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Water Wise

Managing Low-Capacity Private Drinking Water Wells During Drought

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Groundwater from aquifers supplies almost all household water use in Nebraska's rural areas. When groundwater levels decline during a drought, efficient water use and good management of groundwater are particularly important.

Nearly all of Nebraska's rural residents rely on groundwater for household water use. Nebraska's groundwater comes from aquifers, natural underground layers of sand and gravel that contain water. Groundwater is a renewable resource, replenished mostly by precipitation and water flowing through the aquifer. However, groundwater resources are not limitless, and groundwater levels can decline when use exceeds recharge. This has been true in areas of heavy groundwater use, such as agricultural irrigation, during dry years.

Efficient water use is especially important during periods of drought, when groundwater levels can decline. To make informed management decisions, it is important to first have an understanding of the water source, the well and distribution system, and water needs.

The Water Source

Groundwater in Nebraska does not reside in, and is not stored in, large underground lakes or rivers. Groundwater is stored in the spaces and cracks between particles of soil, sand, gravel, rock, or other material (*Figure 1*). These materials form what is called the groundwater aquifer. Nebraska has large aquifers and a vast supply of excellent quality groundwater. However, there are areas where the groundwater supply is limited and the quality is not desirable for consumption.

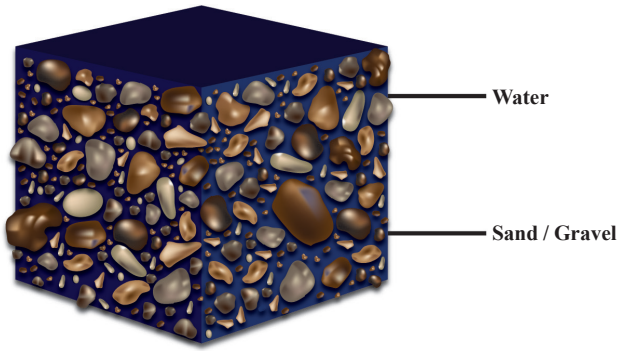

Figure 1. Example of saturated aquifer material.

The majority of the groundwater found in Nebraska is in the High Plains aquifer system, which extends from south central South Dakota through central and western Nebraska, to Texas. Large yields of good quality water can usually be obtained from the High Plains aquifer, which includes the Ogallala, Brule, Arikaree, and alluvial aquifers. Groundwater in eastern Nebraska is not part of that aquifer system. Northeast and southeast Nebraska are in glacial drift areas. Glacial till, locally known as boulder clay, or rock flour, covers most of the eastern region and is underlain by the Dakota Formation aquifer. These areas are extremely variable, and it is difficult to predict water yields and water quality from them. In addition, there are perched aquifers consisting of isolated mounds of groundwater above a layer of clay or silt. Perched aquifers may provide limited water well yield, particularly during drought.

Water is removed from an aquifer by drilling wells and using pumps. Pumps use mechanical energy supplied by an electric drive motor or fuel-powered engine to force water up toward the land surface. Removing water from the aquifer can lower the water level in the well. The difference between the initial water level, or static water level, and the pumping water level causes water to move within the aquifer. Since the water level or pressure is lower in the well, water from the surrounding aquifer flows toward the well to replace the water being removed.

When pumping starts, most of the water is removed from very near the well. With continued pumping, water is removed farther from the well, thereby lowering the water level in an unconfined aquifer, or pressure in a confined aquifer, at a greater distance from the well. Drawdown decreases with the distance from the well until at some distance, the water level may remain relatively unaffected by pumping (*Figure 2*).

The Water Well

During drought conditions, it is important to understand your water well. The first step in well construction is to drill a borehole into the aquifer. After drilling, a casing is placed in the center of the borehole (*Figure 3*). The casing is a pipe that supports the hole from collapsing and provides a conduit for water to be drawn out of the aquifer.

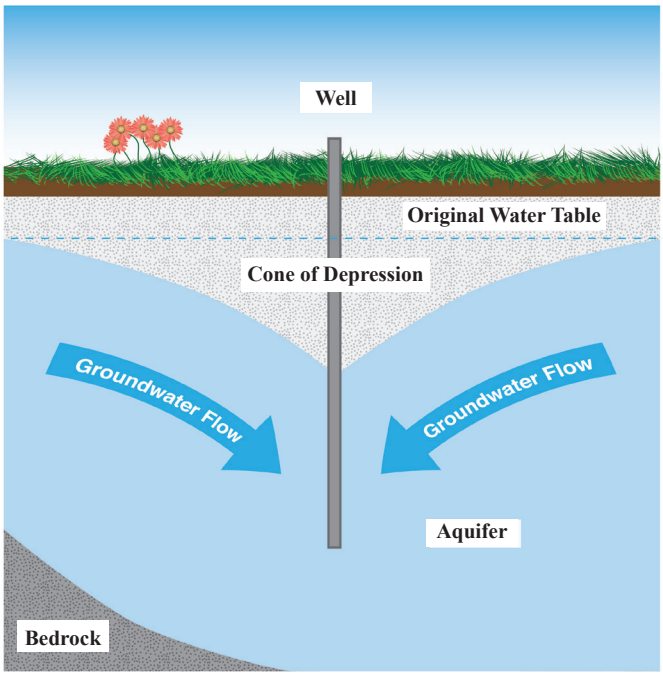

Figure 2. Single well with cone of depression.

Water in the saturated zone of the aquifer must have a way to enter the well casing. This is achieved with a well screen. The screen is located in the water-bearing zone of an aquifer. It has apertures (slots or louvers) in the casing that allow water to pass through. The area around the well screen is packed with clean sand or gravel that stabilizes the aquifer material while allowing water to move into the well.

The Nebraska Department of Health and Human Services regulates well construction standards and licenses well professionals. Any licensed water well contractor or owner who constructs a well must keep an accurate well log that documents the layers of soil, sands, gravel, and other subsurface materials that are drilled through to reach the aquifer. The licensed well contractor or owner must register the well with the Nebraska Department of Natural Resources (DNR) (*dnr.ne.gov*) and the log is part of the registration.

Older wells may not have a log and may not be registered. On its website, the DNR states that "All registration documentation for water wells registered after January 1, 1995, except Public Water Supply wells, is now available." The well log can provide a great deal of information that will be useful as homeowners consider options for well management, including the description and depth of the aquifer material into which it is drilled, the static water level, the water level when pumped at a designated rate, well yield (typically in gallons per minute), the well depth, and the screen length. All of this information can be helpful in assessing the ability of a given well to withstand drought conditions.

In addition, all Nebraska Natural Resources Districts require permits for high capacity wells (generally any well that will pump 50 gallons per minute or more) prior to drilling, and some require permits for smaller wells. This may be another source of valuable information.

The Distribution System

Most private drinking water systems require a pumping system, usually a pump and motor, to move water from the well to the land surface for use by a household (see *Figure 3*).

The pressure tank in a private water system has three purposes. It stores water and provides water under pressure when

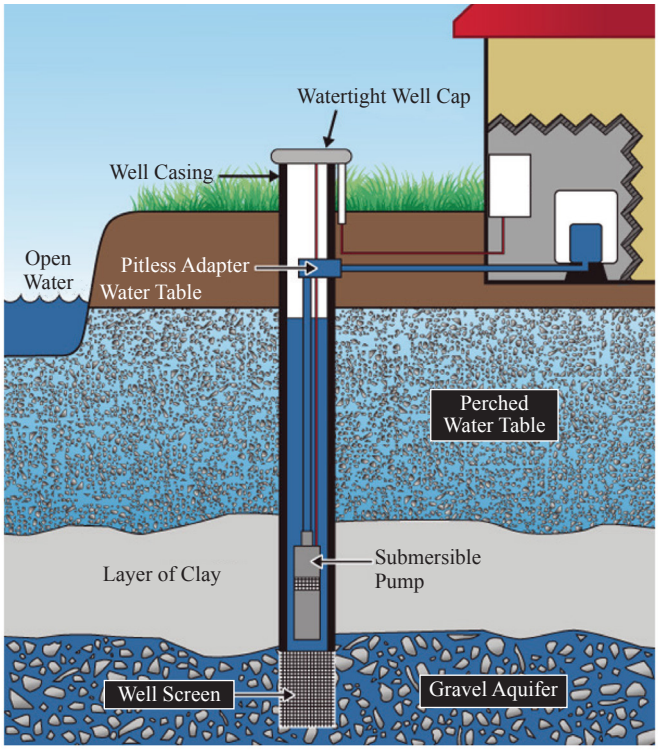

Figure 3. The depth of the borehole and the well casing will depend on the depth and thickness of the aquifer's saturated material and the desired well yield.

the pump is not running. It builds up a reserve supply of water so the pump starts and stops less often, prolonging the life of the pump. In addition, it provides a reserve supply of water for use during times of high water demand.

Water Needs

The average American uses from 60 to 100 gallons of water per day, plus the water that is used for lawns and gardens, possibly resulting in 900 to 1,300 gallons per day in the summer. The total daily domestic water demand can be estimated by multiplying use (100 gallons per day) by the number of people living in the home, plus lawn and garden use in the summer. This gives an estimate of the total gallons per day that will be needed for domestic use. Minimizing water use will reduce the total daily demand.

While small businesses also may rely on small-capacity wells for domestic or commercial needs, the water needs of small businesses vary greatly. This publication is intentionally directed toward low-capacity residential, domestic wells. Small businesses seeking specific information related to their needs are encouraged to contact a professional for assistance since this type of information is beyond the scope of this guide.

Water use will not be the same over the course of a day; it will fluctuate. Water systems must meet many demands during short periods of time. These times, called peak use periods, usually occur near mealtimes, during laundry periods, and when occupants are showering or bathing (such as morning, noon, and evening). If the water system cannot produce sufficient water quantities to meet peak demand, intermediate storage can be used to supplement the water supply during peak use periods.

Insufficient Water Supplies

If you experience water outages, sudden drops in water pressure, air bubbles coming out of a non-aerated faucet, or if the water suddenly becomes cloudy or heavily silted, your private drinking water well may be having trouble keeping up with

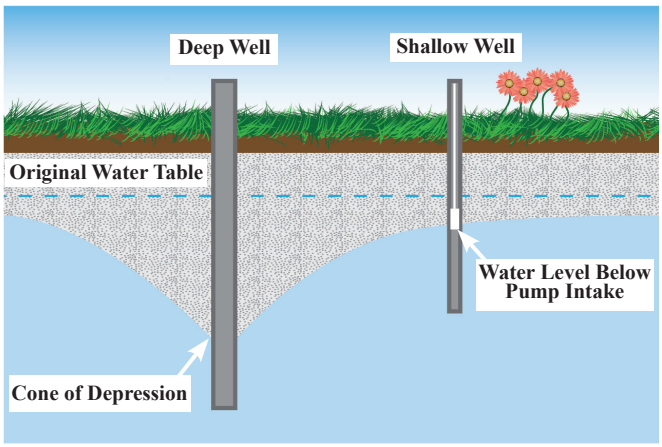

Figure 4. Two wells with cones of depression.

the water demand. Other problems associated with valves, waterlines, pumps, well casing, or pressure tanks can also cause some of these problems, so it is important to work with a State of Nebraska licensed professional to identify and solve the problem. Contact a licensed well driller for assistance. A list is available on the Nebraska Department of Health and Human Services website: *http://www.nebraska.gov/LISSearch/search.cgi.*

The natural reaction to "running out of water" is to assume that a new well is needed. However, there can be many reasons for water supply problems, each of which is tied to one of the four main parts of a water supply well. The first main part is the aquifer and possible depletion of the groundwater supply by over pumping, well interference, and/or decreased water table due to drought.

Another part of the water supply system that may be causing or contributing to a water supply problem is the well. The efficiency of a well can diminish with time, due to chemical, mechanical, and microbial clogging of the well intake and surrounding aquifer. In addition, the actual pump and motor performance will degrade over time due to wear and tear from years of use. Motors don't last forever, and will wear out; and impellers can drag or have excessive clearances.

The other main component that can impact the ability of a well to deliver sufficient quantities of water is the distribution system. In this case, the problem could be associated with partially closed valves, broken or damaged pipe lines, or lime-encrusted pipes with reduced ability to transmit water. An investigation of a well by a professional can help to determine the cause of a supply problem.

This troubleshooting should take place at the location of the water supply system. Generally, it involves a flow test to determine system output, along with a check of the aquifer water level before and during pumping (if possible), pump motor performance (checking amp load, grounding, and line voltage), and pressure tank and pressure switch contact. In addition, an inspection of well equipment to assure that it is sanitary and meets local code requirements should be conducted. A professional in the water well industry will need to conduct these tests, which will help to determine the cause of water shortage. In some cases, multiple factors may cause a water shortage, and solving one or more may help to avoid the need for well replacement.

In some situations, multiple wells may be pumping groundwater from the same aquifer or nearby connected aquifers. For example, a shallow private water well may be pumping groundwater from an aquifer that is also being pumped by a nearby high-capacity irrigation, industrial, or community water supply well. These may be considered "competing wells" since they are competing for the same groundwater. Under drought conditions, the nearby high-capacity well(s) may be pumping a large volume of groundwater to meet water demands such as crop irrigation or product manufacturing.

In general, the amount of drawdown will increase as the volume of pumped groundwater is increased. There may be times when the nearby high-capacity well or wells are able to pump so much groundwater that they lower the groundwater level below the nearby private well(s). Thus, the shallow private well exhibits problems because the drought has increased the water demand on nearby high capacity well(s), while the increased demand has lowered the groundwater level, and the private well is no longer able to pump the groundwater that it once was able to produce (*Figure 4*).

If you think your private well has been adversely impacted by a competing well or wells in the area, you should consider these recommendations:

- Contact a local well driller for an evaluation to determine if the problem is with the groundwater level rather than mechanical (pump), etc. Determine if immediate action such as lowering the pump can remedy the problem.
- If it's reasonably clear the problem is a competing well, contact the owner of the competing well, if possible, to discuss solutions.
- Contact the Natural Resources District for the area. The NRD is responsible for groundwater management in its area, and will have information about groundwater availability. The NRD may get involved in finding a resolution for the problem. For example, it may have funding for domestic well repairs or alterations if needed. In some areas, the NRD may be able to recommend connection to an existing Rural Water District. In some situations, it may be able to work with private well owners to create a new Rural Water District to serve the area. A variety of options might be considered depending on the circumstances. Locations of NRDs are available on the NRD state association website: *http://nrdnet.org/.*
- Groundwater usage in Nebraska is based on "correlative rights," which means groundwater users share in times of abundance and shortage. Unlike surface water usage, an older well does not have greater rights to groundwater use than a newer well.
- Nebraska's Constitution gives first preference to domestic water usage, followed by agricultural and industrial usages.
- To enforce a groundwater right legally, an individual needs to work through the court system. This would likely involve hiring an attorney as well as groundwater experts, such as an engineer or a hydrogeologist.
- Mediation or arbitration may be a good alternative for finding a resolution to the conflict that better serves the needs of all parties than going to court. The process is usually much faster and less expensive than the legal process. The list of Nebraska mediation centers is at *http://court.nol.org/mediation/pdf/Roster_ODR_Mediation_Center.pdf.*

In some cases, problems may only occur during peak demand periods, when water is being pumped from the well continuously for a period of time. This may be during periods of water use for showers or clothes washing. Under these conditions, you may be able to continue using the well by initiating water conservation measures and timing the water use so that high water use activities do not occur at the same time.

Initiating Water Conservation Measures to Reduce Total Daily and Peak Demands

When initiating water conservation measures start with the fixtures and the activities that use the largest volumes of water. The toilet, shower/bath, and clothes washing machine account for two-thirds of the water used in an average household.

Toilets manufactured after January 1, 1994, are water efficient, using no more than 1.6 gallons per flush. Older conventional toilets use 3.5 to 5 gallons or more of water per flush. Replacing an older toilet can achieve significant water savings.

Toilet dams or water-filled plastic containers can be installed in older toilet tanks to reduce the amount of water used per flush, but the reduced flow can affect the effectiveness of a flush. In older toilets, about 3 gallons of water may be needed in the tank to flush properly. Avoid placing bricks that crumble in the tank; they may affect operation.

Use of the toilet as a wastepaper basket to dispose of other household trash results in unnecessary flushing and should be avoided.

Leaks account for a great volume of water usage. About 20 percent of toilets leak. To test for a leak, put a few drops of food dye in the tank. If after 15 minutes, color appears in the bowl, there is a leak that should be repaired. Typically, the toilet flapper needs replacing or the water level needs adjusting.

The rate that water flows through fixtures will affect the amount of water used. Showerheads manufactured after January 1, 1994, are water efficient, with flow rates of no more than 2.5 gallons per minute (gpm.) Older standard faucets can use 6 to 8 gpm. Replacing older showerheads can save a considerable amount of water. Taking shorter showers can help as well.

To reduce peak demand, spread out showers during the day. Avoid having multiple showers within a two- or three-hour period of time.

Water-saving clothes washing machines use about one-third as much water as traditional washing machines. The average older washing machine uses 40 gallons of water per load. High-efficiency washing machines use 18 to 25 gallons per load. When purchasing a new washing machine, check the label to determine water efficiency. Features to look for include the ability to adjust water levels to accommodate different size loads or different soil levels.

When laundering, adjust water levels to the laundry load size and degree of soil. Typically, fewer full loads use less total water than several small loads.

To reduce peak demand, spread out loads of laundry. Do only one or two loads of laundry per day, waiting several hours between loads.

Many areas of Nebraska have hard water, which is often managed with the use of an ion-exchange water softener. Water softeners use a significant amount of water during the regeneration cycle. Regeneration cycles can be optimized by using water softeners with demand-initiated regeneration. Regeneration will occur only when required as determined by the gallons of water used, a change in the electrical conductivity of the resin bed, or a change in water hardness. The water softener can be switched off to entirely eliminate regeneration cycles while drought persists.

Significant water savings can be achieved through attention to lawn and garden watering. This topic is very important during drought and more information can be found in other NebGuides that are a part of this *Water Wise* series.

Modifying the Well or Distribution System

When drought persists, initiating water conservation measures to reduce total daily demand and peak demand might not eliminate water supply problems. Replacement of your pressure tank with a larger one or installation of a second tank to provide additional water storage might be enough to take care of the problem. For a well with a slow recovery rate, the additional storage can reduce demand on the well during high water use periods by storing water extracted during lower use periods.

As drought continues, the water level in a well can drop below the submersible pump or pump intake, causing a loss of water. This drop in water level can be due to natural changes in the water level, and/or due to changes caused by nearby pumping wells. Shallow wells are more susceptible than deeper wells. It may be possible to lower the pump or pump intake within the existing well, although this might provide only a temporary solution. A more permanent solution might be achieved by deepening the existing well or drilling a new well. Work with a State of Nebraska licensed professional to first make sure a new well is necessary, and then determine the best solution for your situation.

Resources

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