Flowing Wells in Minnesota

Flowing wells present unique challenges for well drillers, pump installers and homeowners. These unique features can be found throughout the state of Minnesota and are not limited to certain areas or geography. Proper well construction is necessary to maintain a safe flowing well. The Minnesota Department of Health (MDH) regulates water well construction in Minnesota and provides information on their website: Flowing Well and Boring Special Construction Area**.**

What is a flowing well?

Flowing wells and borings are drilled holes that encounter an aquifer with sufficient natural pressure to force water above the ground surface, so that water will flow without pumping. Many wells in Minnesota are completed in confined aquifers with artesian conditions, meaning the water level in a water well rises above the top of the aquifer. If the water level rises above the land surface, it is known as a flowing artesian well, as shown in Figure 1.

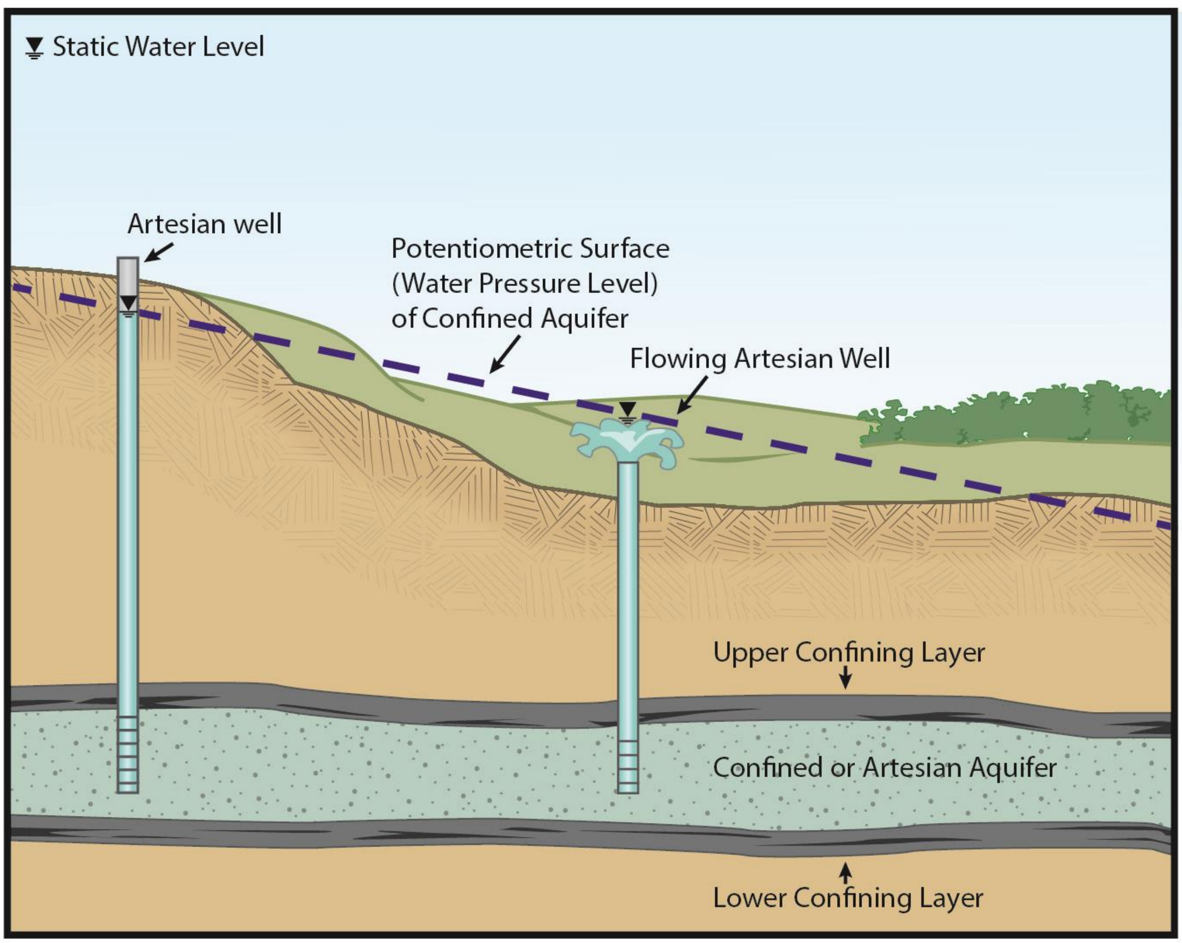

Figure 1. Terms relating to flowing artesian wells.

Why does my well flow?

Groundwater is water beneath the land surface that fills the pore spaces in rock and sediment. It is replenished by precipitation that seeps through the soil and into underground aquifers. The most common example of flowing artesian conditions exists when a low permeability confining layer, such as clay or shale, overlies the aquifer. This puts the groundwater under pressure because the material doesn't permit water to flow through it. When a well is installed, the confining layer is breached, creating a sort of "pressure relief valve" which allows the water to rise above the top of the aquifer. If the pressure in the aquifer is great enough to force water to rise above the land surface, the well flows.

In some settings, the presence of faults, fractures, or solution cavities can cause a well to flow. In other cases, a well may flow only part of the year or in response to a number of variables such as atmospheric pressure or nearby wells being pumped. Flowing conditions can also occur in an unconfined aquifer, most often at lower elevations in groundwater discharge areas near rivers, lakes, or other waterbodies as shown in Figure 2.

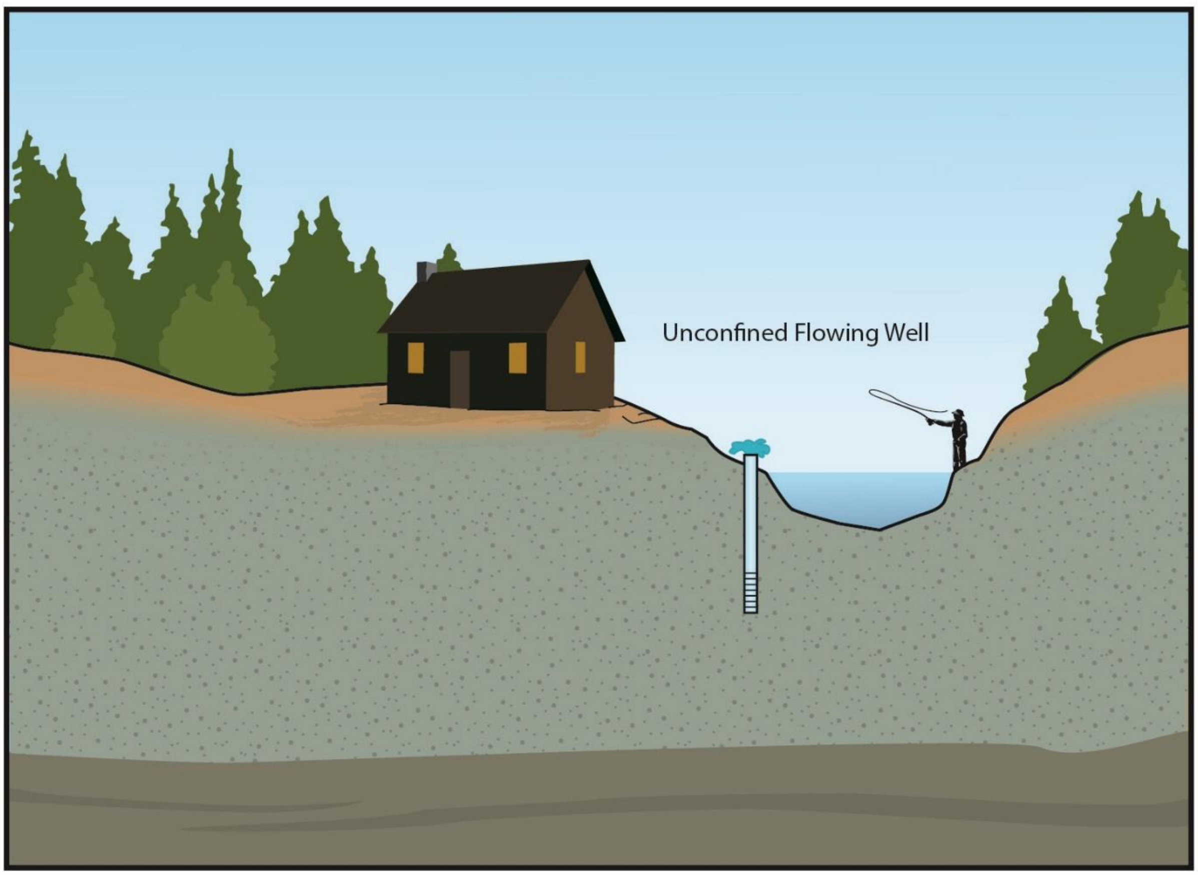

Figure 2. Unconfined flowing well.

What are potential problems with flowing wells?

Flowing wells are the result of pressure due to the confining layer above an aquifer. Pressure can range from slightly more than atmospheric to tens of pounds of pressure. Flows can vary from less than one gallon per minute to hundreds of gallons per minute.

Pressure can cause water to flow above the ground level, sometimes with great force, causing damage to property and surface waters. Higher pressures can also make installing or sealing a flowing well difficult. Sometimes the pressure can force water to flow around the outside of a casing that hasn't been grouted sufficiently. This can cause erosion of the confining layer, erosion around the well, flooding, land subsidence, damage to structures, and safety concerns. This type of flow is difficult to control, and sometimes even impossible. The wellhead also must be protected from freezing conditions. Some well owners choose to let the well flow so the water does not freeze, eliminating the need to provide a heat source for the well. Flowing wells may also waste enormous volumes of our groundwater resources if not properly managed.

What do Minnesota's laws say about flowing wells?

The Minnesota Department of Health (MDH) has adopted rules for constructing wells under flowing conditions. A well or boring with flows above the ground surface must be constructed to prevent erosion above and below the ground. The rules for well construction are in MN Rules 4725.3450. In brief, wells or borings in flowing conditions must be constructed to prevent water flowing up the outside of the casing. The well must also be constructed to have the capability of stopping all flow from the well. If the water flows from the well onto the land or into a receiving tank or surface water, the outlet must have an air gap and a noncorrosive mesh screen to protect the water supply. Visit the following MDH website for more information on well construction: Flowing Well and Boring Special Construction Areas.

Discharges in excess of 10,000 gallons per day or one million gallons per year require a DNR water appropriation permit. As a reference, continual flow of just 1.9 gallons per minute will equal one million gallons of groundwater per year. All permit holders are required to measure monthly water use with an approved measuring device, like a flow meter, to an accuracy of 10%. In addition, the permit requires annual reporting of water use and a fee based on the total amount of water flowing from the well per year. Minnesota Statute 103I.103 states that the DNR may require owners of wells to prevent the waste of water in order to conserve the groundwater supply of the state, especially flowing artesian wells.

Flowing wells and well interference

If the DNR receives complaints regarding a loss of water due to the pumping from a high volume water appropriation nearby, either from private domestic well owners or a public water supply authority, the procedures are outlined in MN Rules, Part 6115.0730. Flowing domestic wells should be handled like non-flowing wells. The domestic flowing well should be controlled and contained in a water distribution system to be eligible under the well interference law.

Water freely flowing over the landscape from a flowing well is not protected under the well interference law because it is considered a waste of water, the lowest priority for water allocation by Minnesota Statute. For example, some domestic flowing wells that provide water for a home have an overflow connected to the well in order to keep water away from the well and to provide pressure relief for the domestic supply. The overflow of water is not protected, but the flowing water for the domestic supply is eligible under the well interference law. Although the overflow is not protected, the reduction of flow from the overflow pipe could indicate sustainability issues in the aquifer and would likely be investigated further.

Flowing well examples

Flowing Well at a Roadside Rest Area

A flowing well was developed at a state roadside rest area in southeast Minnesota in the early 1950's for highway travelers to use for drinking water. Many of its attributes were unknown but it was thought to be a shallower bedrock well. An investigation conducted in 2010 revealed that the well was deep and completed in the Mount Simon aquifer, and also interconnected the overlying buried sand and gravel aquifers. The possibility for cross contamination made the flowing well out of compliance with MN Rules 4725, governing the construction, maintenance and repair of wells and borings in Minnesota.

Minnesota Department of Health staff determined the flowing well could not be used by the public until corrections were made. Required improvements to the existing flowing well included: adding flow control; extending and sealing the casing into the flowing aquifer (Mt. Simon); extending the casing vertically to at least 12 inches above the ground surface; and repairing the casing to make it watertight – (several holes in the casing were observed at 7 feet below grade). Ultimately MNDOT evaluated the types of repair required and decided to seal the well.

Flowing Well for Domestic Supply

A well was constructed in 1995 along the shores of Esquagamah Lake in Aitkin County to supply water for a cabin. When the well contractor drilled into the confined aquifer, water began to flow at an estimated rate of 1,200 gallons per minute. The water shot up approximately 40 feet high into the air until the contractor was able to control the flow. The well drilling contractor worked for 20 continuous hours to contain the flow in an 8 inch pipe, using an estimated 9,000 pounds of cement to help control the flow and construct the well. A portion of the flowing water supplies two cabins on the lake and the remainder is piped directly to the lake. Much of this water would have eventually discharged into the lake through groundwater flow, but the well was "short circuiting" the natural flow. With the flow under control the DNR did not require an appropriation permit and MDH approved the well construction.

Definitions

Aquifers and Aquitards

Confining layer (aquitard) – Geologic material with low permeability that restricts water movement.

Confined aquifer (artesian aquifer) – An aquifer restricted by an impermeable geologic layer both on the top and bottom. The water within is confined and under hydraulic pressure, causing the levels in its wells to rise above the top of the aquifer. The raised levels are at the potentiometric surface.

Unconfined aquifer (water table aquifer) – An aquifer with no overlying impermeable (confining) geologic layer. The level of water measured in a well reflects the true water level in the aquifer. The water table forms the upper surface of the saturated zone, where all the pore spaces are filled with water.

Potentiometric surface – The level to which water will rise above the top of a confined aquifer. This is also described as the "static water level" of a well completed in a confined aquifer.

Wells

Artesian well – The open portion of the well is in a confined aquifer. The term "artesian" means the water is under pressure and the water level in the well (potentiometric surface) rises above the top of the aquifer.

Flowing well – A well that flows to the land surface without the use of a pump.

Flowing artesian well – Natural flow to the land surface is caused by the hydraulic pressure of a confined aquifer.

Unconfined flowing well – An unconfined aquifer well where the water level flows above the land surface. Flowing wells in unconfined aquifers usually occur near groundwater discharge regions such as rivers or lakes. A flowing well will occur if a well is drilled into a zone where aquifer pressure (hydraulic head) is higher than the land surface. Under these conditions, a well will continue to flow until equilibrium is reached.