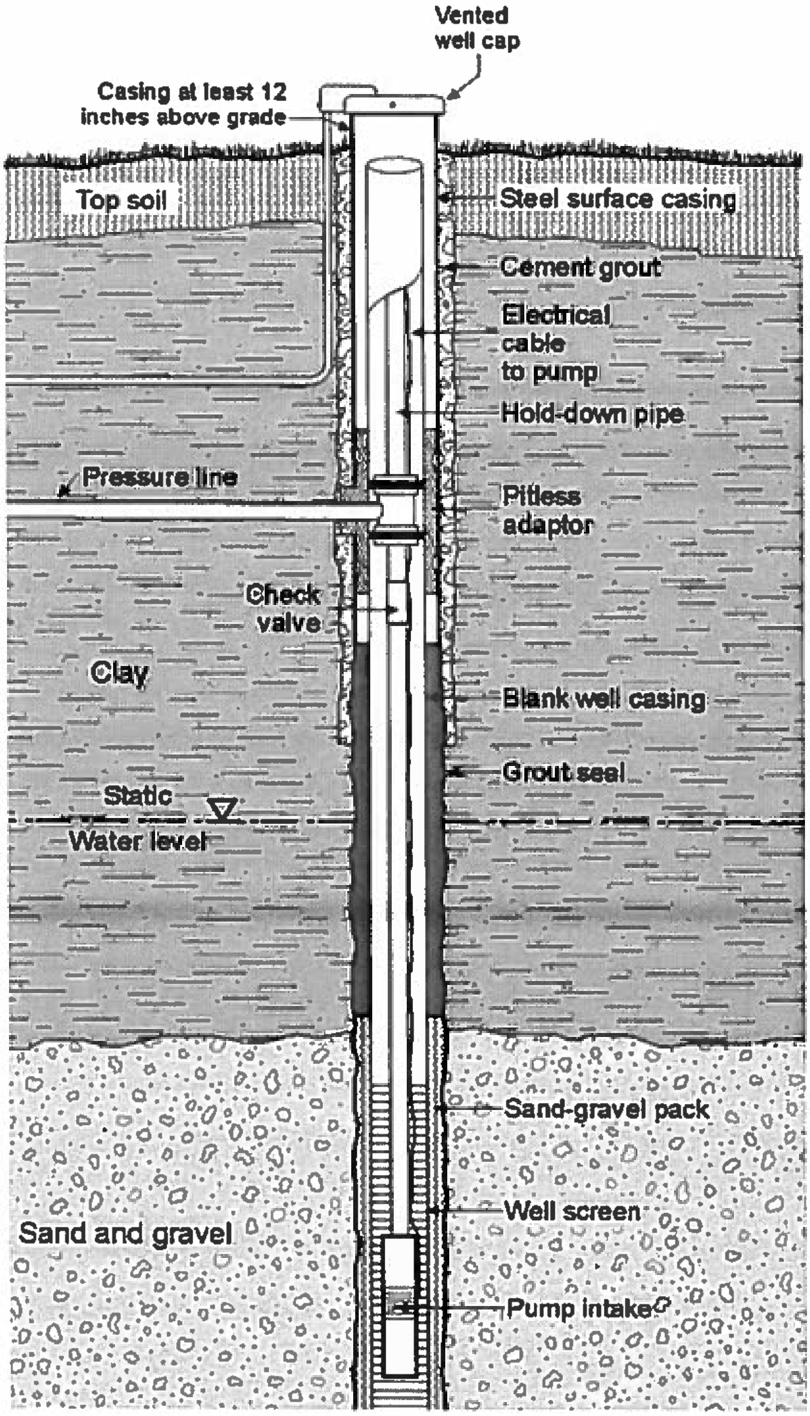


Figure 2 - Typical Drilled Sand and Gravel Well. Source: Colorado Geological Survey.

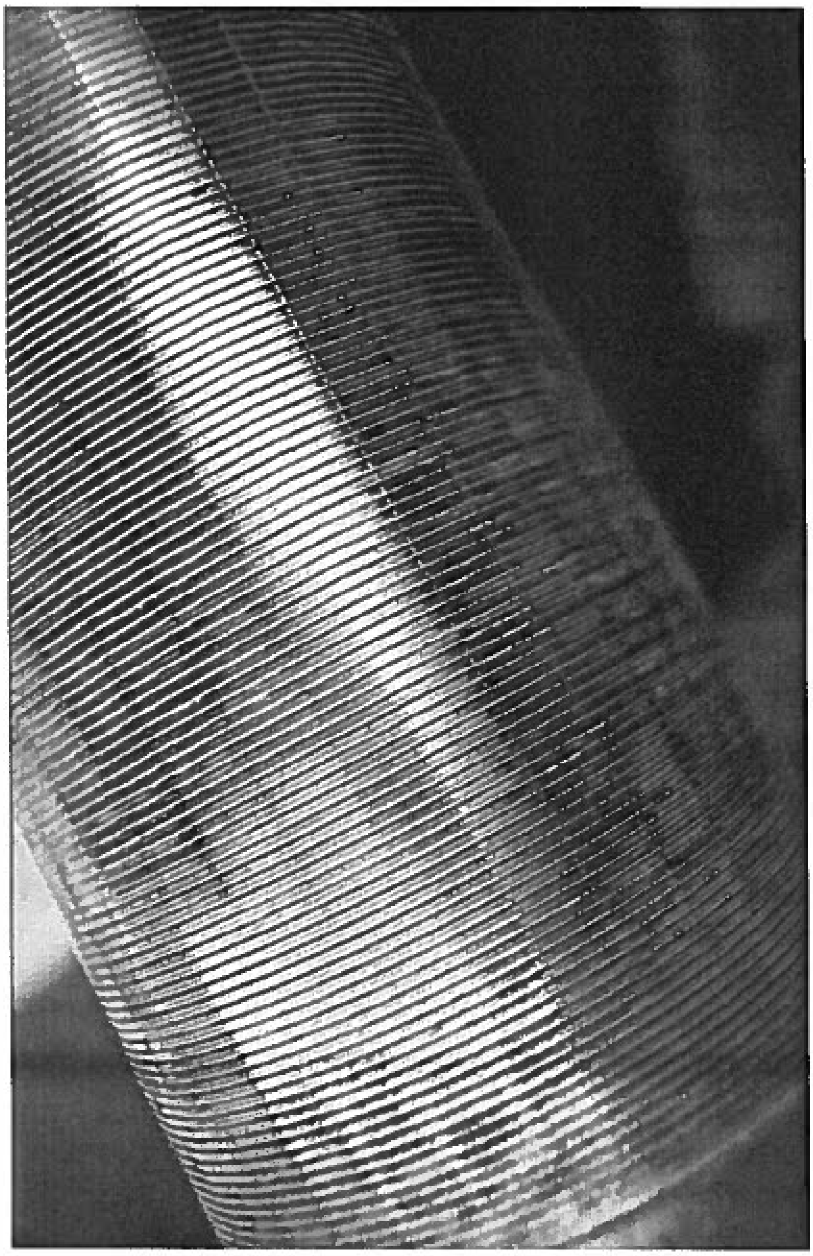


Figure 3 - Well Screen. Source: National Ground Water Association.

A driven well is also a sand and gravel well. It is installed by pounding a screen and pipe into the ground to the desired depth. As you can imagine, driven wells are usually at locations where the aquifer is very shallow, as is the water table. We aren't going to go into much detail about driven wells, other than to say that they generally have a higher risk for contamination. We don't recommend a driven well for a private drinking water supply, because they are so prone to surface influences. They have no grout at the surface, there is no annulus to fill that can be used to help protect around the well, and there is no gravel pack which can lead to improper screen size that might allow sand to get into the well. If you are in an area with a shallow aquifer that can support a driven well, we recommend you drill a well with the screen near the bottom of the aquifer, so that surface water infiltrating into the ground will have to travel a longer distance to get into the well. Also called "sand points", driven wells are still prevalent in areas where sand is at or very near the surface and the water level is also close to the surface.

Large Diameter Dug and Bored Wells

The last type of well is a large diameter dug or bored well. Dug and bored wells are generally installed at locations where there are no aquifers, in unconsolidated finer materials (clay, silt, loess, etc.) that may or may not have very thin sand lenses that can move small amounts of water. These wells are built big to provide storage and allow shallow groundwater to slowly seep into them.

Before modern drilling methods were available, many wells were dug by hand. Though Figure 4 is a drawing, it is an accurate example of how hand dug wells may be lined with stones or uncemented brick. Water in this example can seep into the well from nearly any depth, between the bricks or stones, which makes it particularly vulnerable to surface contamination. Many people still use hand dug wells for their water supply, though nearly every state now has construction standards for wells that wouldn't allow a modern well to be constructed this way.

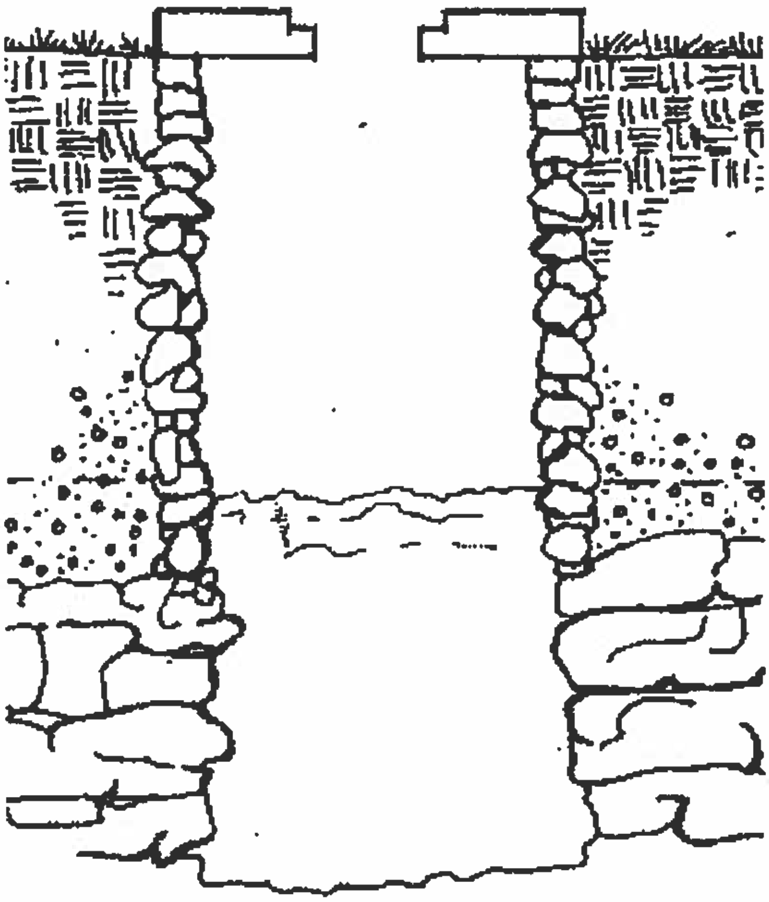


Figure 4 - Drawing of a Hand Dug Well. Source: Purdue University Cooperative Extension.

Figures 5 and 6 are examples of two types of bored well construction. Today, large diameter wells are constructed by machine and are generally of one of these two types. The casing is generally precast concrete in 4 or 5 foot sections that are placed on top of each other and beveled to fit together. At these joints water can seep into the well. Because of the possibility of surface infiltration near the well, the upper 10+ feet around the well is filled with concrete or has a bentonite seal. Bentonite is a very fine clay that expands when wet to create a nearly impermeable layer.

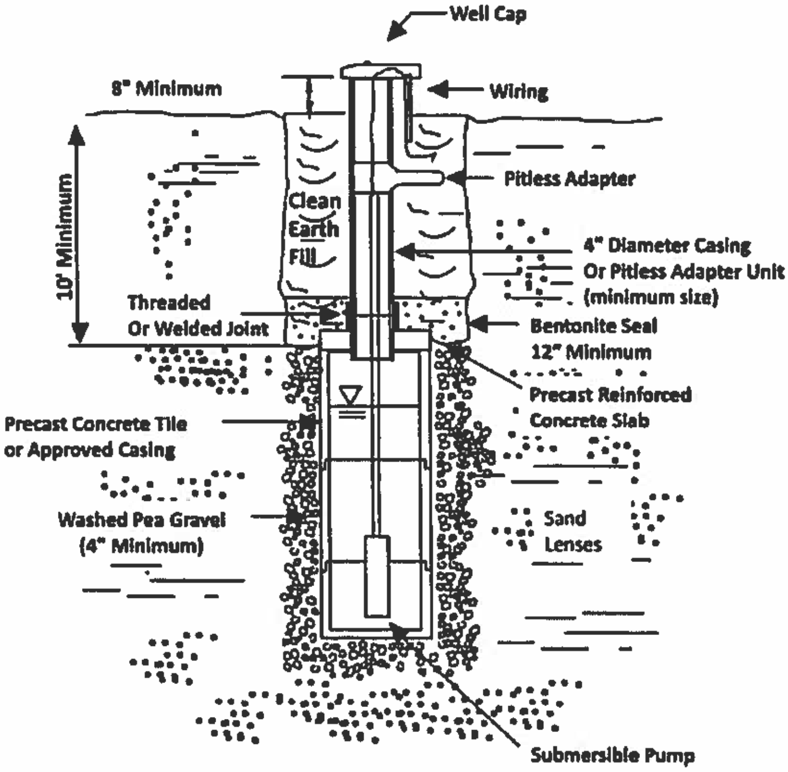


Figure 5 - Bored Well with Buried Slab Construction. Source: Illinois Department of Public Health.

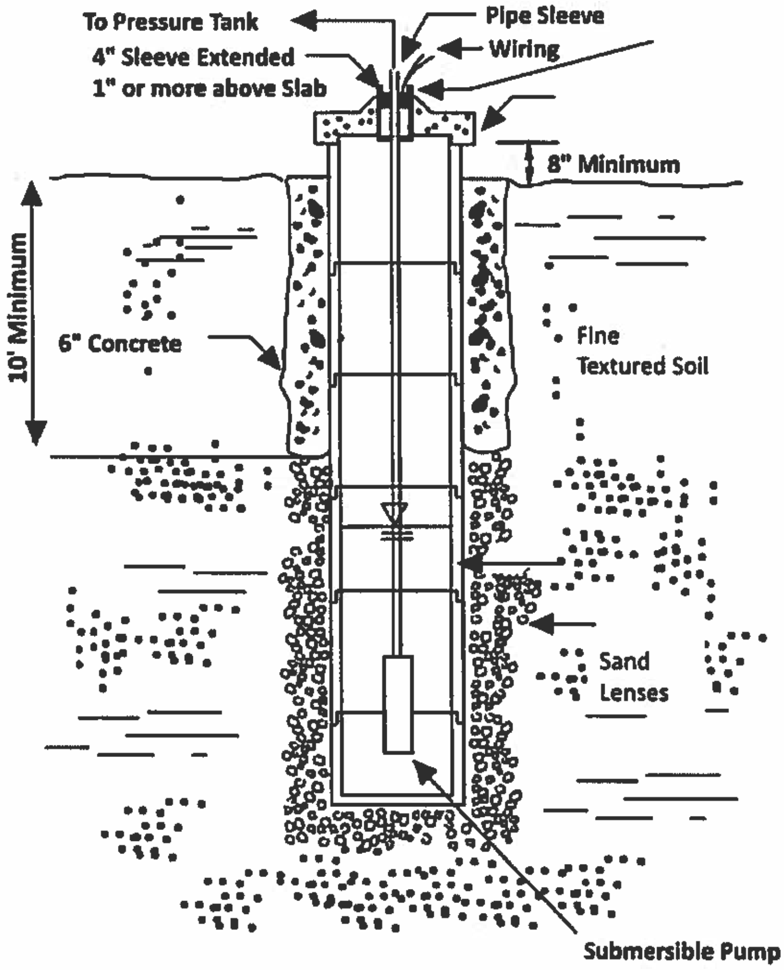


Figure 6 - Bored Well with Concrete Collar Construction. Source: Illinois Department of Public Health.

Dug and bored wells generally rely on shallow groundwater for their supply. Because of this, it's particularly important to be aware of the possible sources of contamination near these wells, and be sure your well construction was completed properly. But for any well, not just dug and bored wells, proper construction is key to protecting your well and aquifer from surface influences. Drilled wells can also be contaminated if not properly grouted at the surface, or if the aquifer is close to the surface, or if the soil at the surface is coarse-grained and allows significant infiltration.

General Well Construction

There are a number of things that are important in the construction of your well. The well cap should be snug, vented, and have a screen to prevent insects from getting in the well. The well should be at least 12 inches above grade, or higher if in an area that is prone to flooding, to ensure that the well cap is never overtopped by a flooding event. The annulus around the well, the area between the casing and the borehole, should be grouted (filled with a bentonite and/or concrete slurry) that will not allow any surface water around the well to go down the well bore or along the casing. If you're not sure whether your well has been constructed this way, check your well log or contact a local contractor for help. We'll cover more details about well components and best practices, like backflow devices, in the next two lessons.

Well Location On Your Property

Is your well in your front yard, behind your home near a stream, or by your garden? Maybe it's in your basement or garage? Location matters. It may be that the well was already there, it's always worked fine, and it hasn't been a worry. If so, then you may not have thought much about its location or accessibility. But in some cases, like if your well is buried or in a building, repair and proximity to potential sources of contamination can be a concern. Your well should be away from buildings, wires, trees, anything that would prevent a drilling contractor from being able to access the well with a drill rig or truck. This ensures there is ample room for repairing a well, pulling a pump, or even deepening an existing well.

It might be that there was no choice where to drill your well. We have seen wells over ¼ mile from the house they were supplying because there was no aquifer at the home. Geology can change dramatically over very little distance, and with those changes, there can be differences in what water supply is available. If you are in a subdivision with only a 1/3 acre lot, there wasn't much location to choose from. In these cases, what your neighbors are doing can also influence your well. If there are other wells in the area, are they pumping? Are they properly sealed? Other local wells are a potential route of contamination, and if they are in use, they can impact the direction of groundwater flow.

Where are your septic tank and septic field? What about your neighbors? Are they down gradient? The same goes for buried tanks, other hazardous materials storage, and even use of chemicals in your garden. Figures 7a and 7b are set back requirements for Minnesota residents regarding the construction of new wells. Though the specific regulations vary from state to state, these images demonstrate the factors a well owner needs to consider when protecting the area around their well. The images were included to show you the range of things you should consider as possible threats to your well. They are not intended to establish the specific distances you should observe for your own well. In general, the further contamination sources are kept from the well, the better, if they aren't eliminated entirely. You can check with your state public health agency to find out if your state has setback requirements and what those are.

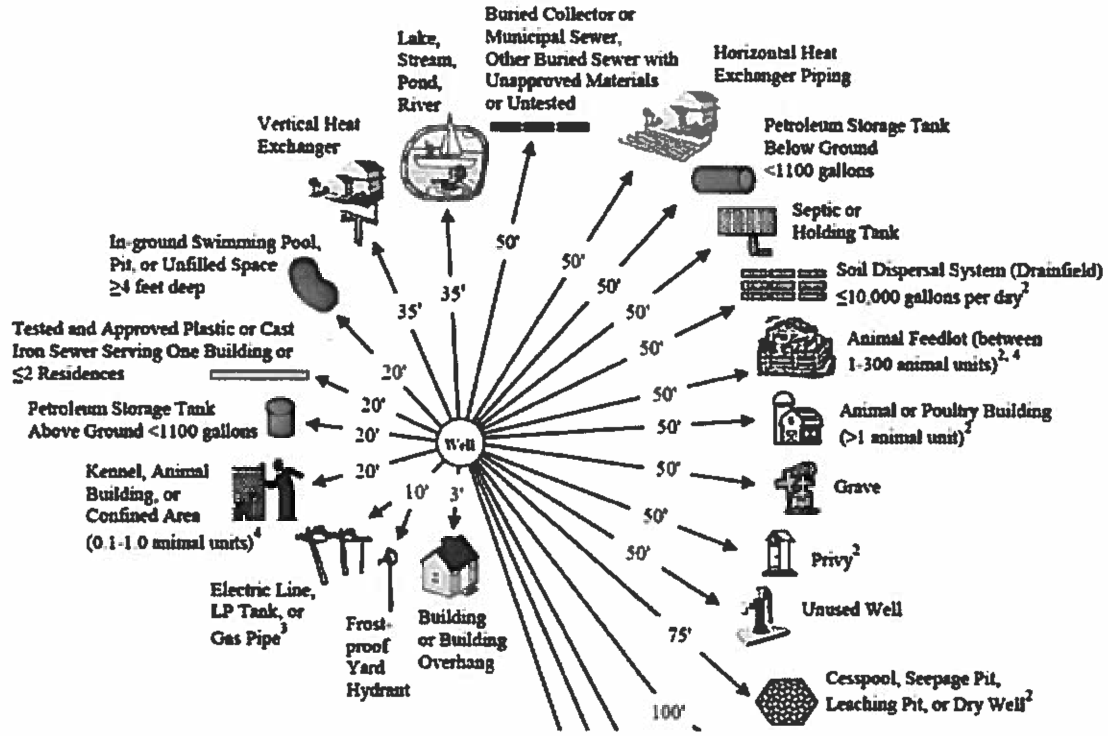


Figure 7a - Setback Distances (top half). Source: Minnesota Department of Health.

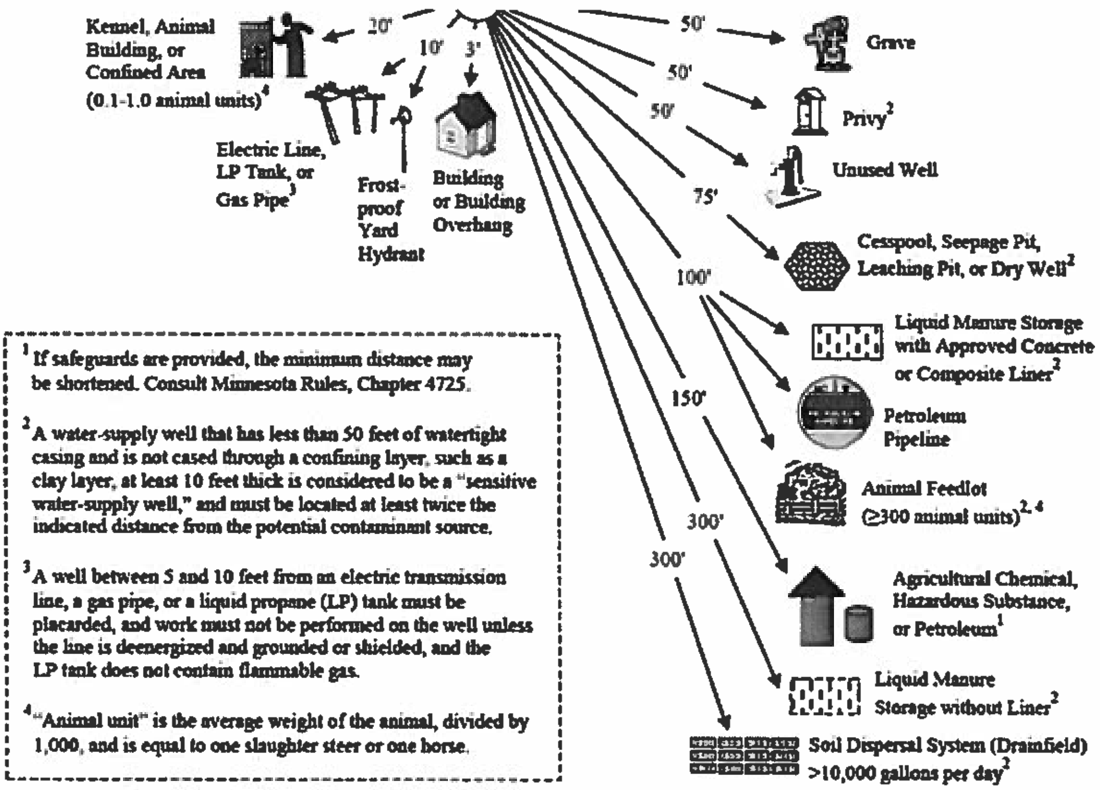


Figure 7b - Setback Distances (bottom half). Source: Minnesota Department of Health.

Groundwater flow direction, which can also influence your well's water quality, isn't always easy to determine. If you have a shallow aquifer, the flow direction is most likely toward a point of discharge (stream, river, etc.), so looking at the landscape might give you some idea of groundwater flow direction locally. But if there are other active wells nearby, pumping can draw groundwater toward those wells. For deeper aquifers, the flow direction is even more difficult to determine unless you know where the recharge and discharge areas are. If you are concerned about groundwater flow to your well, it is worth the effort to contact your state agency that creates aquifer maps to inquire about groundwater flow direction.

If your shallow well is down gradient from your septic system, for example, it could be a source of contamination. On the other hand, if your well is getting water from a deeper aquifer, well below the shallow water table, then a properly constructed well will not likely get contaminated from shallow sources, no matter the flow direction.

To Sum Up

Knowing your well specifics provides you with the awareness you need to understand the possible threats to your well and what the risks are for each type of well. Surface contamination issues are more of a concern for shallower wells and for near surface geology that is less protective of the underlying aquifers. Soil is a natural filter, so the longer the flow path from the surface to where your water is being taken out of an aquifer, the better. The surface infiltration of contaminants is most influenced by having a source of contamination near your well, or having a well with sandy soils or fractured rock at the surface that allow more water to infiltrate. If you do your part by ensuring your well is properly constructed and protected, and eliminate potential contamination sources near your well, you've got a good start toward protecting your drinking water.

Additional Resources

Visit our Resources area at The Private Well Class for a list of resources used to develop this content and materials for further reading.

Susan Keown

From: Private Well Class [info@privatewellclass.org]
Sent: Wednesday, January 30, 2013 5:30 PM
To: Susan Keown
Subject: [Private Well Class] Lesson 4

The Private Well Class

FREE ONLINE TRAINING *for* HOMEOWNERS WITH WATER WELLS

If you have trouble viewing this email, click here to read it on the web.

Lesson 4 – Your Water Well System

Why This Lesson is Important: Before we can get to common problems and maintenance practices related to your well and water system, you first need to understand what parts makes up your water system, what each part does, and how they work together to provide you water. Once we understand the components and process, we will have a better chance of being able to solve problems that arise, as well as understand why we should perform regular maintenance to protect our well and water system.

Well vs Water System

Your well may be where your water comes from, but without the mechanical system to convey the water to your house, store it, and provide the pressure so it will flow, your well would be useless. Figure 1 is a typical well and water system for a home. In this example, the well has a screen, so it's a well finished in a sand and gravel aquifer. The pump is in the well just above the screen. The pump lifts water up a pipe (drop pipe) to the pitless unit or pitless adapter, where it elbows horizontally and goes into the house through the discharge pipe. From there water goes into the pressure tank, or straight into the line to your faucets, shower, or dishwasher (if it's a period of heavy water demand that kicked on your pump). The pressure tank stores water and also creates the pressure in the system that allows water to flow when you open up a faucet or turn on the shower. Each part of your water system will be explained in more detail below.

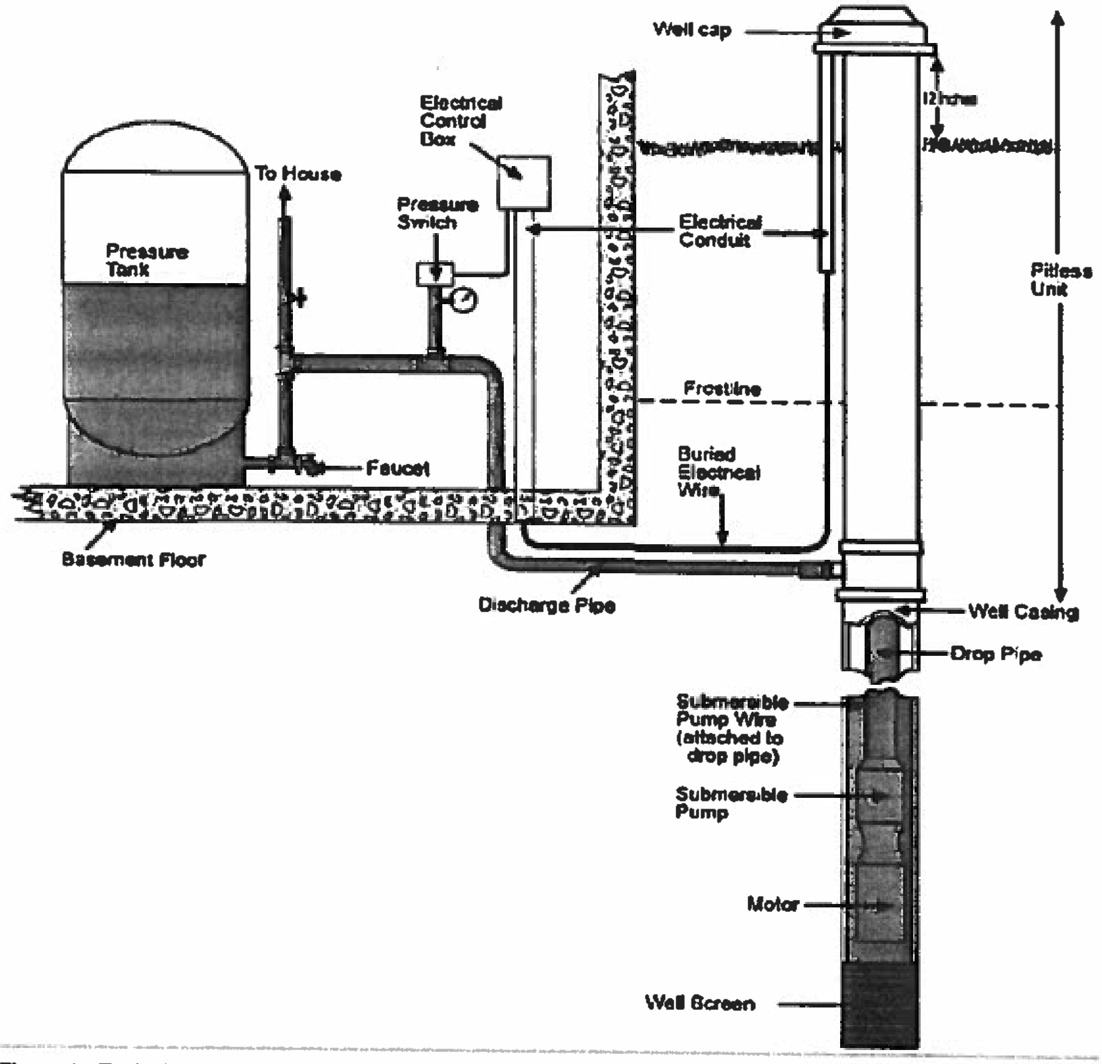


Figure 1 - Typical Well and Water System for a Home. Source: Minnesota Department of Health.

Well Pumps

When a pump is installed in or at a well, it is sized for the particular situation it is being used for, as well as the characteristics of the well. Some of the factors considered include well size, maximum anticipated use, water level, amount of piping, number of sources (# of faucets, fixtures, etc.), well yield, and pressure needed in the home. Pumps are sized by the gallons per minute they can pump and the pump motor size is given in horsepower. You want to have a large enough pump to do the job, but if you have too big a pump, it will waste energy. Also, if your well doesn't produce much water (low yield), a large pump could quickly dewater your well down to the pump intake which could cause the pump to lose its prime, or overheat the motor. Your driller or contractor has professional experience at sizing pumps based on the site conditions. They are your best bet for advice in this area.

Today, there are basically two types of pumps that are installed for private wells: submersible pumps and jet pumps. Typically, submersible pumps are used for wells that need to lift water more than 25 feet, and jet pumps can be used for wells that need to lift water less than 25 feet. It can depend on the contractor, though. There are deep well jet pumps, and there are wells with shallow water levels that have submersible pumps in them. There are a lot of applications for each type, any one of which might fit your situation. In the simplest terms, a jet pump pulls water up the pipe column using suction, and a submersible pump takes in water through the pump near the bottom of the well and pushes it up the drop pipe from below. Knowing all of the details of the inner workings of your pump is probably not necessary, as pump repair should be left to a professional. That being said, knowing how your pump works can help you determine if a particular problem is due to a pump or some other issue.

Jet Pumps

In general, jet pumps (also called suction pumps) are used where the pumping water level is going to be less than 25 vertical feet from the pump. They use suction (low pressure) to draw water up into the column pipe. The pump is not in the well, most likely it's in the basement near your pressure tank. Figure 2 shows a typical shallow jet pump well system. Jet pumps are limited to about 25 feet of lift because the pressure difference they induce is in relation to the atmospheric pressure forcing water into the pump. A perfect vacuum could create over 30 feet of lift, but these pumps can't create perfect vacuums, so it is less. 25 feet is an estimate, and at higher elevations where atmospheric pressure is less, the amount of lift the pump can sustain will also be less. They do make deep well jet pumps that can be placed in the well, but in most cases a submersible pump is used in those situations.

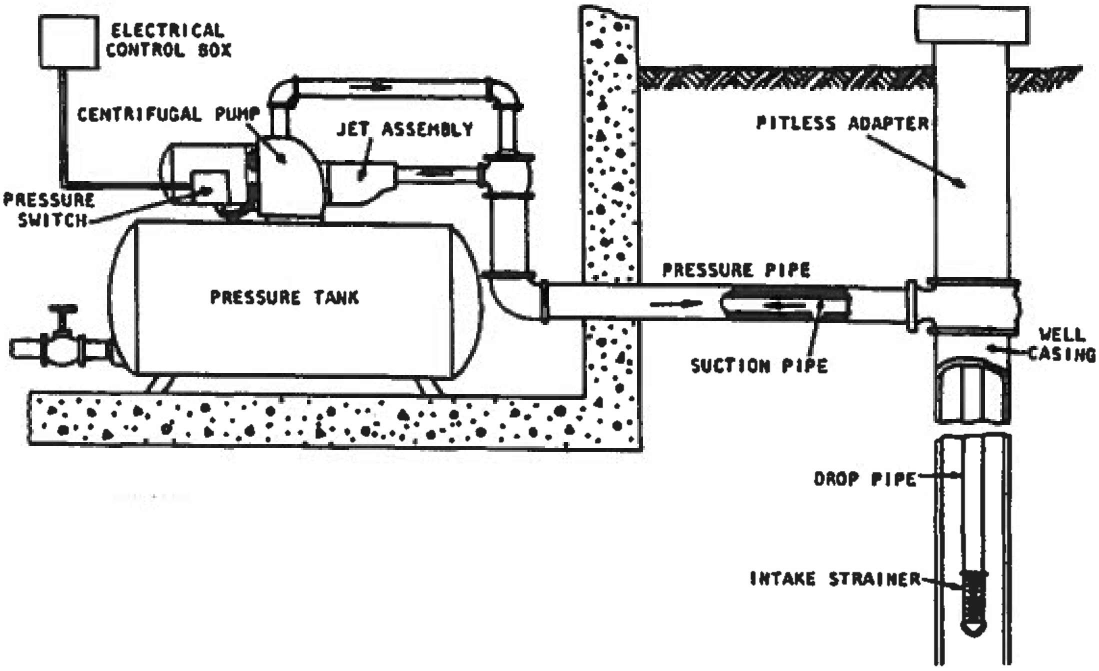


Figure 2 - Typical Shallow Jet Pump System. Source: Illinois State Water Survey.

Jet pumps at the surface have a few limitations. They can be loud. They must also be primed, meaning there needs to be water in the line to the pump to create the necessary suction. If a pump loses its prime, then it may need to be filled by hand to begin operating properly again. Check valves are used to keep the suction pipe full, but if it develops a small leak, then the pump will lose prime frequently. Jet pumps can be energy inefficient if not operated very near the manufacturer's specifications. They are also more susceptible to damage from pumping water with sand or silt. One of the biggest drawbacks is changing water levels in the well. If the well is low yielding, or the water level is already close to 25 feet, then it's possible that pumping the well may result in the water level dropping to a point that a jet pump cannot maintain suction and it will not work.

One big advantage of jet pumps is that the pump is not in the well. This is the case for both the shallow well design and the deep well design. Both allow for easy maintenance and they have few moving parts which should limit repairs.

Submersible Pumps

A submersible pump is just like it sounds, a pump submersed below the water line in a well. A submersible pump system is shown in Figure 1. The pump and motor are sealed and kept near the bottom of the well, generally. Water enters the pump and is pushed through the pump by a series of impellers, up the drop pipe, and into the discharge line. Submersible pumps are probably the most common type used for domestic supply. They can provide more water than a jet pump of the same size, which means they are more energy efficient. They are cooled by the water in the well and are always primed.

Though submersible pumps are the most popular type of pump for domestic wells, they do have a few drawbacks. Most notably, if a pump needs to be repaired, the entire column of pipe and pump have to be pulled from the well. They are also more prone to lightning damage than other types of pumps.

Variable Speed Drive Pumps

Variable Speed Pumps are a more recent design that has gained popularity because of the benefits they provide. Many times, there can be pressure issues in a home using a private well system because at times of high demand (shower, flush, and dishes at the same time, for instance) there is a loss in water pressure as the system tries to keep up with the pressure and flow required. The advent of sophisticated controllers and variable speed motors has allowed contractors to develop systems that react to changes in pressure quickly. These systems change the pump motor speed in order to maintain a nearly constant pressure in the system throughout a home. What that means is that the pump can be used to help maintain a constant pressure in your home, which reduces the need for a pressure tank. Typical designs today include a pressure tank of less than 5 gallons. Constant pressure at all times also benefits other parts of your system. According to the National Ground Water Association, they help water softeners, iron removal devices, and other equipment work more efficiently.

Variable speed pumps won't work in low yielding wells. The entire premise of these systems is to be able to rapidly change from low to high pump rate and back again as water use in the home changes. In low yield situations, water needs to be pumped into storage (pressure tank and/or auxiliary tank) during periods of low or no use. This way, there is water available during high use times when the water being used exceeds the capacity of the well.

Piston Pumps

There is an additional type of pump, a piston pump, that is still found in rural areas, but they are being slowly replaced as they wear out or as construction codes require a more accessible well. Figure 3 is a diagram of a well with a working head piston pump. They are generally very old and are not used on modern well water system installations, but we mention them here because there are some rural well owners with older wells that still use them today.

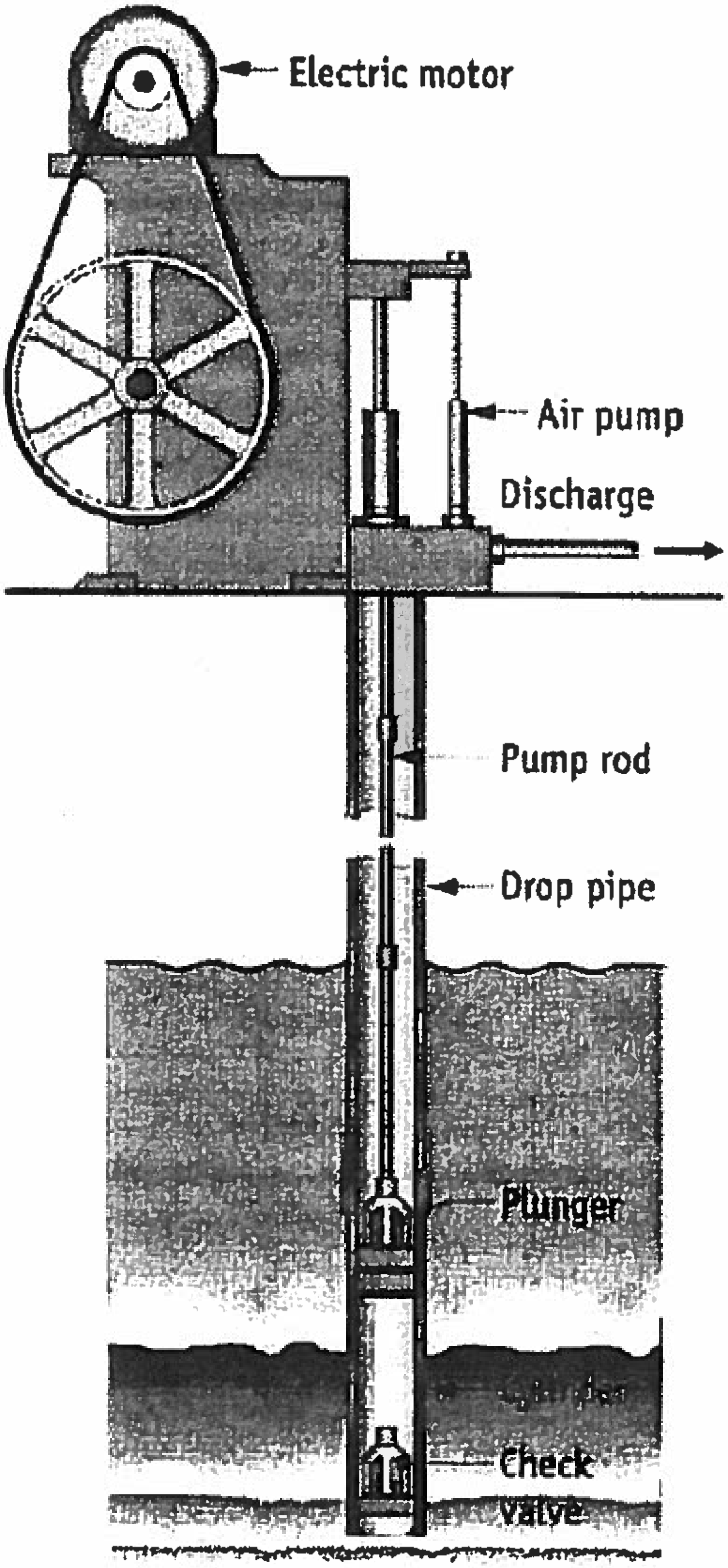


Figure 3 - Piston (Working Head) Pump, Source: Midwest Plan Service.

How many of you had or have used an old hand pump like the one we have as the logo for The Private Well Class? It's also a piston pump, but it has no motor or on/off switch. It takes manual force to make it work. You are the motor for the piston that lifts water up and out of the well. There is a cylinder with a check valve near the bottom of the well, and when you lift the handle, you create suction in the cylinder that allows it to fill with water, then when you lower the handle, you lift the water up the drop pipe. Water can't flow back down because there is a check valve that keeps it in the pipe. With each stroke, more water enters the cylinder and is lifted up and out of the well.

An electric piston pump operates in exactly the same way as a hand pump, but uses an electric motor and a belt to create the piston action. Piston pumps have several drawbacks. The piston assembly has to be directly over the well, and because the motor and system are usually protected from the elements, the pump and its cover are usually sealed. Both of these factors make access to the well difficult, as you have to move the motor away from the top of the well. Piston pumps are also prone to be loud, and they can cause vibrations in your piping system because of the alternating nature of the water flow. The leather or rubber seals on the piston also wear out and have to be replaced.

There are cases where a piston pump might be preferred, such as when the water has gas in it (natural gas) that might come out of solution when pumped and the pressure is reduced, or if a well pumps sand. Piston pumps handle these issues more effectively. There are newer models of these systems for those specific instances, but in general, if you have an old electric piston pump, you should consider eventually upgrading to a more modern system that allows easier access to your well.

One last thing about hand pumps. They still have their place, just not for a drinking water well. They are still being manufactured and can be a used at locations where there is no power. The problem is that some people are having hand pumps added to their wells so that when there is a power failure, they can still get water from their well for livestock, or even to boil for human consumption. I would recommend that if you are in a remote location or a location that is prone to power outages, a better investment would be a back-up generator. Creating additional access to your drinking water supply just creates more opportunity for problems. It may also go against your jurisdiction's well construction code.

Flowing Wells

In some areas, a well may tap into an aquifer and the resulting water level is above the top of the well casing and land surface. As we learned in an earlier lesson, this is a flowing artesian well. Flowing wells are an interesting phenomenon, and can allow a well owner to provide water to their home without a pump. Some states have rules about flowing wells, and there are pitless adapter designs meant to prevent flow from these wells. In western states, like South Dakota, their well regulations require owners of flowing wells to limit flow to actual use and/or to the limit of their water rights permit. By far, the most comprehensive information we could find on flowing wells comes from the Michigan Department of Environmental Quality. The Flowing Well Handbook describes not only the Michigan rules, but has information on best practices, well designs, and responsibilities for flowing well owners. It also includes a history of Michigan's flowing wells that is really interesting, whether you have a flowing well or not.

One problem with flowing wells is that in times of extreme drought, like the summer of 2012 in some parts of the country, some flowing wells may stop flowing because enough pressure is taken off the aquifer system from pumpage of wells and lack of recharge. This can also happen in areas where many new wells are drilled. Each well relieves a little of the artesian pressure on the aquifer system. In Illinois, it resulted in well owner complaints that irrigators had "ruined" their well during the 2012 drought. The reality is that it was the first time most of these well owners had their water level drop below the top of their well casing. A good solution is to use a design like in Figure 4, from the Michigan handbook, and install a pump for assurance of constant supply.

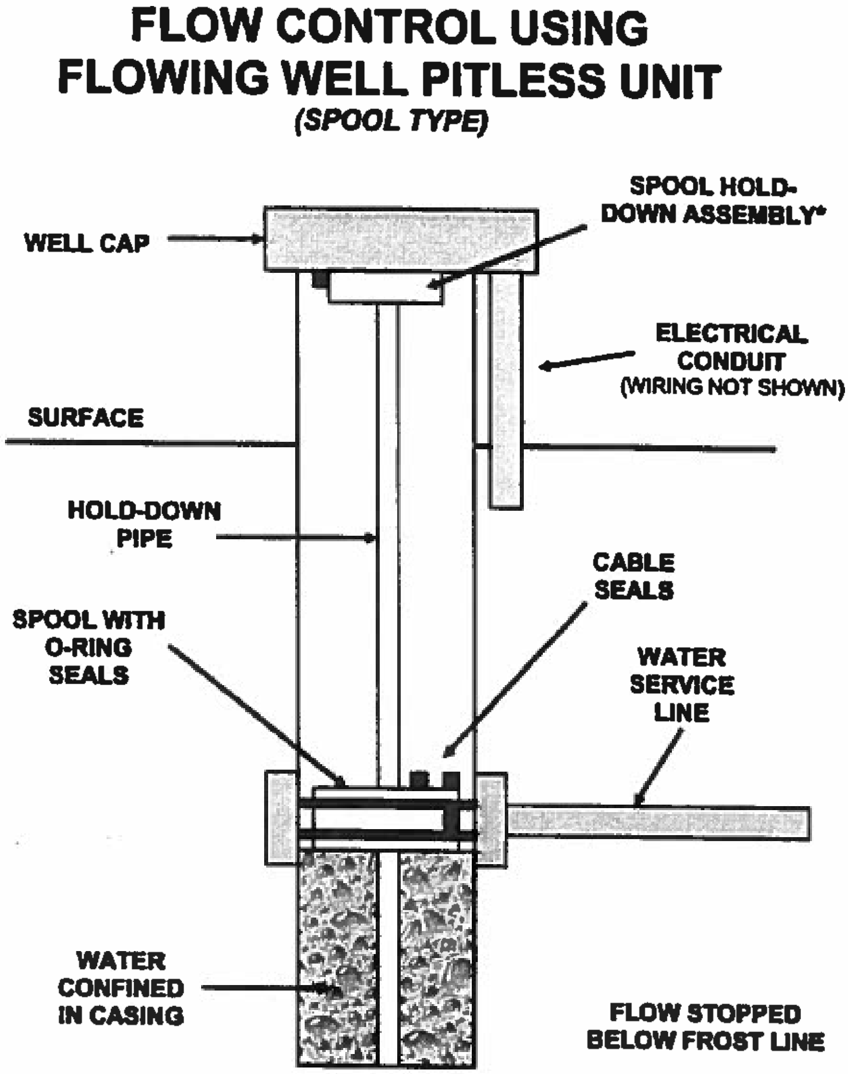


Figure 4 - Flowing Well Pitless Adapter, Source: Michigan Department of Environmental Quality.

Pitless Adapters and Units

A pitless adapter does just what its name implies. It is a fitting for a well that eliminates the need for a well pit. Many years ago, to prevent freezing pipes in the winter, wells were completed below land surface at a depth below the frost line. This allowed well owners to run their water line from the well into their basement without fear of freezing pipes. However, well pits are dangerous. They can hold water that can contaminate a well; they are a safety hazard for people, livestock, and moving equipment; and they can collect dangerous gases that could incapacitate someone getting into the pit. The pitless adapter makes a pit unnecessary. In fact, if your well is in a pit, and many still are, it's in your best interest to have a contractor extend your well to above land surface and use a pitless adapter to maintain the discharge line connection to your well.

A pitless adapter is a fitting that goes through a hole in your well casing at a depth below the frost line that provides a sealed connection between the drop pipe in your well and the discharge line going from the well to your house. A pitless unit refers to a pre-constructed section of pipe that includes a pitless adapter that is fastened to the well casing at a depth below the frost line. It replaces the well casing from just below the frost line to land surface. The pitless unit includes the pitless adapter, the additional section of well casing, and the well cap. Figure 5 is a diagram of a pitless unit (a) and a pitless adapter (b).

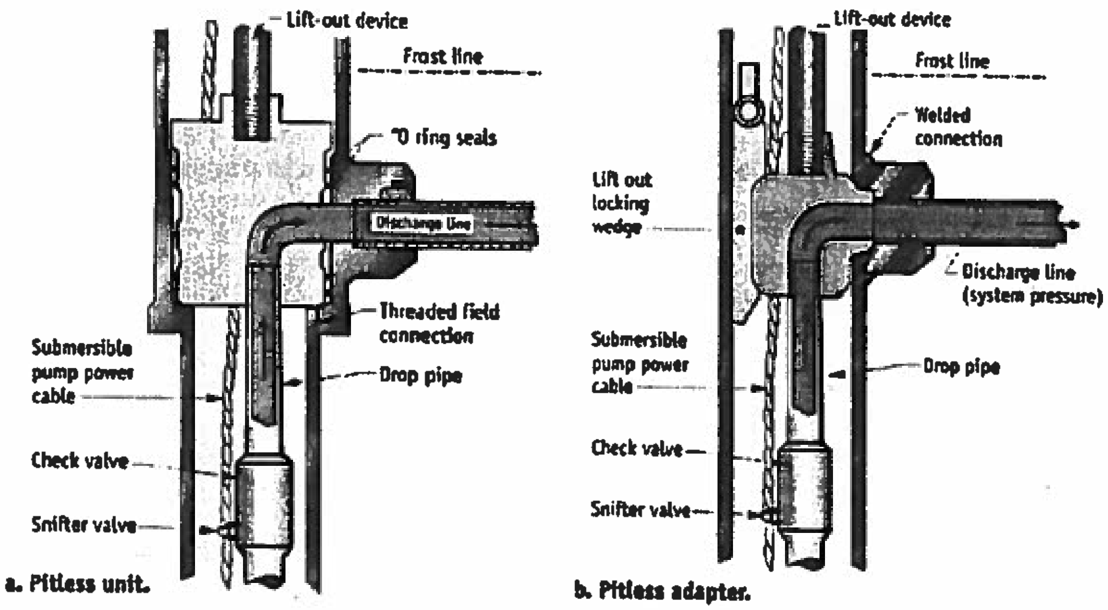


Figure 5 - Pitless Unit and Pitless Adapter, Source: Midwest Plan Service.

Pressure Tanks

The water entering your home is pumped into a pressure tank (Figure 1). A pressure tank serves several purposes. It provides water under pressure to your home when the pump is not running. It also provides water storage for use when the pump is not running and in times of high demand to help the pump keep up. Pressure tanks operate by maintaining a range of pressure in the tank to force water out into the line when a faucet or other source is opened. Using automatic controls and preset gauges (Pressure Switch in Figure 1), when the pressure in the line drops below the low end preset level (generally 20-40 psi), the pump kicks on and begins pumping water into the tank and home distribution lines. This continues until the usage stops and/or the pressure in the line reaches the preset high end level (generally 40-60 psi). The minimum pressure has to be high enough to lift water to the highest and farthest point in the line. Figure 6 shows three common types of pressure tanks in use today. The first is a standard air pressure tank, the middle tank has a float or "wafer" to help keep the air-water interface separated, and the last is a bladder tank that uses a stretchable container (bladder) to keep the water and air separated.

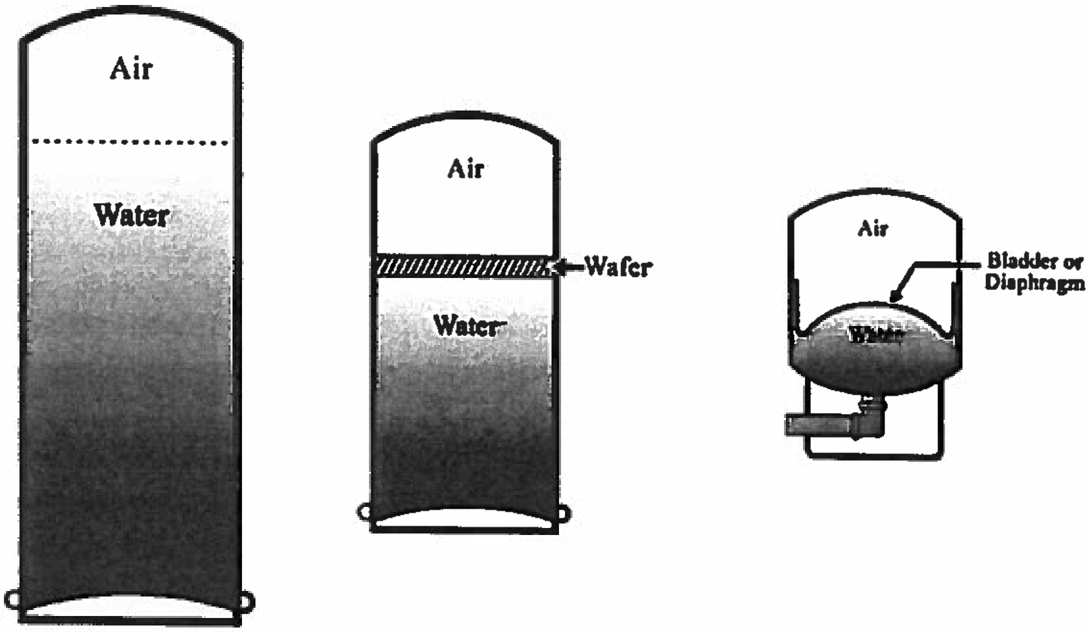


Figure 6 - Pressure Tanks, Source: University of Nebraska-Lincoln Extension.

There are a number of factors influencing tank size. A low yielding well, for instance, would require a larger tank for water storage so that the pump can provide water at a much lower rate when no one is using water, store it in the pressure tank, and have it available during times of higher demand. Without a large pressure tank, water use would quickly empty the tank, requiring the pump to kick on and try to keep up. If the demand were high, like during a shower, and your well only produces a few gallons a minute, it could cause a supply interruption.

If well yield isn't a concern, then it might be possible to use a variable speed pumping system and controller to help maintain water pressure. In these cases, the pump maintains the pressure in the system and changes speeds to match the pressure requirements at that time. For these installations, which are also called constant pressure water systems, the pressure tank is only a few gallons in size and helps keep the pressure constant on pump start up.

Standard Air Pressure Tanks

The original pressure tank was a single tank with air in it, kept under pressure, that water could be pumped into. Because air compresses but water really doesn't, pumping water into a pressurized air tank compresses the air even further, creating the pressure needed to push the water throughout your home. Many of these tanks are still in use today. However, they can become waterlogged (dissolve air into the water) and thus require more maintenance. Mosty new installations use the bladder type tank. When a tank becomes waterlogged, your pump cycles on and off much more often, which both wastes energy and is hard on the pump.

Pressure Tanks with Floats or Wafers

To help deal with the waterlogging problem and to help the tank maintain its air for a longer period of time, a wafer or float can be installed in the tank. This separates the water and air with a flexible barrier that keeps them in their own compartments. The advantage is that the tank operates more efficiently and will require maintenance less often.

Bladder Pressure Tanks

As the name implies, a bladder tank contains a flexible bladder that permanently separates the water and air. The water goes into the bladder, which expands against the air pressure in the tank. Most tanks are of this type for installations in the last 30-40 years. As water is used, the bladder empties into the distribution line until the pressure drops to a point that the pump kicks on, before the bladder is empty.

Other Parts of Your System

There are many additional parts that make up your water system. In Figure 1, some of the things shown include the well cap, electrical control box, pressure switch, and a faucet off of your pressure tank. We can't stress enough the importance of a properly sealed well cap. So many systems we come across have missing bolts, are cracked or broken from being hit by a mower, or have no screen on the vent tube. Any kind of opening creates a pathway for insects or contaminants. In the extreme, animals can fall in a well. A sealed, well secured cap is a simple way to provide important protection for your well.'

The pressure switch and electrical control box work together to cycle your pump on and off when the pressure goes below or above preset levels. The faucet is really a best management practice. It allows you to periodically flush your tank and also provides an access point to collect water samples. Other things you might have on your system, like a pressure release valve on your pressure tank, are part of the best practices lesson that will come later.

Additional Resources

Visit our Resources area at The Private Well Class for a list of resources used to develop this content and materials for further reading.

Instructor's Note: We generally try to utilize freely available resources. However one resource listed for this lesson, the Midwest Plan Service's Private Water Systems Handbook, is not. It had more technical information about design, pumps, and system components that was needed to develop the lesson.

Teresa Purtee

To...

Cc...

Bcc...

Subject: FW: [Private Well Class] Lesson 5

Attachments:

The Private Well Class
FREE ONLINE TRAINING *for* HOMEOWNERS WITH WATER WELLS

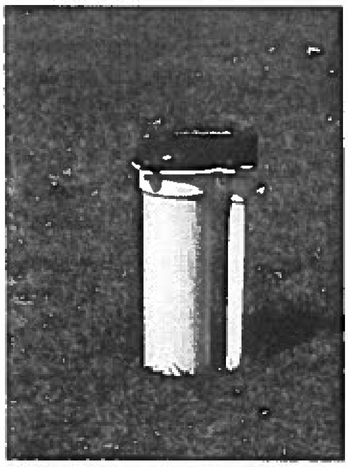
If you have trouble viewing this email, click here to read it on the web.

Lesson 5 – Necessary Maintenance, Common Operation Issues, and Best Practices

Why this Lesson is Important: Now that we understand how our well works, we can move on to how to best care for our well system, including what maintenance we need to perform and what best practices we can employ to keep our drinking water safe to drink and to keep our well system working properly. We'll also cover a few common operational issues you might encounter with your well system.

Wells and your water system have a lifespan. Some components will eventually fail and need repair or replacement. How you care for and maintain them will determine how long they last. In addition to proper operation and maintenance, there are best practices every well owner should be aware of and follow to both help protect your water system and protect your groundwater source. We will go through some of the main things a well owner can do, and also talk about some practices you should follow that will likely require a professional contractor.

Figure 1 - Well located in a flooded well pit.



Completed well pit upgrade.
Source: Province of Manitoba.

Correcting Poor Construction

We encourage you to look at the construction standards for wells in your state or territory. Some things that were the norm even 30 years ago are now considered dangerous, unsafe, or a threat to groundwater. Still, there are many older systems out there that have not been brought up to current standards. When new codes were enacted, existing wells were generally grandfathered in. They may still work fine, but they are either a threat or have limitations that don't make sense for your own personal safety and for protecting your water source. Issues of most concern are the lack of materials standards and protection from surface influences. We have learned the hard way that we aren't isolated on our own property, but we are part of a much larger community that may share and rely on a single water source. Because of that, what one person does can affect others, and many of the rules put in place today are to help prevent the actions of one person from affecting many others, whether because of accident or ignorance.

Well Pits

We discussed pitless adapters and units in the last lesson. Pitless adaptors were developed so that wells no longer had to be finished below grade in a pit. To review, well pits were originally created to allow for the piping from the well to be elbowed horizontally from the top of the well into the house below the frost line. This was to prevent pipes from freezing in the winter. For some of you in warmer areas like in Arizona (Figure 2) this isn't an issue, but in many parts of the country freezing weather is our reality.

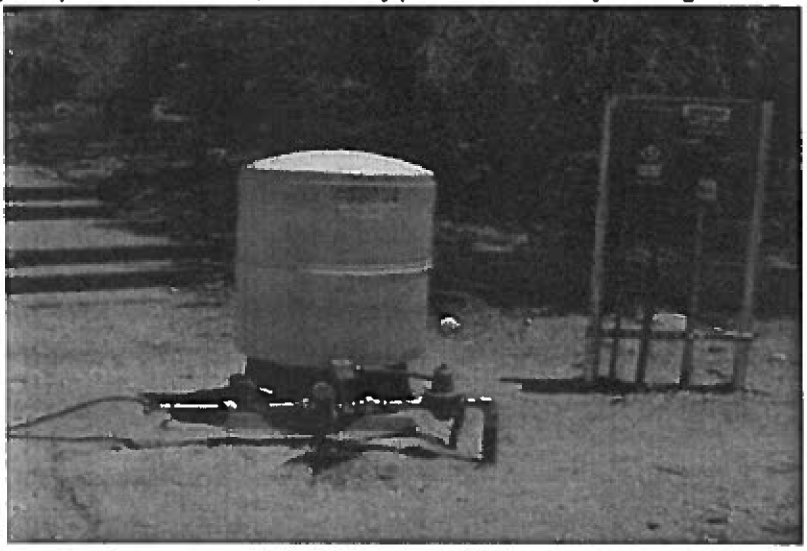


Figure 2 - Typical Domestic Well System with Pressure Tank. Photo: G. Hix. Source: Arizona Cooperative Extension.

Well pits are dangerous. They can be improperly sealed at the top, which makes them a risk for children, livestock and even moving equipment that might run over them. They can get flooded, which could compromise the quality of your well water. Because of this, a well in a pit should have the casing extended to above the surface, using a pitless adapter or unit. The extension should be fitted with an approved wellcap, and the well pit should be filled in and graded such that water will flow away from the well. There are minimum heights in most construction codes for the well stick-up you should follow. You should contact the well regulating agency in your state or territory to ask if you need a permit or to provide any paperwork regarding the improvements you make to your well. Your local well driller can professionally modify your well and ensure it meets current standards. Once completed, your well should be disinfected and then sampled for coliform bacteria to be sure your well is safe to use again.

Getting rid of your well pit is worth the trouble and effort because it will eliminate a very likely source of future contamination of your well .

Hand Dug Wells

A hand dug well is not an acceptable construction method anymore. Many still exist and are in use, but their design poses a risk for both surface contamination and safety if not properly protected at the surface. There are a couple of options to consider if you have a hand dug well. One is to drill a well through the bottom of the dug well into an aquifer if available, and then seal the annulus according to proper code using grout to fill the dug well in around the new drilled well casing. If the existing well produces a good supply of water from a sufficient depth, another option might be to install a bored well casing inside the dug well, finishing the well according to current construction standards for bored wells. You will need to find out the legal responsibilities for doing this, but your well driller should be able to help you as well.

One of our staff grew up on a hand dug well that was constructed in the 1930's. It was in a pasture with livestock, at the lowest point on the landscape so that water would run to the well and help keep it full. It did have a wellhouse over it but the casing was uncemented brick, and over time surface runoff from around the wellhouse created a seep. This meant that when the well was full, the excess would drain down gradient, like a small stream. This drainage slowly eroded the surface soil on the low side of the well, eventually leading to missing bricks and access by animals. The piping was in the wellhouse, as was the pressure tank, which was about 100 yards from the home. All in all, not a safe source of drinking water.

Figure 3 is another hand dug well still in use today. There is no way to keep insects, rodents or other things from getting in the well. The slope of the land surface will take water from the corn field toward the well. This is not a safe situation for protecting the quality of the water being taken from the well.

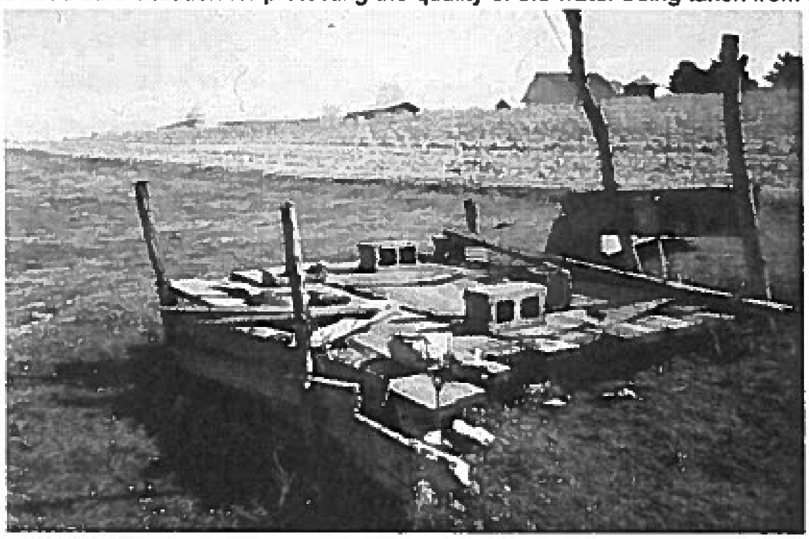


Figure 3 - Hand Dug Well. Photo: S Wilson.

Shared Wells

There are a number of reasons why one well might serve more than one home. Maybe the homes were originally owned by members of the same extended family, or one homeowner couldn't find adequate water and their neighbor was willing to share the well. More and more, developers are installing one well for multiple homes to reduce costs. However, they are being careful to limit the homes on a single well such that the well is not considered a public water supply. These developers have basically found a way around a law put in place to protect public health and we would question any developer that regularly designs multiple house units in this way.

What you really need to know about shared wells are the potential pitfalls. There can be pressure issues if not designed properly and even water shortages if the well doesn't have a large enough yield. In some cases, the well is written into the deed, in others there is a separate written or possibly only a verbal agreement in place. The point is to do your homework and protect your investment in your home by ensuring you have accessible and adequate water supply when sharing a well.

Seasonal Wells

If you have a "house in the country" or "at the lake" that you use for only part of the year, you may have have water sitting in pipes, pressure tanks, etc for long periods of time. The Washington State Department of Health has developed a set of procedures for "shutting down" and "start-up" for non-community water supplies that might be helpful for you. Non-Community supplies are places like campgrounds or schools or restaurants, that serve the same 25 or more people at least 60 days a year. Most are small, with wells that are similar in construction and use to a private well. All of the procedures aren't relevant for private water systems, but many still are, and if you have a seasonal well this guidance will give you some useful tools to help protect your water system. There is a checklist that provides some basic inspection suggestions that are relevant for all systems too.

Operational Ideas and Suggestions

The next lesson, Lesson 6, is all about problem solving, and we will talk about how to deal with common problems that arise with a private water system. Today, we are going to cover some suggested practices that will help prevent some of those problems from occurring.

Your Well Pump

Here are two basic steps that can limit the wear and tear on your well pump. The first is to limit the number of times it cycles on and off. The second is to ensure the water is free of sediment that can damage the pump and piping. If you have a submersible pump, there isn't much that can be done about sediment before water enters the pump. It's possible that moving the pump to a different depth might help, but that isn't an easy task. Howver, if you have an above ground pump, a sediment filter could be installed prior to the pump. To find out if you have sediment in your water, you can check the bottom of your pressure tank, if it's not a bladder type tank. Another possible place to check is in your toilet tank, where sometimes sediment will settle. If you find sediment either of these places, then determine the texture. If chalky or silky feeling then it is likely fine clay or silt which is less damaging than sand, which would have a more abrasive feel. That abrasive is also working on your pump and piping and can lead to problems.

If your pump kicks on soon after your water is turned on, then you may have a problem with your pressure tank, or your pressure tank could be undersized. The best way to find out is to work with a contractor who can determine the correct size pressure tank for your situation. A larger tank will lower the number of times the pump kicks on because it increases the amount of water coming from the tank first, before the pump is needed to keep up.

Another way to protect your pump is to install a low pressure cut off switch. Your pump is connected to a switch that monitors the pressure in your water system. When water is being used, it typically comes from the pressure tank initially and as the tank drains the pressure in the system drops. When it drops to a certain level, the pump kicks on to assist in providing water to the system. If you have a low-yield well, or are using more water than the well can yield, then eventually the water level in the well will drop to the level of the pump intake. If air gets in the pump, the motor can become damaged or overheated. However, because the pressure in the system is still below the cut off pressure, the pump will continue to try to run. A low pressure cut off switch recognizes that the pressure has dropped below normal operating pressure, so something must be wrong, and it automatically shuts off the pump. The pump can't start again until a manual control is changed. Typically, these switches are set to 10psi, where normal operating pressures are 30-60 psi. Most systems probably don't have to have a pressure cut off switch, but if you have a low yield well, it could save your pump if a hose is left on, or some other high volume water use lowers the water level in your well.

Pressure Tanks

One of the most common problems with private water systems is the lack of consistent pressure. Assuming your system is properly sized (meaning you have an adequate pressure tank and well pump), then the best way to provide consistent pressure is to be sure your pressure tank maintains the proper air pressure. The tank has to be drained to check the pressure and generally its recommended that the tank air pressure be kept just a few psi under the low end pressure for the pump to kick on. If you haven't been shown how to do this, we recommend having your contractor show you the first time. Checking it every 6 months or so may help you identify a potential problem before it becomes a pump cycling issue.

The Minnesota Department of Health had some advice for us about the older style aire pressure tanks after last week's lesson. These are the older style tanks we discussed in Lesson 4 that allow pressurized air and water from the well to have contact. The MDH pointed out that these tanks can serve as a low-tech treatment device. The tanks can be very effective in reducing levels of dissolved gases in groundwater, such as hydrogen sulfide, methane, and radon. The MDH says they also can precipitate dissolved iron and manganese. If you have these issues, your tank should be modified to vent the gases and have a drain to remove the sediments from the tank. Just be aware that these older style tanks do require more maintance because the air can dissolve into the water, and that affects the tanks ability to maintain pressure. They generally will need to be checked more frequently to maintain their air pressure (personal communication, Minnesota Deparment of Health).
Along the same lines, as a safety measure, your system should have a pressure relief valve either on or very near the pressure tank. Some states now require a pressure relief valve so that should a pump not kick off at the designated pressure, it doesn't cause a rupture in the tank or distribution lines somewhere. The valve should be able to pass the full pump volume.

Best Practices

The last thing we want to present in this lesson are some best practices for your well and water system. The first thing you need to do is maintain a file for your well and water system, similar to what you would keep for repairs and maintenance on your car or home. It should include the well log, dates of any work or service on the system with a description of what was done, billing records and receipts, equipment warranties, sampling results, the well driller contract, and dates and information from inspection and maintenance (discussed below). You might think this is overkill, especially if you have had your well a long time, but it not only prevents or identifies problems proactively, it helps you become more familiar with your system, how it works, and what can go wrong. For example, if you are looking at your well cap regularly, you are more likely to notice when something changes or looks different. If you have kids who mow your yard, what is the likelihood they are going to tell you they cracked the well casing? Due diligence could help avoid an expensive repair or unknown contamination.

There are many agencies and organizations that list a number of best practices regarding the maintenance and protection of your well and water system. The list below has many of those recommended by multiple entities. There are likely others we could have added, so feel free to email us with your suggestions.

1) Use a licensed driller, pump installer, or contractor when constructing, servicing, or repairing a well. If your state or territory doesn't license well drillers (Pennsylvania does not) then try to use a driller that is certified by the National Ground Water Association. NGWA's testing and accredidation means that a contractor meets a set of standards of practice that indicate they have the profefssional ability to properly do the job at hand.

2) Periodically check the wellcap to ensure it is sealed and structurally sound with no cracks, breaks, or missing bolts, and that the vent tube has a screen. Ensure the annular seal is solid and not sunken around the well.

3) Keep the area around your well free from debris. Your well should always be accessible.

4) Use back-flow preventers on all hoses and spigots. Never put a hose into a tank for mixing, and install vacuum breakers on all threaded spigots and faucets that might have a hose hooked to them.

5) If you have treatment devices, set up a schedule for maintenance and for replacing/cleaning filters, as well as for adding chemicals, so they operate properly.

6) Properly maintaining your septic system is a best practice that can influence your well significantly. If not pumped on a regular schedule, solids getting in the drainfield can plug the laterals and soon your septic system will stop functioning. We could devote an entire lesson to septic tank issues, but because that is not the focus of this class, we are providing some useful reference material for you to follow instead. Most states license septic installers and pumpers, so use someone who is licensed. The thing to remember is that your septic will fail. They have a finite life because eventually the soil around lateral lines in your drainfield will become clogged with organic material. Proper maintenance will extend its life significantly. The Montana State Cooperative Extension reference for this lesson does a really good job of explaining the basics of septic systems. The Illinois Cooperative Extension has a good maintenance record that goes along with their septic information. Like your well system, you should keep good records of maintenance and repairs of your septic system.

7) One of our pre-test questions was about best practices and shock chlorination. Shock chlorination may be a good practice for a limited set of wells around the country, but in general, you should only disinfect when necessary. Chlorine is an oxidant, it can help release metals from groundwater formations. It can also be hard on equipment in your well and can lead to earlier repair or replacement.

8) The state of Oregon requires new wells to have an access port for taking water level measurements (Figure 4). Though some might disagree on the need for such a port, we consider this to be a good management practice in many situations. By having a dedicated port on the well cap to allow access for

water level measurement, you eliminate the need to remove the entire cap and you eliminate the opportunity for your measuring device to get caught in the wiring or pump intake. Several of our staff have measured water levels in well over 1000 private wells in their careers. From our perspective, anything that will minimize the risk of damaging the well, pump, and wiring, as well as minimize the risk of contaminating the well, we would consider a good practice. It is both convenient and maintains the integrity of the well.

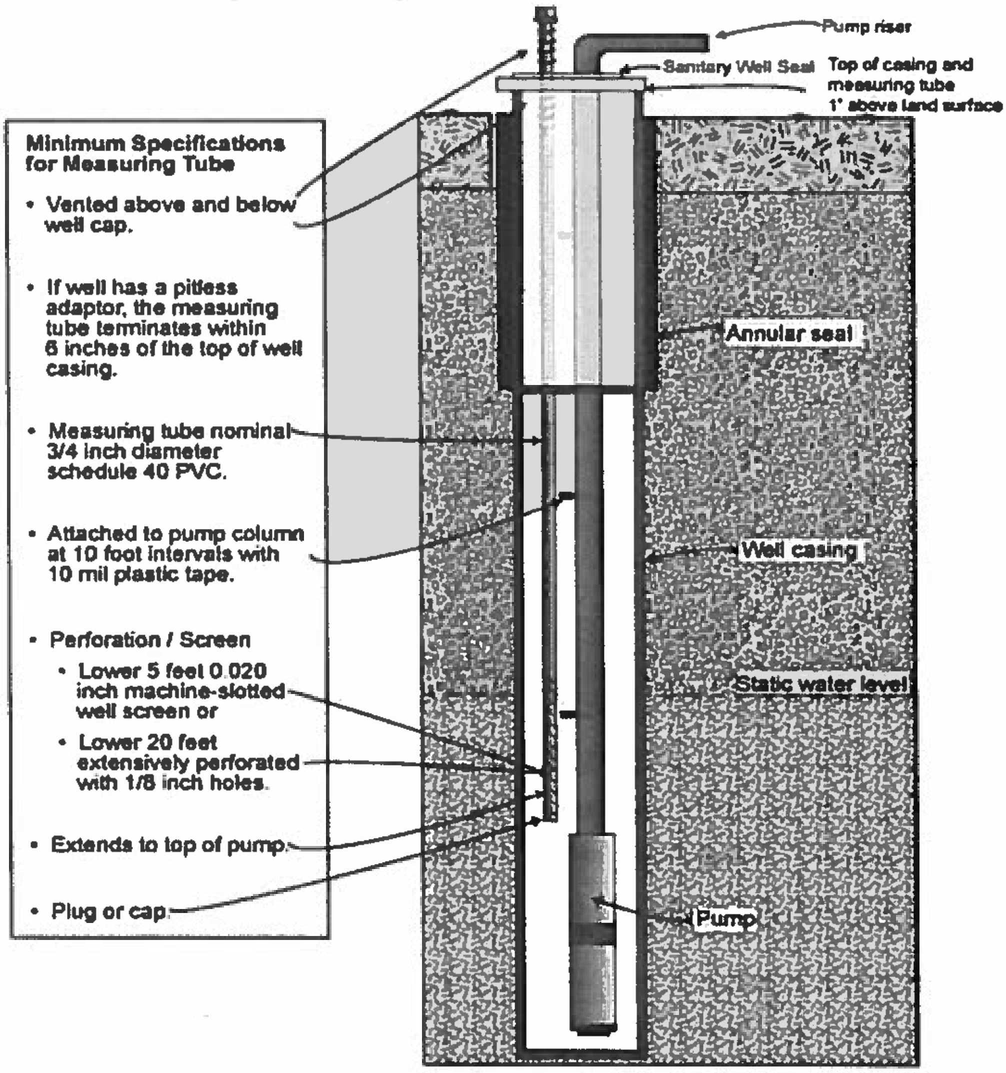


Figure 4 - Measuring Tube on an Oregon Private Well. Source: Oregon Water Resources Department.

9) Sample your well annually. In addition, you should sample your well when one of the following occur:

- Any time the well is repaired or serviced;
- If you notice any change in taste, color, odor;
- After chlorination (chlorine kills bacteria, but is also an oxidant and can release metals);
- If recurring illness is occurring;
- If a new infant is brought into the home or someone is pregnant; or
- If a neighbor has a water quality issue with their well

More About Sampling

Every jurisdiction may have a different set of recommendations for what to sample for and how often.

You should talk to your local health department and your state/territory well agencies about your location, and any additional constituents you should be concerned with (arsenic, for instance). It may also change depending on the type of well you have. We recommend sampling for coliform bacteria, nitrate, pH, and hardness. Coliform bacteria and nitrate are indicators of possible well contamination from the surface and should be completed every year. pH should be between 6.5 and 8.5 for most groundwater. Outside that range, water is corrosive which can cause pipe leaks, so its good information to have. Hardness is important for the many of you that use or need a softener. Very hard water can cause hard water deposits and reduce the effectiveness of soaps. Your state may have maps that describe the general water quality of the main aquifers. In some cases these maps are available online.

Well Head Protection and water quality issues will be discussed in more detail in lesson 8, but for today, we want to point out some of the common sense best practices for protecting your well, which include keeping any potential sources of contamination away from your well. Things like buried tanks, septic tanks, septic fields, storing chemicals or fuel, livestock near the well, tying a dog to the well head, etc., that would pose an obvious risk near your well.

Abandoned Wells

Earlier, we mentioned that the construction codes have changed as we have learned more about the risks to our health and the threats to our groundwater. A good example is the serious problem of improperly abandoned wells. In some areas, well logs did not have to be filed with an authority until less than 30 years ago. So, any well installed before that time does not have a public record of its existence. What that means today is that in many areas of the country there are more undocumented wells than there are wells on file. Abandoned wells that are not sealed are everywhere and most are a threat to our groundwater because they provide a direct conduit to an aquifer.

We have seen what can happen when an abandoned well is not taken care of. How many of you remember Jessica McClure? As an 18-month old, she made national headlines in 1987 because she was rescued from a well after being stuck for 22 hours. It captivated everyone at the time. There was live coverage, and many people watched the entire event unfold. However, her experience was not as unusual as you might think. Many other people and countless animals have fallen into wells. (For just a few examples, Google "horse falling into a well") They just received less media coverage, and may not have been as fortunate as "Baby Jessica" (Figure 5).

Figure 5 - Abandoned Well Headlines. Source: Illinois Water Well Sealing Coalition.

If you have an abandoned well on your property, contact your jurisdiction's well agency and find out the requirements for properly abandoning the well. The regulations vary on what is and isn't allowed, but its definitely worth getting it taken care of. In many locations, if a person is hurt from an abandoned well or if an aquifer is contaminated by an abandoned well, the well owner is responsible for the damages. If anyone has an abandoned well and wants to have it properly plugged and sealed, send us an email, we will help you find the correct local authority to make sure you know the requirements.

Additional Resources

Visit our Resources area at The Private Well Class for a list of resources used to develop this content and materials for further reading.

Note: In developing the information for lessons 5 & 6, we have come across a number of websites put together by do-it-yourselfers, homeowners, and others that talk about common maintenance issues and potential solutions. Though these sites may be helpful in some cases, we recommend always talking to your local contractor and/or agency when you have questions related to maintaining and repairing your water system; they are the experts. Conditions are different in different parts of the United States, and the world for that matter, and direct information from a professional is the best approach to protecting *your well water system and water quality.*

ERA Cristopher Creek

Subject: FW: [Private Well Class] Lesson 6

The Private Well Class

FREE ONLINE TRAINING *for* HOMEOWNERS WITH WATER WELLS

If you have trouble viewing this email, click here to read it on the web.

Lesson 6 - Emergency Situations, Failures, and Problem Solving

Why This Lesson Is Important: Being prepared, both for the unexpected and by performing the proper maintenance on your system will ensure that fewer problems arise, but also that you will be ready when they do. This lesson covers some of the common issues that affect many private well system owners, and should give you a better feel for how some of the parts of your system work.

Emergency Situations

When an emergency situation presents itself, whether flood, fire, some other natural disaster, or loss of power, ensuring your water supply is safe and useable is very important. If you live in a remote area, it is that much more so. Your water supply is one of the easiest things to take for granted and the one thing it's really hard to do without. Most people don't realize how important clean drinking water is until they don't have it. That said, there are things that are out of our control, so the best approach is to be prepared and have a plan.

If you lose power, meaning you have lost all electricity to your home, not just to your well, then really the only thing you can do is have a generator for back up. This is a good practice, not only from the standpoint of running your well, even if only periodically, but to run your freezer, fridge, and furnace as well. In some remote areas that are prone to lose power in bad weather, a generator just makes sense. If you have an older well with piping coming to the surface in a well house, then loss of power in the winter could mean frozen pipes as well. This should be avoided at all costs, because it could burst the pipes. In this case, a portable propane heater that can be used in the well house could save you a lot of trouble.

Wells Going Dry

If you have a shallow dug or bored well and it goes dry, then you may not have many options. These wells are built in areas without significant aquifers for the purpose of storing water that seeps into the well slowly. If it's a really dry year, it may be that the water table has dropped below your well. The best thing you can do in this situation is have a potable water tank as a backup. You can have water delivered or haul it yourself from a municipal source, and practice conservation until the situation changes. The other option would be to drill a deeper well. If that is a consideration for you, then you should contact the agency in your jurisdiction responsible for well logs and find out what possible options you might have. Then contact a driller to get further advice on possible aquifers at your location. In general, large diameter wells are not preferred, so it may be that there are no other options in your area. If you have been at your location very long, you probably have had this problem before, and may already have a solution in place.

Sometimes, wells aren't dry, but the water level has dropped below the pump. This could be because of well interference. Maybe a large capacity well, for irrigation or industry, is close to you and has lowered the water levels in the aquifer below your pump. It's important to keep water level measurements and pump setting depth in your records for just this reason. If you can determine that there is still water in your well and your pump can be lowered below that depth, it's a fixable problem.

Flooded Wells

If flood waters overtop your well, assume your well is contaminated. Once the water recedes, you should have your well disinfected and sampled for bacteria before using it again. You should also inspect your wellhead to be sure no debris got in your well. This is a particular concern if your vent screen is missing. If you think there is debris, have a contractor clean and disinfect your well. Remember to disconnect any treatment that might be inline in your system prior to disinfection too. If water doesn't overtop your well, but reaches your well, it is still safest to disinfect and sample prior to use.

If you have the luxury of knowing there could be a flooding issue, be prepared. Beforehand, store a supply of clean water that you can use during the flood period and after. Disconnect the power supply to your well to prevent any electrical damage from shorts circuits. Plug the vent holes temporarily to prevent debris from getting in your well.

There are other options that you can consider to help prevent flood contamination, but they are more costly. One is to have a contractor create an extension for your well to raise the pipe. We have seen wellheads that are in flood prone areas that extend 10 feet or more above land surface. Another option is to replace your vented cap with a waterproof one for just during the flood event. This may provide added protection, but it's still always best to have a sample analyzed after the flood to be sure there were no leaks or other avenues into the well that flood waters may have found.

Well pits are a shock hazard, so be sure the entire pit is dry before entering. If your pit is a confined space, then do not go into it because of the risk of dangerous gases. Have a qualified professional inspect and restart your system. If your pump is above ground, like in your basement or over the well, flood waters could short circuit the system and even start the pump. Be sure the power is off in advance of the flood, and have your pump checked and tested by a professional before using it again.

Septic systems can also be damaged or cause contamination issues during floods. Make sure the access points are sealed. Your septic system should have a backflow preventer before the tank to keep sewage from backing up into your home during a flooding event. If your septic has its own pump, be sure to shut off the power.

Fire Damage

In some parts of the US, the danger of forest fires is a real threat to homes and their water systems. If you have experienced a forest fire, do a check of your system. There could be damage to wires, casing, well house, treatment equipment, etc. You should flush the water lines. Initially, the water may have an earthy or smoky taste or smell. If there was a loss of water pressure, then repair damaged equipment and disinfect water system. (Loss of pressure can be checked by turning on a faucet. If there is any air in the line, then likely it lost pressure.) If you have any doubts, it's always best to have a contractor check out your system to be sure.

Common Problems and Their Solutions

Next, we are going to talk about some of the common problems well owners have with their water systems. We won't cover many possibilities, but we are going to try and talk about the most common things that can happen. The best way to deal with all of these issues is to contact your system professional and seek their advice and help for your particular situation.

Loss Of Water Pressure

A very common problem with private water systems is the loss of pressure when there are multiple uses of water at one time. There are a number of possible causes and solutions. The pump and pressure tank work together to provide your water pressure, so you need to consider both. Systems are designed to work between two pressure ranges. When you use water the pressure in your system decreases until a low pressure switch kicks on your pump. This is the cut-in pressure. The pump supplies water and increases pressure in your system until a high pressure switch is tripped, which shuts the pump off. This is the cut-out pressure. Most systems operate with about 20psi between the cut-in and cut-out pressure. For example, they may be set at 40 and 60psi, or 30 and 50 psi. So, inherent in your home system is a drop in pressure of 20 psi as water is used. When you turn on a tap, water is coming from the water stored in the pressure tank. As it drains, the pressure in the tank and system decrease.

Heavy water use means the pressure tank will eventually need help from the pump to keep up with use. The larger the tank the more water that is stored under pressure. One option may be to increase the size of your pressure tank, though this can be expensive. Once the pump kicks on to help supply additional water and maintain pressure, if the pump isn't of sufficient capacity to provide the water being used, the pressure will continue to decrease as long as the use is ongoing. When the water use stops, the pump continues to run, filling the tank and increasing the pressure until the cut-out pressure is reached.

If your system is in working order, but doesn't maintain pressure, the National Ground Water Association offers these three solutions:

1) Use a constant pressure valve between the pump and pressure tank. It adjusts flow from the pump to maintain a preset pressure in your system. It maintains a constant pressure rather than having the pressure drop between the cut-off and cut-in pressure your system is designed to work at. In essence, the valve never lets the system reach the cut-out pressure that would turn the pump off while water is being used. This valve works well as long as the pump has sufficient capacity to keep up with the water being used.

2) Increase pressure tank capacity, either a larger tank, or a 2nd tank for those times when you need adequate pressure during high use. As already mentioned, this works until tank(s) are empty, then you will be relying on the pump to keep up as before. This is the best solution if you have a well that can't keep up with use, so that more is stored during those times of non-use and there are fewer instances where you need the pump to help maintain system pressure.

3) Use a variable speed pump. These pump motors can run twice as fast as a conventional pump motor. Its speed is tied to the pressure in the system so when there is high demand, the pump increases speed to keep up. These pumps are a good solution as long as the well has the capacity to continue to provide a high volume of water.

Air At Your Tap

If you have air coming out of your faucets, there are several likely causes, but the most common are dissolved gases in the water and water levels in the well dropping to the level of the pump intake. If you have gas in solution, like methane, it can be released from the water at your tap. This occurs because the water pressure you maintain in your system keeps the gas in solution, but at the tap the pressure drops to atmospheric pressure, allowing the gas to bubble out of the water.

Dealing with trapped gasses in your water can be complicated. First, be sure your well has a vented cap. This should help vent some of the gas from your well. If you already have a vented cap, or if installing one doesn't help, then the options get more expensive. You have to aerate your water at some point before it reaches your tap to remove the gases. This can be complicated and involves a holding tank to vent the gases, then a 2nd pump to get water under pressure back into your home. Figure 1 is an example of a vented tank methane removal system from the National Ground Water Association's Water Well Journal. In addition to methane, other gases may be present in your well water. If you have these issues, the best thing to do is contact your local health agency and a contractor for advice on how to best deal with this situation.

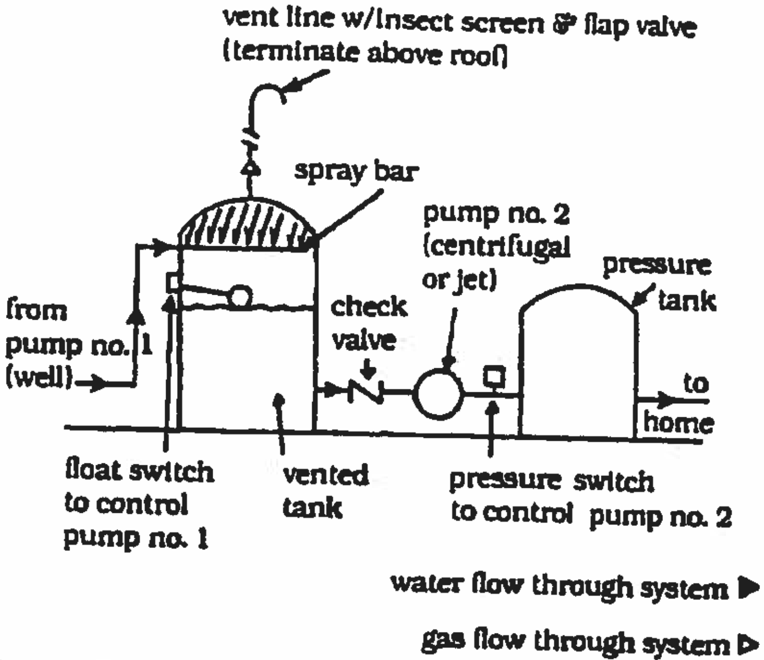


Figure 1 - Vented Tank Method for Gas Removal. Source: National Ground Water Association Water Well Journal.

The other typical cause of air at the tap is the water level in the well being lowered to the pump intake causing the system to pump both air and water. If this is the case, then you might be able to lower your pump in the well. Or, if this is a new problem, then it's possible the yield of the well has diminished for some reason, and it might require maintenance or rehabilitation.

Low Yield Wells

A well may be in an aquifer that just doesn't provide that much water. These wells are termed low-yield wells. There may be plenty of water in the aquifer, but it has to be drawn out slowly to maintain a sufficient water level in the well. In many cases, these systems use a large or multiple pressure tanks so that more water is stored and ready for use, rather than relying on the pump to keep up with water use. The pump is sized small enough to maintain the water level in the well above the pump intake, and it slowly fills the pressure tank(s) at times when water is not being used. If the pump is too large in capacity, the water level in the well will drop down to the pump intake causing air to get in the system and causing a lack of pressure buildup which can keep the pump on and damage it. One way to protect the pump, if you have this situation, is to install a low pressure cut off switch, which will shut off your pump when the pressure in the system is very low, below the normal cut-out pressure for the pump, so that your pump doesn't continue to run when water isn't available. Before considering this, you should talk to your contractor for advice.

All in all, low-yield wells can be problematic for other reasons, even if you have a very large pressure tank and can manage to provide an adequate water supply to your home. These wells generally can vary significantly between the non-pumping and pumping water levels. Especially in bedrock wells that are open hole (have no casing in the bedrock), the repeated introduction of air on the rock can cause changes in chemistry, releasing metals into the water, causing sediment formation in the well, and possibly additional scale buildup on components. It can also provide better environment for biofilm growth. At a presentation attended by one of our staff, a low-yield well in Pennsylvania was sampled throughout the day as the well was used and the water level in the well dropped and recovered. Their data showed significant changes in water chemistry almost on an hourly basis.

Loss of Well Yield

If your well provided plenty of water at one time, but now can't keep up, then there may be something else going on. Sometimes a well slowly loses yield over time. This can happen for a couple of reasons:

1) Lower water table – if the water level in an aquifer or the water table drops in the area, because of dry conditions or overuse, there may not be much that can be done. In some jurisdictions, there may be laws that protect a well owner when another user causes well interference. You will need to check with your state or territorial agencies to determine what options you have if you are in this situation (also see the discussion of dry wells above). It may be that you can lower your pump, or it might mean you need a deeper well.

2) Plugged holes or screen – silt, clay, iron bacteria, slime, sediments, and mineral deposits can all cause losses in yield because of clogged openings. Figure 2 shows a well screen that has calcium and magnesium carbonate scale formation that is limiting the screen openings. If you have had a reduction in well yield, contact a well contractor for help. There are mechanical and chemical cleaning methods that can restore well production. For more information on the causes, check out the reference "Arizona Wells: Maintaining and Troubleshooting Wells".

Figure 2 - Scale Formation on a Well Screen. Photo: Gary Hix. Source Arizona Cooperative Extension.

Pump Problems

To understand if your pump is working properly, you need to be able to tell when it is running. If your pump is in your basement (i.e., a shallow jet pump), it's obvious when your pump is running and when it isn't. But when the pump is in the well, it isn't as easy to know if your pump is on or off. Luckily, you can watch the water pressure tank gauge to check your pump. Let's say your pressure control switch is set so that the "cut-in" pressure is 30psi and the "cut-out" pressure is 50psi. This means your system is set up to turn the pump on when the pressure drops down to 30 psi and shut off when the pressure reaches 50 psi. During the time the pump is on, the gauge should be increasing from 30 to 50 psi as water is pumped into the pressure tank and water system. It will shut off when it reaches 50 psi. If your pump is working properly, the gauge will follow this cycle. Though you can't actually hear a submersible pump running, you should hear the pressure control switch click as it turns the pump on and off, and when the pump is on, you can see the pressure increasing on the gauge. If this isn't what you see happening, then there might be an issue. Below are some possible pump problems and their causes. Though these guidelines can help diagnose a problem, we would suggest that most well owners contact a well/pump contractor to actually fix any problems with a pump. Piping is grounded and you are working with electricity, so these aren't things to try and learn as you go.

The Pump Cycles Rapidly – This is likely a pressure tank problem where the air and water pressures are not correctly balanced. If you have an older style tank with air and water in contact, then likely the tank is waterlogged. This means that most of the air in the tank has dissolved into the water, so the air is gone from the tank, and there is no way for the tank to build up pressure. (Remember that air is the compressible fluid that allows your tank to build up pressure) For this older style tank, air needs to be added. You should also check to be sure the tank isn't leaking air. If you have a bladder tank, which are the most common today, then the bladder is likely ruptured and the bladder or tank will have to be replaced. Most bladder tanks are pre-charged and you should not add air to them. Contact a contractor if you have questions. Though not as likely, it's possible the problem is with the pressure control switch, but in most cases when this switch fails, it typically prevents the pump from being turned either on or off at all. Another less common cause could be a clogged water filter. If you have an inline filter, you can check this by taking the cartridge out altogether just to test the system. Filters have to be maintained to work properly.

Pump Doesn't Shut Off – There are numerous causes of this. Many are due to the system not reaching the cut-off pressure. It could be that the pump is working hard but the pressure in the system is not reaching the cut-off pressure so the pump remains on. This can happen if the pump inlet screen is plugged, if the water level in the well drops to the level of the pump intake, if the pump parts are worn and causing leaks, or if there is a hole in the drop pipe bringing water up in the well. A stuck or malfunctioning pressure control switch can also cause a pump to run continuously. Sometimes sediment can clog the sensor opening. If this happens, then it may need to be replaced. If there is a filter inline in the system, a clogged filter could also keep the pump from supplying enough water to pressurize the system properly. Check the filter first, if you have one. Another possible cause is a pressure control switch that is not set properly, meaning the cut out pressure is set higher than the pump can deliver. This isn't as common, most of these switches are pre-set. If it isn't any of these problems, then the pump should be pulled and checked. If the pump runs continuously, then it's only a matter of time before it wears out.

Pump Won't Turn On – First thing to check is that the pump has electric power. Has a fuse been blown or a breaker tripped? Was there a power outage or lightning strike? If so, it could have melted wiring or caused some other damage that won't allow the pump to work properly. Maybe it runs for a few seconds then shuts off. This could be a short in the wiring as well. If it's not a short, then check the pressure gauge and make sure the system is below the cut-in pressure that should turn on the pump. It could be that the pressure switch for the pump is malfunctioning, and may need to be replaced. Some of these switches have a manual bypass lever. If yours does, you can force the pump on using the lever. If the pump comes on, then the problem is likely in your switch. It could be sediment or debris in the pipe that the switch is mounted to. If you have narrowed it down to a switch or gauge, you should probably have a contractor diagnose the problem for sure.

Pump Running When No Water Use – In theory, once the system is at its cut-out pressure, it should stay pressurized until someone opens a faucet. If your pump kicks on when there is no use, then you probably have a leak in your system. First, check for a running toilet. That is probably the most common problem. If the problem isn't with the toilet, then there may be a leak in your water lines somewhere. Another possibility is that the foot valve that keeps the water from running back down your well is leaking, which would reduce pressure in the system.

Bad Pressure Gauge

If there is water pressure when you turn on a faucet and the pump control switch is clicking on and off, meaning the pump is turning on and off like it is supposed to, but the system pressure gauge doesn't move, then it could be the gauge itself is stuck and not working properly. This can happen if it is old, or if sediment has plugged the gauge opening. The pressure gauge on your system is an important tool in maintaining your water system and diagnosing problems. If it sticks, have it replaced.

Septic Systems

Lastly, we want to mention a few things about septic systems. We consider both the water and wastewater systems of your home part of your overall water system responsibilities. A septic system that isn't maintained can cause a host of other problems. Septic systems failures can be a source of well contamination or cause your discharge to back up into your house. This can be caused by a buildup of solids in your septic system that can clog the drainfield lines. Another common problem is too much wastewater entering the system, which doesn't give the system time to disperse the liquids in the drainfield or it can allow solids to get into the drainfield piping. Some older septic systems only have a tank overflow for the liquids and under certain conditions can allow solids to get over the overflow. When this happens, the lines that disperse the liquids get clogged and wastewater can back up in your home. There is nowhere for the wastewater to go if the perforated drainfield pipes become clogged. Wastewater discharge can also travel upward from the drainfield, reaching land surface, or push water through the soil and down into an aquifer before it has time to be treated naturally if the system is overused. If you find a wet area where your drainfield is, then you likely have a septic problem. Septic discharge is highly contaminated, especially with E. coli bacteria. It is simply unsafe to have sewage coming to the surface.

To avoid these problems, properly maintain your septic system and follow best practices as much as possible. A septic system is built to treat the waste from your home by separating the solids and liquids, then dispersing the liquids in the soil where they can be treated naturally. Figures 3 and 4 show typical septic systems, which consist of the tank (Figure 3) and the drainfield (Figure 4). The solids fall to the bottom of the tank and the liquids flow out into the drainfield. The solids build up in the septic tank, and based on size, they will have to be pumped out on a regular schedule, usually every 2-5 years. Doing so will prolong the life of your septic system. Not doing so is one of the main causes of septic system failures. Another way to help your septic system work properly is to limit the water entering the tank. This means using water conservation as a way to help the septic system work better and longer. The less water the better.

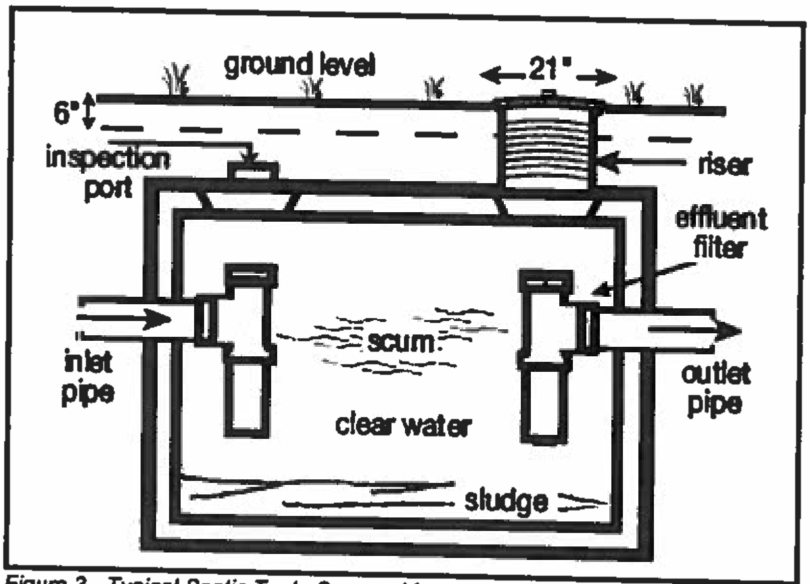


Figure 3 - Typical Septic Tank. Source: Montana State University Extension

Service.

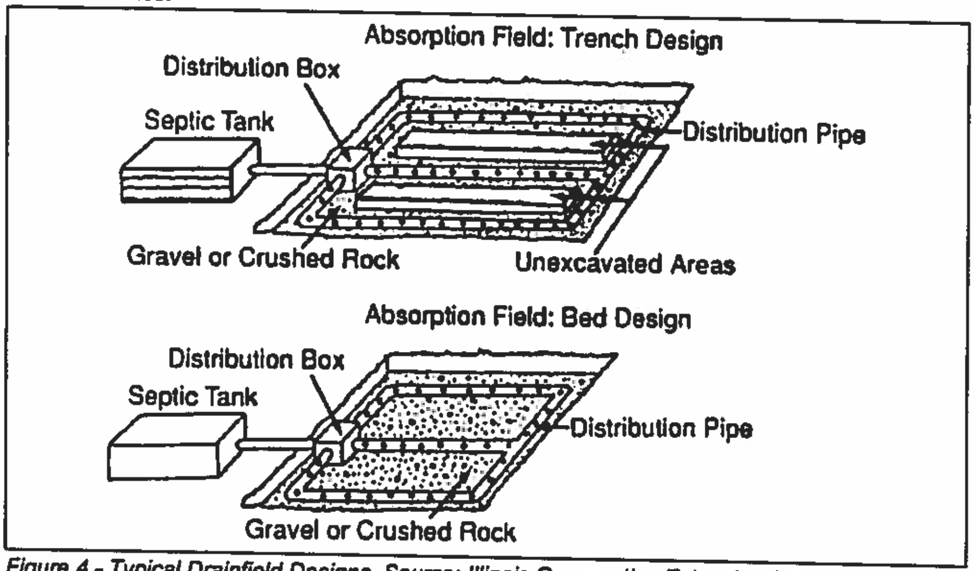


Figure 4 - Typical Drainfield Designs. Source: Illinois Cooperative Extension Service.

What you put down your drain or flush down your toilet can have a significant impact as well. Never put any solids down your drain or toilet. Some examples of things not to flush include dental floss, coffee grounds, paper towels, cat litter, or anything that could potentially be trapped or clog an opening. Chemicals can interfere with the proper biological breakdown of sewage, so it's a bad idea to put things like antifreeze, paint, oil, pesticides, or other household chemicals down the drain (or flush them down the toilet). Even using your washer too often can affect your septic system. Try to spread out washing machine use during the week so that the system has a chance to break down the soaps and bleach properly. Garbage disposals are also a source of additional solids and can be a plugging problem.

Next Steps

This week in particular, we have only covered some of the possible issues on these topics. We recommend you take the time to go through the provided references to develop a better understanding of what issues may arise with your water and septic system. We also want to remind you that your well contractors, health officials, and other assistance providers (extension, DNR, etc), are here to help you and you should get to know those folks and learn who can help you in your area.

Additional Resources

Visit our Resources area at The Private Well Class for a list of resources used to develop this content and materials for further reading.

If you have trouble viewing this email, click here to read it on the web.

Before We Get Started – Feedback Requested

With Lesson 7 we begin the transition from talking about the physical parts of your water system to discussing water quality issues. Lessons 8-10 will be about water quality, sampling, and treatment. We thought now would be a good time to get some feedback. Before we get to the lesson please click the link below and let us know how we are doing so far and what we can do better. It's only four short questions. Thanks! Click here to provide feedback.

Lesson 7 – Getting Help, Finding Local Answers

Why This Lesson Is Important: The focus of these lessons is to provide the resources you need to learn more about your well and water system, with the goal of helping you become a more informed and capable well owner. Since this class reaches the entire US and its territories, there may be issues specific to your area that we won't be able to cover or discuss in detail. In this lesson, we hope to share some of the resources and options you might have locally that will give you additional support and provide you with contacts that can help you with these issues. We also hope to show you strategies to find this information in your area.

Your Well Driller and Contractor

The driller you use either to install your well or to perform maintenance/repairs is probably the most important asset you have. Proper care of your well means you will likely need your driller sometime in the future, so pick carefully, as you will probably have a long-term relationship. Do your research, and be sure you are comfortable with them. A good driller/contractor will stand out. They should be licensed for your jurisdiction. You should also ask if they are certified by the National Ground Water Association. In some areas, NGWA certification is a requirement to get a drilling license. We would also recommend that you use someone that can do everything related to your well, meaning they not only drill wells, but install pumps, water lines, and water system equipment. You should expect them to know everything about your system, so that you only have to deal with one person no matter what the issue might be that requires support or advice.

Ask a lot of questions. Do they file logs, and can you see a log from a nearby well that has been filed? They should understand the geology of the area and be able to easily answer your questions. They should provide both an estimate and a contract with performance, materials, and workmanship guarantees for any big project. Be sure they have liability insurance. Ask for references, specifically customers who have had the same work completed you have. Ask neighbors for recommendations. Contact the agency responsible for regulating drillers and your local health agency to ask for recommendations and find out if any of the contractors you are considering have had any complaints filed against them. Your well and water system contractor is a professional, like your realtor or dentist. Take the time to find the best fit for you.

Water System Issues

Who do you talk to when you need help with pitless adapters, pressure tanks, and common maintenance issues related to properly maintaining your well and water system? Your local contractor is an excellent resource. Another is the agency that regulates drillers and well construction standards for your state or territory. We have come across some really knowledgeable agencies that have helped with the class, and helped answer questions from well owners. For example, the Minnesota Department of Health and the Washington Department of Ecology, as well as various state offices of the Cooperative Extension Service have been very helpful. As a well owner, the thing to remember is all of these folks are here to help you, so lean on them, ask questions, and learn from them.

Help In Your State/Territory

Every state is governed just a little bit differently. Because state laws were developed to meet the needs of each jurisdiction, different state agencies have different authorities and manage different programs. For example, in Washington State licensing of drillers is governed by the Department of Ecology. In Missouri, licensing is handled by the Department of Natural Resources. In New York, it's the Department of Conservation. In Pennsylvania, they don't license drillers at the state level. The point is you need to learn who has jurisdiction for what, and where you can go for specific information on different topics. In the sections below, we'll be discussing the kind of information you'll be looking for, as well as a few ideas on which organizations in your area might have that information.

Well Logs

In Lesson 1, we talked about how knowing your geology and specific information about your well is important for understanding both your options regarding water sources, and construction issues should you have a well problem. Your well log is a good place to start as you collect this information.
Well logs are different in each state. In Illinois, there is a place to put the static and pumping water level, pumping rate, and duration of pumping. These things tell you how much drawdown you will have when pumping at that rate and give you some idea of how much water your well will likely produce. Other states may not require this information on their logs. Oklahoma, for example, asks for an estimated yield in gallons per minute, but there is no explanation on the log on how the driller might have come up with this number.

You should know what the information on your well log means. The best way to find that out is to contact the agency that requires or houses the well logs in your area and go over your log with them. This is usually the organization that licenses drillers, or that requires well logs to be filed, or that inspects new wells. Or it could be all three. In Illinois, for example, the Illinois Department of Health licenses drillers and requires well logs to be filed in each county with the county health department. The logs are also sent to the Illinois State Geological Survey and the Illinois State Water Survey where copies are also kept. The county health departments inspect new wells and keep records of initial sample results that show the well is free of contamination.

Other states operate differently, and a simple phone call to the organization that maintains your well logs, like a DNR, DEC, or Scientific Survey, will help you get in touch with someone who can explain how the process works for your area. Figure 1 is a Google search for well logs in Missouri. Google can help you track down the correct organization for your state, which should help you find a phone number or contact who can tell you more about the process and where to get information.

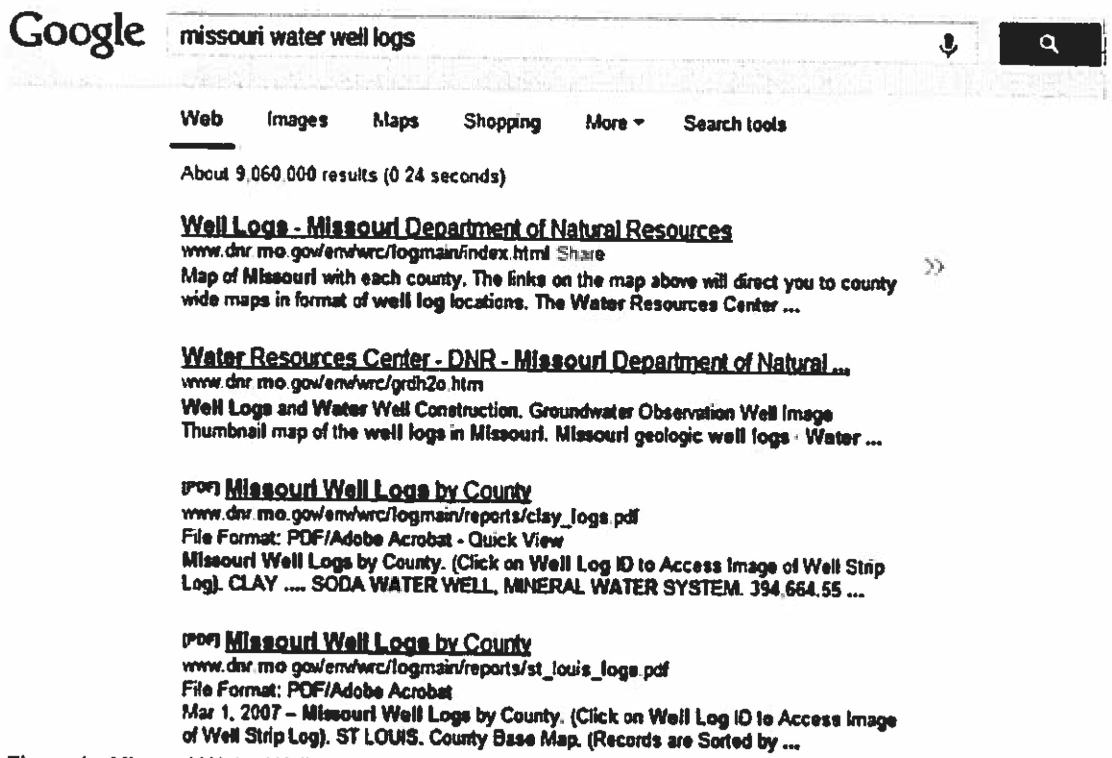


Figure 1 - Missouri Water Well Logs Search Results

Geology and Aquifer Information

The same organizations mentioned above may be able to provide you with geology and aquifer information for your property. However, the organizations that map geology and aquifers are most likely to have staff that can explain the water availability and (often) the aquifer water quality of the area. In many states this is the Department of Natural Resources, the Department of Environmental Quality, or a State Geological Survey. (Note: Illinois is the only state with a separate scientific survey devoted to water, the Illinois State Water Survey. Most states have only a State Geological Survey.) Other possible sources are universities or the USGS. Figure 2 is an example Google search for aquifer maps in Oklahoma. As you can see, the search shows Oklahoma has a Water Resources Board and a Department of Environmental Quality. The folks at either of these organizations can provide guidance to Oklahoma well owners.

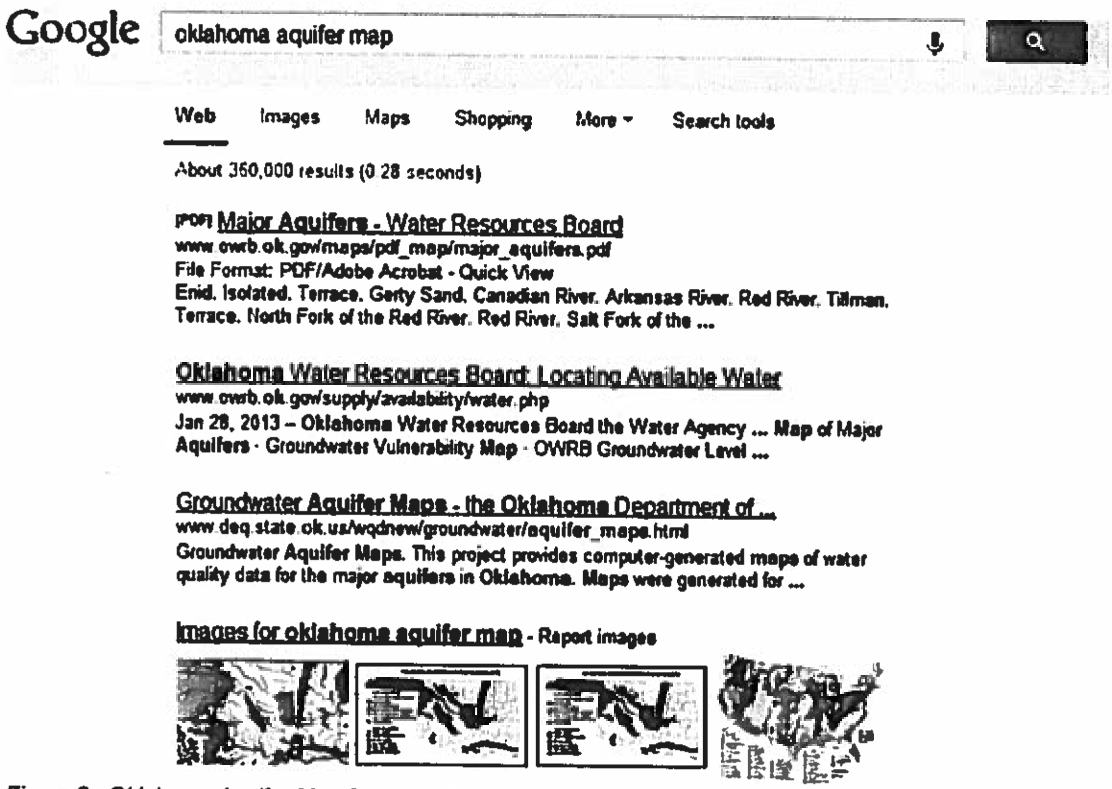


Figure 2 - Oklahoma Aquifer Map Search Results

Groundwater Quality Information

It's important to note that there's a difference between groundwater quality and private well drinking water quality. When water is pumped into a home, it can go through a number of stages before it reaches the tap. Water might sit in a pressure tank or water line overnight. It could also go through one of several treatment processes. Changes in water quality can occur because of the introduction of oxygen, removal of certain minerals, or because of leaching in older pipes. Because of this journey, we might get different results if we were to collect a water quality sample at the kitchen tap versus a spigot near the well. Generally these differences are minor, but it's important to keep in mind that researchers who have determined the groundwater quality of an aquifer are talking about the natural water quality in the ground. This may or may not be the same as the quality of what comes out of your faucet in the kitchen.

With this distinction in mind, most states do have groundwater or aquifer water quality information available. The term some use for the natural water quality of an aquifer is "ambient." You may find that term used in monitoring water quality, as we did in the search for "California groundwater quality" (Figure 3). In California, because of water scarcity and water rights issues, there are multiple jurisdictions that are involved in groundwater quality. California water boards are part of their State Environmental Protection Agency. The Groundwater Information Center is part of their Department of Water Resources. The Florida state agency is the Department of Environmental Protection (Figure 4). These agencies will be able to provide you with water quality information about the aquifer you use for water supply.

Google california groundwater quality

Web Images Maps Shopping More Search tools

About 1,700,000 results (0.29 seconds)

Scholarly articles for California groundwater quality
... of groundwater quality, Mojave River Valley, California - Dawdy - Cited by 56
Groundwater Hydrology Edition - Todd - Cited by 1674
Effect of irrigation on groundwater quality in California - Schmidt - Cited by 29

GAMA – Groundwater Ambient Monitoring & Assessment Program
www.waterboards.ca.gov/gama/
The Groundwater Ambient Monitoring and Assessment (GAMA) Program is California's comprehensive groundwater quality monitoring program. GAMA collects ...
GeoTracker - Groundwater Reports - GAMA Domestic Well Project - Contact Us

Groundwater Information Center - State of California
well.water.ca.gov/
Sep 26, 2011 – Proper stewardship of California's groundwater is important to avoid quality degradation and land subsidence. Groundwater issues vary ...

Groundwater Quality - North Central Region Office - State of California
www.cd.water.ca.gov/groundwater/gwquality.cfm
California's future depends on protecting groundwater quality. Having groundwater with very poor quality is like having no groundwater at all. Some groundwater ...

Figure 3 - California Groundwater Quality Search Results

Google Florida groundwater quality

Web Images Maps Shopping More Search tools

About 632,000 results (0.28 seconds)

Scholarly articles for Florida groundwater quality
... and groundwater quality: Issues and problems in four ... - Holden - Cited by 117
Applied hydrogeology - Fetter - Cited by 2799
Groundwater Hydrology Edition - Todd - Cited by 1674

Water Quality Data - Florida Department of Environmental Protection
www.dep.state.fl.us/water/monitoring/data.htm
Sep 21, 2011 – Historical (pre-2000) groundwater data may be obtained via EPA ... In turn, the Florida STORET Program provides the national water quality ...

Ground Water Quality Monitoring Network - Florida Department of ...
www.dep.state.fl.us/water/monitoring/gwqmn.htm
Sep 21, 2011 – Organization and Establishment of Florida's Statewide Ground Water Quality Monitoring Network. In 1983, the Florida Legislature passed the ...

Ground Water Program - Florida Department of Environmental ...
www.dep.state.fl.us/water/groundwater/index.htm Share
Feb 1, 2013 – Sources of high quality ground water underlie virtually all of Florida. Ninety percent of this state's population relies on these ground water ...

Figure 4 - Florida Groundwater Quality Search Results

Well Drinking Water Quality and Sampling

The only way to know your drinking water quality for sure is to collect a sample at your tap or faucet. The water quality in aquifers can vary from location to location and the site specific conditions related to your water supply can influence the final water quality (existing treatment, lead pipes, etc.). We will get more into sampling and drinking water quality in later lessons, but today we wanted to make the point that sampling is the only way to be sure of your drinking water quality and that there are some areas where sampling may be required. In New Jersey, for example, extensive sampling is required at the time of property transfer. In Rhode Island, testing is required for a certificate of occupancy and for new wells,

as well as at property transfer. The agencies responsible for these programs are a wealth of information

Well Owner Resources and Support

There are a number of sources of information and support for well owners in addition to state agencies and local contractors. One is the National Ground Water Association. They have a page for looking up contractors as well as page that provides links for state agencies related to contractors and well drillers. The USEPA has a list of all of the contacts for the state agencies that certify labs in each state.

Cooperative Extension Service

The Cooperative Extension Service plays a very large role in private water well issues in many states. If you have been looking at the resources that go along with the lessons, you can already appreciate the amount of information out there from Cooperative Extension geared toward rural well owners. They also have the advantage of being a network from the county to national level, meaning if your local co-op extension office doesn't have a resource or answer, they have a network that can find answers for you.

In some states, Co-op Extension has developed a Master Well Owner Network. These groups use the train the trainer concept to help well owners become "Master Well Owners" who can, in turn, help other well owners with issues at a more local level. Pennsylvania, Maryland, Virginia, and Texas all have these networks in place. There may be others we are not aware of. We encourage you to get involved, if you are in one of these states, and take the training so that you can help your neighbors learn more about their wells too.

Well Owner and Environmental Groups

Many times, when there is a local issue of significant concern, citizens rally together, organize, and develop a group to help inform others or to share resources in dealing with that issue. These groups might spring up when someone wants to put in a landfill, or when there is a pollution event that affects an area. They can also be inspired by threats to natural resources, like by development or urban sprawl, or when volunteers are needed to help monitor local water changes or educate students. Some develop into very beneficial stewards for groundwater protection and education.
There is no way to point out or identify all of the local groups that are engaged in these activities, but we wanted to give you a few examples of groups we do know. We want to encourage you to look for such groups in your area. If you find a local educational group that seems relevant to your interests, we'd also like to encourage you to consider volunteering. Groundwater protection, for example, is everyone's concern. It only takes a few misguided folks to contaminate an aquifer that could affect thousands of people.

BACOG - The first group we want to mention is the Barrington Area Council of Governments (BACOG). They are a local groundwater protection group west of Chicago, in Illinois, that was formed to help inform the landowners in the area about the sensitive natural areas they have. The region is full of bogs, fens, and other wetlands that are sensitive ecosystems and encroaching development is threatening some of those areas. BACOG is now probably 10 years old, maybe a little less, and has evolved into a strong voice for groundwater protection in their area. They have set up sampling days for private well owners to get their water tested by their county health departments. They participate in pharmaceutical take back days, remind people not to put things into their septic systems that can harm their aquifers, and have even developed information about the geology and hydrology of their area with the help of local professionals. They are an example of local action that has engaged hundreds of well owners in various capacities, raising awareness of groundwater protection and well owner stewardship. They have a website, which you can visit here.

WCBMN - The Wisconsin Citizen-Based Monitoring Network is supported by Wisconsin DNR and provides a clearinghouse of information related to monitoring of all natural resources in Wisconsin, including animals, groundwater, plants, surface water, and soil. Their website is a collaboration of dozens of local groups in Wisconsin. If you click on the "Who's who" section, then "subject", then "groundwater", you will see a list of a dozen local groundwater monitoring and guardian groups, some supported by other organizations, like The Groundwater Foundation.

WREN - The League of Women Voters in Pennsylvania's Citizen Education Fund has developed the Water Resources Education Network (WREN). WREN educates Pennsylvanians about water resources issues. They provide grants ($65,000 in 2012) to communities to carry out water resource education projects as well as many other positive programs. We subscribe to their monthly e-newsletter, and find out about many groundwater related activities going on in Pennsylvania through their outreach. Pennsylvania residents will find the newsletter has information that is relevant to other topics as well.

Financing

There are programs out there geared to assisting rural land owners with well construction or upgrades to their water systems. Some are also available for proper abandonment of contaminated or unsafe wells. Other programs may help pay for testing your well water. There are still many wells throughout the United States that are unsafe, not built to code, or using outdated equipment that may pose a safety risk. We would like to see every well pit, every shallow hand dug well not built to current code, and every abandoned well replaced with a system that better protects the user and the groundwater source. You, as a property owner, should also realize that having an unsafe well will affect your ability to sell your property.

Selling Property With A Well

Before we get to the funding available for various well improvement projects, we want to take a moment and mention private wells and property sales. Every state is different in their rules regarding property transfer when a private well is involved. Some have no rules, others have very strict rules regarding sampling. In some states, a mortgage loan may hinge on a sampling result or even well placement. FHA mortgage insurance has a number of provisions related to new well construction and water testing that could affect a property sale. If you're considering buying or selling property with a private well, be sure to check the property transfer requirements in your state.

Loans and Grants for Wells, System Upgrades, and Repairs

USDA Rural Development has a "Rural Housing Repair and Rehabilitation Loan Program" available for low-income rural residents. You can find out more about it from WellOwner.org. In addition, on the same webpage, there is information about organizations offering low-interest loans and grants for water well work. These organizations only cover certain areas, so if you're interested, be sure to check to see if they're offered where you live.

Some states also have programs. Minnesota residents have several options for loans to assist with rehab or replacement of a well, as well as for sealing an abandoned well. Another example is the Wisconsin DNR well compensation program for contaminated wells. In Iowa, the Grants to Counties Program is a huge contributor to groundwater protection and well owner safety. In FY 2012, 120 wells in Iowa were renovated using this program and 5621 water tests for well owners were paid for using thus program.

Abandoned Wells

If you have an abandoned well on your property, there may be funding for part or all of the cost of properly abandoning/sealing the well. Many of these programs are local, or motivated by a regional group trying to protect an aquifer. For instance, in Minnesota, the Capital Region Watershed District has

Other Programs

In some cases, an organization may apply for a specific grant to assist the well owners in their area. This can mean funding for free analysis of water samples or for well owner education programs. We mentioned the WREN e-news above, and the November 2012 newsletter mentions such a program that was funded in 8 counties in Pennsylvania. It's worth your time to ask your county health department, state USDA office, Co-Op Extension office and other private well related organizations if there are any programs to support water testing, education, well sealing, or system upgrades. In Anne Arundel County Maryland, they have radium issues and if your well is high in radium, the county will reimburse up to 25% of the cost of installing radium treatment. They also have an assistance program for repair or replacement of a failed well or septic system. We realize these are all local programs, but you just never know what funding may be out there that could save you a little or a lot of money for sampling, repair, or even well abandonment.

Additional Resources

Visit our Resources area at The Private Well Class for a list of resources used to develop this content and materials for further reading.

ERA Cristopher Creek

Subject: FW: [Private Well Class] Lesson 8

The Private Well Class
FREE ONLINE TRAINING *for* HOMEOWNERS WITH WATER WELLS

If you have trouble viewing this email, click here to read it on the web.

Lesson 8 – Groundwater Quality and Source Water Protection

Why This Lesson is Important: Understanding how your well and the groundwater you rely on can be influenced by surface infiltration, naturally occurring contaminants, and even water availability gives you clues to the problems your well might face. Some of these issues include drinking water quality, having enough water for supply, and understanding the risks you might have if you use a well that is in a more vulnerable situation.

Groundwater Quality

We talked in detail about groundwater quality in Lesson 2. It would be a good idea to go back and review those materials. Both natural and anthropogenic contaminants can be a concern to well owners. The most important factors that influence groundwater quality near your well include vulnerability to surface influences, existing natural groundwater quality, and proper well construction. In most cases, if a well has a water quality problem, it is related to one or more of these three issues.

Natural groundwater quality is what it is. If you are in an area with an elevated natural contaminant, like iron or arsenic, there isn't a lot that can be done except to treat the water. The contaminant is part of the make-up of the geologic material and will likely be found commonly in the aquifer near your current well. Aside from treatment, the only other option may be to drill a well into a different aquifer, if that is possible at your location.

Anthropogenic contaminants are the result of human activities. Finding a contaminant may mean that a number of wells are deemed unusable, and generally a regulatory agency will get involved to try and trace the source of the contamination. If it's a local problem, because of poor management of sources near a single well, the owner will likely be responsible. If a larger issue involving a larger extent of an aquifer or if the source is likely to move within the aquifer to other areas, then a responsible party may have to mitigate the problem by removing the contaminant, if possible, or providing a clean source to those who are affected. Removing a contaminant is difficult, which is why there are so many efforts and rules aimed at protecting groundwater quality in the first place.

What Does Source Water Protection Mean?

For domestic wells, source water protection means protecting both the *quality* of the water in an aquifer and near a well, as well as protecting the *availability* of water for use as a domestic water supply. Since there are both water quality and water quantity aspects to source water protection, source water protection may have a different emphasis depending on where you live. In some parts of the country, water quantity issues and the right to use water from a well may be more of an issue than the water quality.

Regarding water quality protection, much has been done to protect aquifers from contamination. There are laws in place that require anyone using a potential contaminant to properly dispose of it, and to ensure that their use doesn't lead to groundwater contamination. The establishment of the EPA and state regulatory agencies in the 1970s is the direct result of pollution issues related to proper use and disposal of harmful chemicals in our land, water, and air. Today, there are legal and financial

The book, "A Civil Action" describes a court case involving groundwater contamination in the town of Woburn, Massachusetts in the late 1970's. The contaminant caused a leukemia cluster in the community affecting a number of children. Though this example is about a community water supply, it could just as easily have affected private wells. The aquifer that was contaminated eventually had to be cleaned up by the company that caused the contamination at tremendous cost. It's a tragic story of what can happen when someone improperly disposes of harmful chemicals. The book is a very interesting read, and was made into a movie of the same name.

Water Rights

Before we talk more about what you can do to protect your source water, we'd like to talk about your right to take water out of the ground. In many areas, this right is taken for granted because groundwater is plentiful, but in some areas, as water becomes more and more scarce, laws that govern those rights may limit your individual rights to groundwater.

Nearly every jurisdiction in the United States has some water law that governs the fair use of water, whether that be common law or legislative action that has specified exact rules on water use and water rights. Generally, water law has evolved in most areas through court decisions based on water use conflicts. Water law today has evolved from the following four doctrines (From Wisconsin DNR):

English Rule: Groundwater use is a property owner right. They can use the water under their property at any time for any purpose. They can sell water or allow others to use the water on their property completely at their discretion. This was the original rule in most places, and has been replaced in many areas based on conflicts that have arisen where one user has caused harm to another. Does it make sense to allow a person to pump as much as they want for any use, if it affects others that may be sharing the resource?

Reasonable Use Rule: Groundwater is still considered a property right, but the use must be reasonable when compared to the water needs and uses of their neighbors. Reasonable can be defined in many ways, and conflicts in states that use reasonable use as their accepted groundwater use doctrine still end up in court. In Illinois, a reasonable use state, we see most conflicts come up in areas where a new industrial or high capacity user affects existing wells. If a high capacity user is not willing to mitigate the impacts of their high capacity well on nearby wells, the impacted well owner has no choice but to take them to court. Most states east of the Mississippi River apply the law of reasonable use, primarily because there are not as many water availability issues as in western states.

Correlative Rights Rule: All landowners in an area have an equal right to groundwater and the amount they are allowed to use depends on the amount of land they own.

Prior Appropriation Rule: This is the basis for most western US water law. It's also commonly described as "first in line, first in right". It means that the first user of the water has the right to continue using that same amount of water before anyone else. They retain this right even if in times of water shortage it means that other users are left with little or no water to use. Water rights are not connected to land ownership, but instead to the user and the initial time they put water to a beneficial use. These rights can typically be sold or given to others.

If there is any question as to the water law in your jurisdiction, contact the proper water resources agency to determine what the law is in your area. If you are unsure, the agency that regulates well construction is a good place to start.

Wisconsin Example: From English Rule to Reasonable Use

English Rule was adopted in Wisconsin in 1903. It wasn't overturned until 1974, when a company dewatered a number of private wells in order to install a pipeline. The state took them to court and determined the company's actions were a "public nuisance." This opened the door for a modified reasonable use rule that limits groundwater use only for beneficial purposes and only if pumping does not cause unreasonable harm to their neighbors. Before groundwater flow was well understood, groundwater was considered a private property right, consistent with English Rule in Wisconsin and elsewhere. However, now that we know how groundwater flows as part of the hydrologic cycle, with movement over large distances at times, it is viewed more as a public resource. Reasonable use, which reflects this shift in thinking, is the only law that is needed in Wisconsin because there are few water availability issues in that state.

Washington Example: Prior Appropriation Rule with Exemptions

In Washington State, water rights are governed by their Department of Ecology. Small uses, such as for a private well, are exempt from their requirement to get a permit of water right prior to drilling a well. However, the exemption is subject to specific exceptions that must be followed, or a permit is required. These exceptions include watering livestock, ½ acre or less for lawn or garden irrigation, 5000 gallon per day limit for a single home or group of homes, and 5000 gallon per day limit for industrial uses. There are additional considerations in their law. If you develop land to sell, then the combined use, even if broken into pieces with each piece having its own well, must be less than 5000 gallons per day. Water rights in Washington are based on the prior appropriation rule, "first in line, first in right".

Other States

Oregon has similar water rights to Washington based on the prior appropriation doctrine. In their well owner handbook, it explicitly states that "senior" water rights come first, even before exempted uses. This means that if you are considering installing a new well, you should contact the state first. It's possible you are in an area with limited water resources where any new water use may be restricted or prohibited, meaning you may not have a right to use a well at all.

Here in Illinois, our water law is based on reasonable use, mainly because we are considered a state with plenty of groundwater available. What we are finding now, though, is that the growth in the Chicago area may lead to new water law in Illinois as there is more competition for groundwater that is in finite supply.

Texas still uses the English Rule for groundwater rights, meaning the land owner can pump as much water as they want from under their land, regardless of how it may affect neighboring wells. There are a few exceptions to the rule in Texas, based on harm or malicious intent, but generally the land owner can pump what he wants. Recently in Texas, they have set up "underground" water conservation districts. These districts have some authority to develop rules, at the local level, to help conserve, protect, recharge, and prevent the waste of groundwater.

Water Conservation

Another way well owners can protect their groundwater supply is by practicing water conservation. We aren't going to say a lot about it here as there are many, many resources available on the internet that list best practices related to water conservation. When on a dug or bored well, or during dry periods where the groundwater supply might be affected, saving water can help. Some simple water conservation methods include:

1) Use low flow showerheads, and limit time in the shower. Short showers use less water than filling a bathtub.

2) Fix any leaky faucets or toilets, drips can add up quickly

3) Wash full loads of laundry and dishes.

5) Sweep sidewalks and driveways, rather than spraying them off with a hose.

6) When using water at the sink, whether for brushing teeth or shaving, use a glass to rinse rather than leave the water running

7) Compost food scraps instead of using a garbage disposal. Garbage disposals use more water and are also hard on your septic system.

Protecting Your Drinking Water from Contamination

The keys to protecting your drinking water are those three things we mentioned at the beginning: 1.) knowing how your well water might be influenced by surface sources including groundwater flow from offsite, 2.) knowing the natural water quality of the aquifer you are using, and 3.) ensuring your well is properly constructed so drinking water is protected at the well. The next few sections summarize what you need to know.

Natural Groundwater Quality

If you haven't had a sample of your well water analyzed to understand the natural water quality in the aquifer you are using for water supply, call the agency in your state or territory that maps aquifers as a starting point. They will most likely have data on natural groundwater quality. The other source would be your local or state health department, which in some states may be the same agency in both cases. In Illinois, if a well owner calls the Water Survey, we can look up water quality information we have in our database, as well as contact our state EPA who manages an ambient groundwater monitoring network. In addition, some county health departments in Illinois have their own lab facilities and may have additional information on basic groundwater chemistry in those areas. You just need to ask, to get the ball rolling. If you run into a dead end, we can probably help find the right contact for you. Knowing there is a potential contaminant just means that when you are ready to have your water sampled, which we will discuss in Lesson 9, you need to be sure and have the analysis include that constituent.

In some states, they have information online about potential for contaminants in given areas based on geology or other factors. Rhode Island shows a map where arsenic and beryllium are recommended for testing. Massachusetts has maps showing the probability of drinking water exceeding the standard for arsenic and uranium on their Department of Environmental Protection website. They also have a mapping tool online that allows you to put in your address and it will tell you the probability of arsenic or uranium in private bedrock wells.

Influence from Surface Sources

In Lesson 3, and repeated here, we provided the setback diagram of possible sources of contaminants for wells in Minnesota from their Department of Health (Figure 1a and 1b). Figure 1 provides some great guidance on the different possible sources that could influence your well water quality locally. Every jurisdiction has its own setback rules. You should become familiar with yours. Knowing the current standard will give you a better idea of the risk you might have for contamination. You should isolate your well as much as you can from any contamination sources and ensure the sources you do have are down gradient of your well.

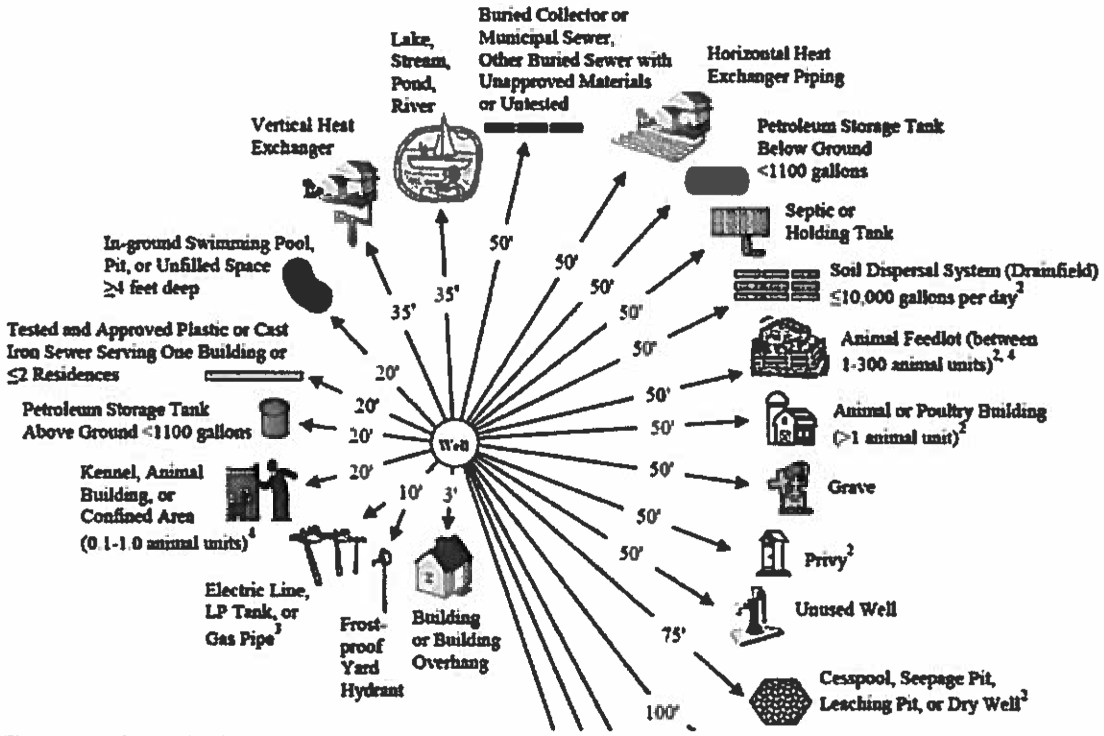


Figure 1a - Setback Distances (top half). Source: Minnesota Department of Health.

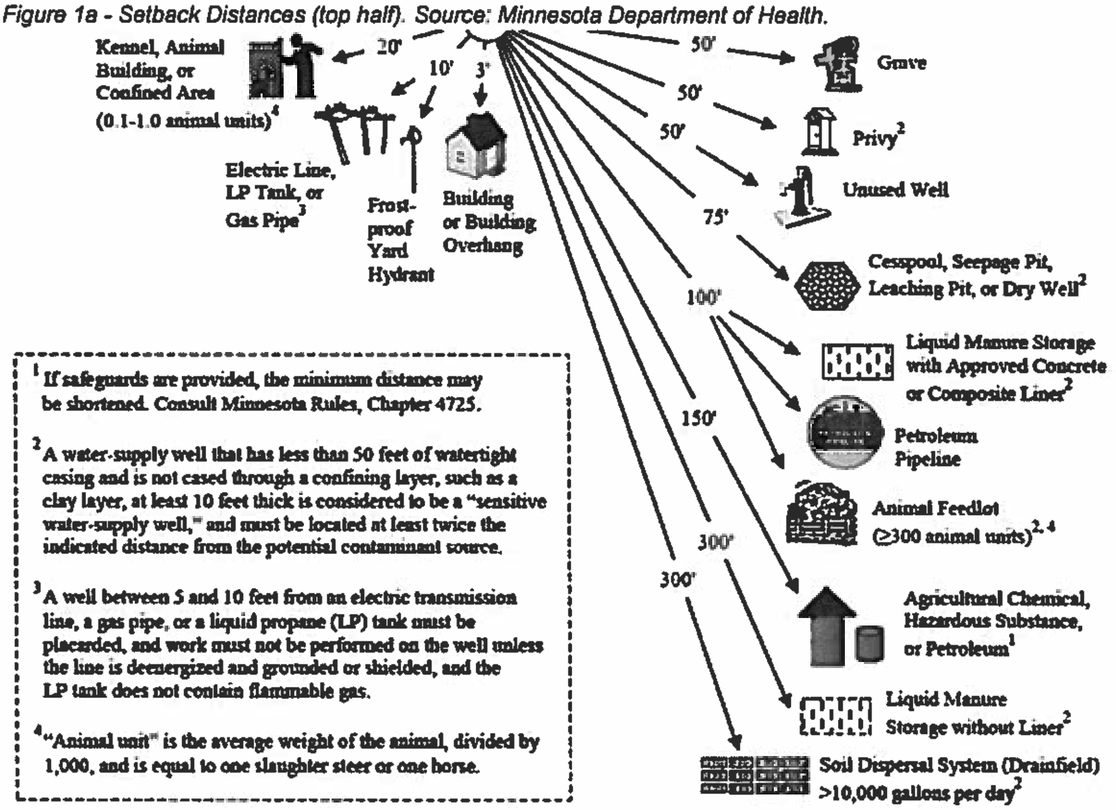


Figure 1b - Setback Distances (bottom half). Source: Minnesota Department of Health.

The flow direction of the groundwater you are using for your well is a critical component in understanding how to protect your water supply. Knowing where your water is coming from and where it is going can not only guide you on storage of possible hazardous chemicals on your property, but also provide some guidance on where else you might need to look for sources that could influence your water quality. Maybe your septic system is down gradient from your well, as it should be, but your neighbors who may be up gradient from your well, may also have septic systems on their property. What

The other pieces of this puzzle include your well depth, well type, and surficial geology. If you have a dug or bored well, then you are likely getting your water from areas that are very near your well. These wells are typically shallow, which increases the likelihood of water from the surface near the well actually becoming part of the water you withdraw from your well. If you are located in an area with a very shallow aquifer and sandy soils, then the infiltration in the area is high and surface influences will be that much stronger in your well. Finally, well depth--or more importantly, the depth at which your well is getting water--is important to how much influence surface infiltration will have on a well. It could be that you have a bedrock well that is 150 feet deep, but the bedrock surface is at only 15 feet and the well is an open hole from maybe 20-25 feet below land surface to the bottom. In this example, your well is getting water from 25 feet through 150 feet, which is much different than a 150 foot sand and gravel well that has a 5 foot screen from 145-150 feet below land surface. In the latter case, the water getting in the well is only from 145-150 feet and much less susceptible to surface influences.

Well Construction

There are many, many old wells still in use today that don't meet current well construction standards. The standards that have been developed are meant to protect the well owner from harm by protecting groundwater from contamination. If you have a well that doesn't meet current well code, it's worth your while to modify the well, if possible, to provide adequate protection from the surface. Your well driller is probably the best source for advice on these issues, as well as the agency that regulates well construction.

Next Steps

Lesson 8 explains why many of the other pieces of the class are important, especially the early lessons (1-3). It would be a good idea to review those lessons if you would like to refresh and reinforce the concepts related to groundwater quality and source water protection. This will also prepare you for what to do if a water sample from your well indicates there is a contaminant.

Additional Resources

Visit our Resources area at The Private Well Class for a list of resources used to develop this content and materials for further reading.

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Teresa Purtee

From:	Susan Keown	**Sent:**	Thu 3/28/2013 9:27 AM
To:	Teresa Purtee		
Cc:			
Subject:	Emailing: [Private Well Class] Lesson 9 Please print 2		
Attachments:			

The Private Well Class
FREE ONLINE TRAINING *for* HOMEOWNERS WITH WATER WELLS

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Lesson 9 – Sampling and Interpreting Results

Why This Lesson is Important: Of all the things you do to maintain and protect your well and water system, collecting a water sample is one of the simplest things you can do to ensure your water is safe to drink. It's a critical part of an overall well management strategy that provides you with some confidence that you are properly maintaining your water system.

Some Background Info

Researchers in Wisconsin, Michigan, and Minnesota surveyed over 1700 well owners about their water wells, testing, and perceptions about their well water quality. They were trying to understand why so many private well owners do not get their water tested, even though sometimes counties or other local groups offer testing programs. Figure 1 lists the top ten responses they received to the question "Why haven't you tested water from your well?" When the Private Well Class first started, several health professionals asked us why more people aren't interested in testing, even when there are programs in some areas that might provide it for free. Figure 1 provides some of those answers.
When they analyzed their survey results, the researchers reached some conclusions about homeowner attitudes to well water quality and testing (Figure 2). The study conclusions suggest that people believe their water is safe without being sure. Sampling provides some certainly about water quality. The conclusions also talk about not being informed as a barrier to testing. Our role is to provide you that information, so you know what you should be concerned about.

Figure 1 - Reasons People Don't Test Their Water. Source: Extension Great Lakes Water Quality Program.

Figure 2 - Study Conclusions. Source: Extension Great Lakes Water Quality Program.

Why Sample?

Simply put, testing your water is your best way to know your well water is safe to drink. As you can see from Figure 1, many people assume it's safe. In general, they are probably right, but not in every case. Proper management includes knowing your water quality. There are also other reasons to sample. An initial water sample can identify your general water chemistry to help you, as a well owner, understand any nuisance concerns you might have. If iron is high, for example, or the water is hard or slightly acidic. Knowing your water chemistry could save you ruined clothes. Low pH can cause pitting in copper pipes, which would be really expensive to fix. Regular sampling can also alert you to possible changes in your well. If values change with time, for example, it could be an indicator of something going on in or near your well.

What to Test For

When deciding what to test for, there are a number of things to consider. We realize that sampling can be costly, but ensuring your water is safe to drink is definitely a worthwhile expense. For example, if there are children in the house or someone is expecting, then there are specific contaminants that should be tested for. Depending on where you live, some natural contaminants may be a concern. Depending on the depth and type of well you have, you might have more reason to test for contaminants that could be introduced near the well. Even the age of your pipes can influence what things you test for.

Do Your Homework

Do your homework first. Talk to your county health department, cooperative extension office, state geological survey, and other state agencies (DNR, DEQ, DEC, DPH) that deal with private wells and ask them if there are natural contaminants of concern that might exist in your area. Look online for information about water quality concerns in your area. We gave you some examples of the types of online information that are available in Lesson 8, as well as how your well can be affected by nearby surface influences. It's likely that most private well owners don't have to worry about buried gas tanks from a nearby gas station, but a few certainly do. If your area is more residential, there could be issues with things like road salt. Know what's in your area, especially up gradient of your well.

How Often Should I Test?

You should ask your health department what they recommend first and foremost. We have found it's almost universally recommended that a private well be tested annually for nitrate and coliform bacteria. Both of these things are easy to test for and both are indicators of a possible pathway for contaminants in your well. Coliform bacteria aren't generally found in groundwater, so if you have them in your well, it's likely they got in from a crack, poor seal, or because the well was opened. If the bacteria got into your well, that could mean there are other things getting in as well. Nitrates can cause blue baby syndrome in infants, so expectant mothers and babies need to be sure their water is low in nitrate. We also think that pH and hardness should be tested for regularly. The Rhode Island Department of Health recommends testing annually for sodium, turbidity, and color because all are good general indicators of well water quality. These are guidelines and, as we mentioned before, should be discussed with your health department, and the possibly the lab as well.

If you don't have any information about the chemistry of your well water, then initially it would be good to sample for a wider range of constituents. This provides you with help in determining any nuisance issues and gives you some indication of why you might be seeing things like scale buildup or iron staining, etc. It also provides you with a baseline of water quality parameters for comparing test results in the future. Below is a list of what several state health departments recommend for an initial sample of your well water (in addition to those recommended above):

- Arsenic, Chloride, Fluoride, hardness, iron, lead, manganese, pH, sulfate
- Copper, if you have copper piping
- Zinc and Cadmium if you have galvanized piping
- Anything else identified by those you have contacted for suggestions based on your specific situation.

Some organizations recommend sampling for the above list every 3-5 years. In general, unless something has changed with your well, many of these parameters will be fairly stable over time. However, this is not the case for shallow wells and those that are influenced by surface sources. Vulnerable wells can have dramatic changes in water quality. This would be one reason to sample more often, at least until you are comfortable with how the results might change.

Other Reasons to Sample

A well can be influenced by a number of things. Even an earthquake could affect the water quality in a well. So, in addition to a regular sampling schedule, you should consider testing:

- for nitrate, lead, and coliform bacteria if there is an expectant mother or baby in the home.

- for fluoride if there is natural fluoride in the area and there are any children under 12 drinking the water. Some fluoride is good, too much can discolor or damage teeth.

- any time you notice a change in taste, odor, smell, color, or any other changes (sediment, cloudy water). Depending on what the change is, your health department can give you guidance on what you might need to test for.

- for coliform bacteria if there is an unexplained and/or reoccurring gastrointestinal illness in the family

- to monitor the performance of your treatment device, and any time treatment is installed.

- for coliform bacteria anytime the well is opened or you suspect there is a potential contamination problem.
- after your well has been chlorinated to confirm that the chlorination got rid of the bacteria in your well.
- if a neighbor has indicated they have a well water quality problem.
- if there has been flooding at or near your well
- if something has been spilled near the well

Lastly, if you have a sample result that indicates there is something in your well, we recommend resampling before you do anything else. Labs can make mistakes, and samples can get contaminated when being collected if the sampler isn't careful. Sometimes, the lab will even suggest this to confirm your result.

Where to Get a Sample Analyzed

You should use a lab that is certified in your area. States maintain a list of these labs for community water supplies that must use them for the analyses they are required to submit to their regulatory agencies. The USEPA has a website that lists contacts and a website for each state that will provide a list of certified labs. You can also contact your nearest community water supply operator and ask them what lab they use.

When talking to a lab, make sure they are certified for each parameter you are interested in. Some may only be accredited for microbiology, for example, or for metals, but not vice versa. Being a certified lab means that they are using accepted methods for determining the amount of a constituent in water and that they have the ability to meet certain testing standards and accuracy requirements.

There are also state and local programs available for testing. We mentioned the Iowa Grants to Counties program in the last lesson, for example, and there are other programs available in other states as well. Figure 3 is a screen shot of the New Mexico Environment Department's Liquid Waste Program. NMED offers free testing of well water for fluoride, iron and nitrate for those private well owners who have registered their septic systems with their program.

Figure 3 - New Mexico Environment Department Well Testing Program. Source: New Mexico Environment Department.

Lab Considerations

You should ensure the lab you choose meets your needs. Even state approved labs can vary in customer service. Some may not even offer testing for private well owners. In most cases, the lab will provide all information and supplies necessary to take a sample and get it back to the lab. Some labs may even have staff that come and collect the sample for you at your home. Choose a lab that makes the process as easy as possible for you and is willing to spend time with you on the phone discussing your particular issues.

There are a number of things to discuss with the lab that can affect the number of samples collected for analysis. We recommend that you collect multiple samples under the following circumstances:

1) If there is treatment on the system (including water softeners), you should collect a 2nd set of samples before the treatment system to understand how effective your current treatment is and how it changes the chemistry.

2) If there are lead pipes, you should collect a "first draw" sample, and a 2nd sample after the distribution system has been flushed. A first draw sample is taken to collect water that has been sitting overnight in the piping in the home. This will give you an idea of the effect your lead pipes have on your water quality

In most cases, the instructions will recommend that water sample should be collected at the cold water tap at the kitchen sink. If there is treatment on this tap, such as an RO unit (reverse osmosis), then you should use a tap that is not specifically treated. You should collect a 2nd sample of the treated water to verify it is removing possible contaminants. The lab should give you detailed instructions as well as bottles to use. It's imperative that you follow their directions. If you have questions, get answers before you collect the sample. Read though the procedure and be sure you understand what is being requested before filling the bottles. Some of the suggestions may seem silly or "overboard", but they are not. Samples can be easily contaminated. In most cases, the samples require return to the lab within a short turnaround time, so be sure to plan the actual time of sampling so that you will be able to return the sample as soon as possible. Fill out all forms and keep a record of the details for your well information files. If you are using a lab that sends out staff to collect the sample, be sure and get a copy of any information they fill out, including details on the sample bottle numbers.

Testing Results

"Safe" drinking water is a relative term. There are no drinking water standards for private wells. However, the USEPA has developed a list of drinking water standards that public water supplies must meet. Those standards are generally the accepted "safe" levels that most agencies and professionals use when working with private well owners. Information on all regulated contaminants is available from the USEPA. They provide the accepted levels, the potential health effects, and the possible sources for each.

When you receive your results, you should contact the lab and ask them to go over the results with you. If there is anything on the form that you don't understand or that needs an explanation, the lab should be able to provide it. We also recommend sharing the results with your local health department, if they weren't involved, and seek their advice on the meaning of the results.

Penn State Institutes of Energy and the Environment, along with Penn State Extension, have developed a tool to help you interpret your sampling results. It's called the Drinking Water Interpretation Tool (DWIT). DWIT is an interactive website. You input your sampling results, and it tells you if they meet the EPA drinking water standards. So for example, Figure 4 is a screen shot of the DWIT where we have input values for arsenic at 0.1 mg/l (milligrams per liter), which is .1 ppm (parts per million), which is 100 ug/l (micrograms per liter), which is 100 ppb (parts per billion). We also added lead at 0.1 mg/l. Figure 5 shows the resulting output.

Figure 4 - The Drinking Water Interpretation Tool. Source: Penn State University.

The DWIT is a good screening tool for a well owner, but it doesn't replace talking to a health professional about your results. The nice thing about the DWIT is that it also links to resources that provide more details on some chemical parameters. As you see in Figure 5, under "For more information" there are links to get additional information about arsenic and lead. We realize this tool was developed for Pennsylvania, and the support materials may discuss specific issues in Pennsylvania at times, but they also can help you develop a better understanding of what it means to have certain constituents in your well water. Reading up on what's in your water will better prepare you to ask the right questions when you contact someone to go over your results.

Figure 5 - DWIT Results for Arsenic and Lead. Source: Penn State University.

Understanding Units

For those of you that took the pre-test way back with Lesson 1 (and we greatly appreciate the 71% of you who did), there was a unit conversion question about the amount of arsenic in a sample. It required you to convert the arsenic result into ppb's. The question was tricky on purpose (only 41% of respondents got it right). Lab results are given in different unit sizes because high levels of some things aren't very harmful, yet very low levels of others can be very harmful. The terms and conversions below provide some guidance on common unit conversions that will hopefully help. Just remember that you multiply or divide by 1000 (move 3 decimal places) in most cases to get from one unit to the other.

Terms

mg/l – milligrams per liter ug/l – micrograms per liter
ppm – parts per million ppb – parts per billion
1 mg/l = 1 ppm 1 ug/l = 1 ppb

Conversions

1 mg/l = 1000 ug/l (move 3 decimals right to go from big unit to small unit)
1 ug/l = 0.001 mg/l (move 3 decimals left to go from small unit to big unit)

1 ppm = 1000 ppb (move 3 decimals right to go from big unit to small unit)
1 ppb = 0.001 ppm (move 3 decimals left to go from small unit to large unit)

So,
1 ppb = 1 ug/l = 0.001 ppm = 0.001 mg/l
10 ppb = 10 ug/l = 0.01 ppm = 0.01 mg/l
100 ppb = 100 ug/l = 0.1 ppm = 0.1 mg/l
1000 ppb = 1000 ug/l = 1 ppm = 1 mg/l

If You Have Lead

In most cases, lead in drinking water is due to lead pipes or lead solder in your home piping system. Changing all of your pipes probably isn't a viable option. It doesn't mean you can't drink the water, but it does mean you need to determine how much lead is leaching, and how quickly. We'll talk more about treatment options in Lesson 10, but if your water is corrosive, it may be that you can raise the pH a little and eliminate much of the lead leaching into your water. Another possible technique for minimizing the lead you are actually drinking, assuming you aren't limited in the amount of water you can use, is to let your water run before using it. Water that sits in your pipes for long periods will have more lead. Running a faucet until all of the water that was sitting in the distribution system has been expelled will reduce the lead content because the fresh water from the well hasn't had the contact time to leach lead from your pipes.

Next Steps

If you haven't already, consider getting a water test completed of your well water. Be sure you maintain good records of test results, just like everything else related to your well and water system. Now is a good time to review your record keeping to be sure you have the right phone numbers and contacts. That way, if you notice a change in taste of your water, for example, you will know who to ask about it.

Additional Resources

Visit our Resources area at The Private Well Class for a list of resources used to develop this content and materials for further reading.

Teresa Purtee

From: Susan Keown **Sent:** Thu 3/28/2013 9:28 AM
To: Teresa Purtee
Cc:
Subject: Emailing: [Private Well Class] Lesson 10 pllease print 2
Attachments:

The Private Well Class
FREE ONLINE TRAINING *for* HOMEOWNERS WITH WATER WELLS

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Lesson 10 – Water Treatment Solutions

Why This Lesson is Important: If you have a contaminant in your well water, or a constituent that causes some aesthetic problem, there are options available to treat your water. There are literally thousands of treatment devices out there. Understanding the type of device you need, as well as knowing how different treatment devices work, will help you eliminate bad choices and protect you from expensive--- and possibly unneeded—treatment.

Using Your Water Testing Results

If you're considering treating your well water, it can be a good idea to get a fairly comprehensive water analysis. This provides you with a full list of the things in your water. Sometimes, you might need treatment for a particular contaminant, but there might be other, similar constituents in the water that affect how well certain treatment devices work. For example, hard water can limit the effectiveness of a reverse osmosis (RO) system. Because of this, if you were going to use RO to remove, say, arsenic, knowing you have hard water might mean you should consider a water softener if you don't already have one.

We realize that in most cases, the water you have is what you have to deal with. However, in certain circumstances it could be that your well is contaminated to a point that treatment is going to be a significant ongoing expense. In these cases, it's worth looking at other options. One is to connect to a community water supply, if that is even a remote possibility. The other is to look at the possibility of a different well, either in a different location, or a different aquifer, or both.

In parts of the country with karst geology (areas with caves, caverns, and sinkholes), well owners might particularly want to consider other drinking water options. Because these areas are prone to surface contamination through sinkholes and rapid movement of water through the caves carved through the limestone, a well in these areas will continually test positive for coliform bacteria, E. coli, and other contaminants such as pesticides. In some parts of the Midwest, 80% of the wells tested in karst areas have positive results for bacteria. Water districts that pipe treated water over large rural areas are becoming commonplace in karst areas as the only alternative to individual wells that are continually at risk.

Determining the Source

Suppose your sampling results have identified one or more things in your water system that are either a health risk, or are likely to cause some sort of aesthetic problem. Before deciding on treatment, your first mission should be to determine exactly where contaminants are coming from. Some are obvious, like lead from corrosive water and lead pipes or solder. Or arsenic that you already knew was a possibility because it's been found in your aquifer.

Other things might not be so obvious. Coliform bacteria, for example, or high chloride, could come from any number of sources. If this happens, use what you've learned to figure out what might be causing the problem and if it can be dealt with. It's always best to eliminate the source first. This could mean that continued, long-term treatment might not be needed.

Point of Use and Point of Entry

Home treatment is typically either Point of Use (POU) or Point of Entry (POE). POE means the treatment is at the point where water enters the home. In other words, it provides whole home treatment. This type of treatment is generally more expensive because you are treating more water. It's necessary, however, if you are treating for a contaminant that has a health risk even for a general water use, like taking a shower. Radon is an example of a contaminant that should be treated with a POE unit. Radon gets into the air in your home from any faucet or tap.

POU units typically are used to treat water for drinking and cooking at a specific tap or faucet. These units are used to treat a contaminant that is a health risk if ingested, or that might cause taste issues. Because they are only treating a portion of the water coming into your home, they can last longer, and be less expensive to maintain.

Shock Chlorination

Many, many well contamination problems are caused by poor well construction, or a well that has some sort of casing breach that allows access to the inside of the well. That's one reason why testing for coliform bacteria is considered necessary at least annually. It's an inexpensive way determine if there might be a way into your well from at or near the surface.

If you have a bacterial contamination problem, then chlorinating your well to eliminate the bacteria is a necessary next step. Shock chlorinating a well with no follow-up treatment assumes that you are responding to a one-time event. Maybe you had to open the well, or there was a flooding event. But if the source of contamination is still there and ongoing, like from a feedlot or a failed septic system, then your contamination problem will likely return.

You should talk to your local health department about their recommendations for chlorinating your well. If you have any reservations at all about your ability to chlorinate your own well, we would recommend you contact your well professional for assistance. We have also found many variations on the procedures recommended for chlorinating a well. We particularly like the procedure recommended by the Minnesota Department of Health. Their procedure, outlined in "Well and Water System Disinfection For Private Wells", is comprehensive, includes safety information everyone needs to be aware of, and provides detailed instructions that are clear and easy to follow. There are also procedures listed for how to deal with your existing treatment equipment when you are chlorinating your system. As we said before, talk to your local health professional and ask advice. Possibly even take in a copy of the MDH procedure and ask for an explanation of anything that you might have questions about before you start.

Filter Devices

Filters are a common water treatment device that can be used for a number of different applications. Some are mechanical filters that prevent particles or contaminants that are over a certain size from passing through. Others include media or resins that help bind or adsorb certain contaminants that are attracted to the media.

Filters come in a number of sizes and designs. Smaller units may only treat a few hundred gallons of water before the cartridge needs to be replaced. Understand the maintenance and replacement costs before you make a decision on a filter.

- Mechanical Filters trap solids in the water, like sand, clay or other suspended particles. They reduce turbidity and are sometimes used to "clean" water prior to another kind of treatment to make that treatment more effective.
- Activated Carbon Filters are a type of adsorption media that use a specially manufactured charcoal material that can sorb and hold organic contaminants. When water flows through an activated carbon filter, contaminants "stick" to the media. They are most frequently used to help with taste and odor problems, but they can also help remove chlorine and its byproducts, radon, pesticides, and other organic chemicals. They require regular maintenance and filter cleaning/replacement, and can be a source of bacterial contamination if not maintained properly.
- Specialty Filters can be used for specific constituents, like iron or arsenic. Oxidizing filters, such as a manganese greensand filter, will remove iron and hydrogen sulfide. Oxidizing filters work by changing dissolved contaminants to solid particles that can then be filtered out of the water. A neutralizing filter, typically using calcite, raises the pH of water so that lead and copper leaching in pipes are minimized.

Reverse Osmosis (RO)

RO is a unique form of filtration that works by forcing water through a semi-permeable membrane. The membrane lets some water through, but prevents the contaminants from going through. Figure 1 shows the RO process. The effectiveness of a RO system depends on several factors, including the type of membrane, the pressure pushing the water, and the quality of the source water. RO units waste between 4 and 10 gallons of water for every gallon of water treated.

Figure 1 - The Reverse Osmosis Process. Source: Arizona Cooperative Extension.

RO removes common minerals, like lead and arsenic, as well as other organic chemicals. It works for fluoride, nitrate, and sulfate as well. The membranes are sensitive. Some are rated to be used with chlorinated water (community water supply), and others are not meant to be used with any chlorine. Water hardness can affect an RO unit and in many cases a water softener is recommended prior to the RO unit to extend the life and efficiency of the membrane.

Distillation

Distillation is the process of converting water to steam and then back to liquid, leaving the contaminants behind in the process. Figure 2 is a diagram of the distillation process. Distillation effectively removes inorganic contaminants, including minerals, metals, and particulates, from water. It also kills micro-organisms, including most pathogens. The drawbacks to distillation are the costs and the space requirements for the equipment. It takes a lot of energy to boil water, and the units are generally countertop size or larger. The advantage of a distillation unit is that it removes so many things. If there were a number of different constituents in your water that distillation would remove, then it might be a comparable option to other treatment.

Figure 2 - The Distillation Process. Source: Arizona Cooperative Extension.

Ion Exchange

Ion exchange is the process whereby one or more chemical ions are exchanged with others during the treatment process. The most common application of ion exchange is cation exchange (positive charge) in a water softener. In a water softener, sodium or potassium ions are saturated on the resin in the softener. Hard water has a high calcium and magnesium concentration. As hard water passes through the softener, the sodium and potassium are released from the resin and replaced with calcium and magnesium. During this process, other metals like iron or arsenic can also be removed in small amounts. Anion exchange (negatively charged ions) is also a common treatment process whereby anions, such as sulfate, are replaced with chloride ions. Figure 3 shows the water softening process.

Figure 3 - The Water Softening Process (Ion Exchange). Source: Arizona Cooperative Extension.

Ion exchange requires regular maintenance as well. The resins become fouled with the exchanged ions and have to be regenerated to work properly again. Today, most water softeners are built to be automatic or semi-automatic, meaning the regeneration process basically takes care of itself. They do still need the salt supply for the brine solution to be maintained. There are also additives to help with removing the iron that is trapped in the units, and sometimes they will have to be backwashed to remove those minerals.

Disinfection

Disinfection is the process of reducing the level of pathogens in water to a safe level. The most common approach to disinfection is chlorination. The effectiveness of chlorination depends on concentration in the water, pH, and the contact time. Generally, disinfection is not a continuous treatment process for private water supplies, and the presence of pathogens indicates a problem with the well or water system. The first step is to find the source of the pathogens and remove it, so that disinfection can be a one- time thing.

There are other disinfection methods available like ultraviolet light (UV). UV works by inactivating microorganisms using light of a specific wavelength. It affects their DNA and leaves them unable to reproduce.

UV used for continuous disinfection is more common with community water supplies, not private water supplies. If you are in a unique situation where continuous disinfection is necessary, there are home systems available for both chlorination and UV that can be explored.

The Importance of Maintenance

If you already have treatment or are considering adding treatment, a key consideration is proper maintenance of the equipment. Treatment adds complexity to your system, which increases the time necessary to ensure it is working properly. It's a commitment. At best, improperly maintained treatment equipment may not do its job. At worst, it can cause other problems with your water system. You should follow the manufacturer's recommendations to ensure the equipment works properly and have it installed by a professional. Generally, these devices require regular use to continue to function properly. As a good management practice, sample periodically to be sure the treatment device is functioning properly.

Be Sure You Need Water Treatment

There are many reputable water treatment professionals out there. However, there are others who will try to convince you that your water is unsafe and you need treatment, even when that might not be the case. Be informed, don't be pressured, know what the treatment does, how it's supposed to work, and be sure it's something you really need. Before buying, check out the company. Call the Better Business Bureau to see if there have been any complaints. Ask for customer references. Do your homework.

This includes the actual water sample. If a company offers free water testing, or an at-home water analysis, get details. Ask them to quantify the result (give you a number). You should have a sample tested by a certified lab to be sure you in fact have a problem before committing to any treatment.
As we said, adding treatment is a commitment of time and resources. Know what you are getting into and why. The Penn State Cooperative Extension has a factsheet called "Home Water Treatment in Perspective" that has a lot of great information for homeowners considering treatment. It describes the water treatment industry, the do's and don'ts, and provides an eye opening perspective that reminds us all that being informed is our best defense from making a poor decision.

Equipment Testing, Performance, and Certification

There are several organizations devoted to testing water treatment equipment. These organizations evaluate equipment independently to determine if they work as advertised and also if they meet certain standards in regard to how effective they are at removing contaminants. You have probably seen the NSF seal or the UL seal on appliances or pieces of equipment. These two organizations, the National Sanitation Foundation and Underwriters Laboratories certify that equipment meet certain standards and their seal on a product provides some assurance that the treatment device will reduce the amount of a contaminant in water. These standards, called ANSI/NSF standards, are described in Figure 4 below.

Figure 4 - ANSI/NSF Standards for Treatment Devices. Source: National Sanitation Foundation.

It's important to understand what reduction really means. It's a reduction in the amount, not necessarily the complete elimination of a contaminant. For instance, to earn ANSI/NSF "certification" for copper removal, the testing of the device involves inputting water into the device at an influent concentration of 3mg/l of copper and the device must reduce the copper concentration to below 1.3 mg/l. Some devices might reduce it to 0.5 mg/l, or maybe just 1.2 mg/l, but as long as it reduces copper to below 1.3 mg/l, it will earn certification. So, even when you see a device that has an NSF or UL label, you need to understand that the device may not remove all of a contaminant and there were limits on the amount of contaminant it was tested to remove. When there is a known health standard for a contaminant, like 1.3 mg/l for copper, the ANSI/NSF requirement is usually that the device must lower the contaminant to at least that level. The complete list of substances that NSF certifies equipment to treat can be found on their website on the Contaminant Testing Protocols page. The nice thing about this page is that you can click on a listed contaminant and it takes you to a page that explains the types of treatment that will work for reducing that particular constituent.

Another source of useful information is the Water Quality Association. This is an organization that also does testing for its members, which are many of the equipment manufacturers. They also list all of the treatment equipment they have tested that meets the ANSI/NSF standards (42, 44, 53, 55, 58, and 62), as well as their own independent standards (WQA designation) and have been approved by ANSI as well.

If a treatment device has the WQA gold seal or the UL seal or the NSF seal, that means it meets the ANSI/NSF standard. The seal refers to the lab that did the testing, so if the device has the NSF seal, that means that NSF did the actual testing of the product. Figure 5 is a screen shot from a sales company webpage that shows some of the brands of distillers they sell. The next to last column shows if they have certification, and what type. We are not endorsing any of these brands, just providing an example of the types of information you can find for typical treatment products, and a reminder to do your homework before deciding on what and if to buy.

Figure 5 - Sales Table for Typical Distillers. Source: Fresh Water Systems webpage.

Next Steps

This is the last lesson of The Private Well Class. If you have not attended any of the webinars yet, we encourage you to do so in the future. Next week, you will get an email with a link to the post-test. It will help us tremendously if you will take the test. You'll also get a new score to compare to what you got from the pre-test. (Do you remember your score on the pre-test?) As always, if you have questions you can email us at info@privatewellclass.org. Thank you for participating in this program!

Additional Resources

Visit our Resources area at The Private Well Class for a list of resources used to develop this content and materials for further reading.
