

Measuring Water Levels in Wells

Iowa Department of Natural Resources
Water Use Program Guide



Introduction

Regularly measuring well water levels allows you to help identify and diagnose well interference and capacity issues before they become a serious problem. For all wells under a water use permit, state law requires that groundwater levels be measured as part of the annual water use report form [567 IAC 52.6(1)-52.6(4)]. This guide is designed to help water level measurements be taken accurately and uniformly throughout Iowa.

Why Measure Water Levels

Many factors can influence water levels in wells, including rain, seasonal fluctuations, and pumping from other wells. To help understand your well's variation and trends, it is recommended that water level measurements be taken at monthly or even weekly intervals and plotted on a time series chart (called a hydrograph). Over time (year or more), trends in your well water levels will become apparent, along with any abnormal water levels. Iowa's water use program only requires one measurement submitted to the program during the calendar year, but all water use permittees are encouraged to measure more frequently and keep their own records to help solve any interference or capacity issues that will invariably arise over time.

Know Your Well(s)

It is helpful to know your well through a quick review of your well's driller's log. Driller's logs are forms that detail a well's depth, construction, and original water levels. There are two online databases that store Iowa's driller's logs electronically; these are:

- **GeoSam**
www.iowageologicalsurvey.org/geosam
- **Private Well Tracking System**
<https://programs.iowadnr.gov/pwts/>

If your driller's log is not available through these resources, you could also contact your well driller for copies of that information.

Well Terms Glossary

Water Level Meter (or E-Line): A tape-like meter used to measure water levels in a well.

Air Line Meter: A tube installed down the casing of a well that measures water levels through air pressure in a tube.

Well Interference: When water levels in one well are influenced by pumping at another well.

Pumping Rate: The volumetric rate at which the well is pumped. Typically given as gallons per minute (GPM).

Driller's Log: A record of a well's geology, location, construction, and water levels. This is usually provided by the driller when the well is first drilled.

Well Cap: A cap that covers the well to prevent contamination and tampering.

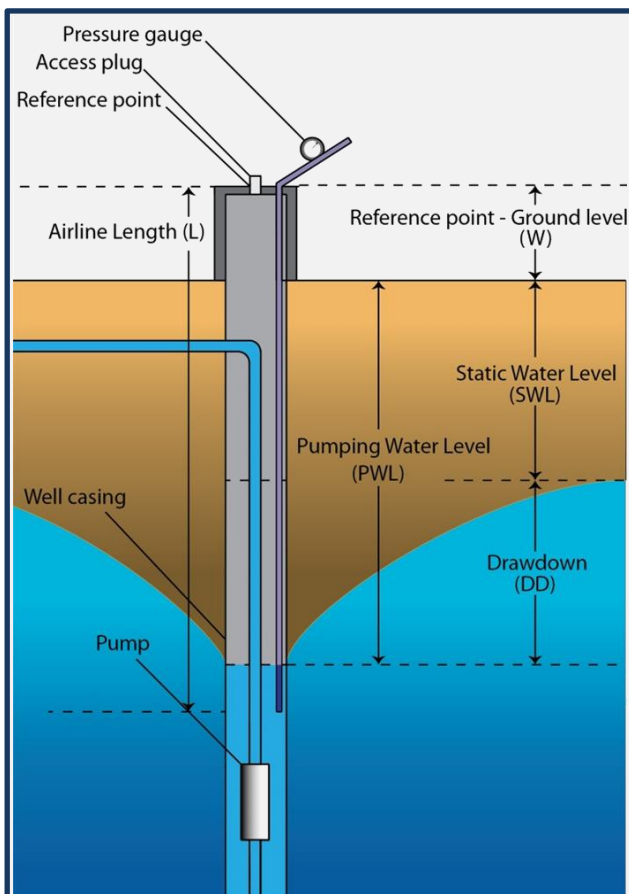
Well Casing: A metal or plastic pipe used to reinforce the sides of a drilled hole.

Water Level Measurement Options

There are two water level measurement options covered in this guide: water level meters (flat-tape or coaxial) and air line meters. The first step for either method is to turn off the well pump for at least two hours before measuring the water level. This will allow you to measure the Static Water Level (SWL).

Air Line Meters

Air lines are an excellent resource for taking multiple water level measurements, as they remain permanently in the well. Air lines also benefit from not giving false reading due to cascading water or oil floating on water. Air lines measure water levels by first measuring the pressure of water above the air line opening. You can then convert the pressure measurement to feet of water above the airline.



Water Level Measurement Terms

PWL: Pumping Water Level from the ground surface

PWLW: Pumping Water Level from top of the well

SWL: Static Water Level from the ground surface

SWLW: Static Water Level from the top of the well

DD: Drawdown between static and pumping water levels.

W: The distance between the top of the well and ground surface

L: Length of the air line

P(s): Pressure on the gauge in PSI while static

P(p): Pressure on the gauge in PSI while pumping

L(s): The length of the tape from static water level surface to well measuring point

L(p): The length of the tape from pumping water level surface to well measuring point

Water Level Equations

$$PWL = PWLW - W = L - (P(p) \times 2.31 \text{ ft/psi}) - W$$

$$SWL = SWLW - W = L - (P(s) \times 2.31 \text{ ft/psi}) - W$$

$$DD = SWL - PWL = SWLW - PWLW$$

The gauge on an air line displays readings as either pounds per square inch (psi) or feet of water. The depth of water in the air line is equal to the measured pressure in the air line, in feet, or the pressure reading multiplied by 2.31. Thus an empty air line would have no pressure, and one psi would have 2.31 feet of water above the airline.

When recording measurements it is important to wait a few minutes to make sure water levels are taken when there is a sustained rate of pumping in the well and the water level has reached equilibrium. These measurements need to be adjusted for any difference in height between the measuring point and the ground surface, not changing. A static water level measurement can be taken when there is no pumping in the well, and the water level has reached equilibrium.

Finding Depth to Water

A 300 ft. deep well has a 250 ft. air line installed along its casing (see above). The well cap is 3 feet above the ground, and the air line pressure gauge measures a steady 21 psi after the well has been pumped continuously for five hours. When the pump is shut off, the pressure increases to 26 psi after two hours.

What is the pumping water level (PWL) of this well?

$$PWL = 250 \text{ ft} - (21 \text{ psi} \times 2.31 \text{ ft/psi}) - 3 \text{ ft} = \mathbf{198.5 \text{ feet}}$$

What is the static water level (SWL) of this well?

$$SWL = 250 \text{ ft} - (26 \text{ psi} \times 2.31 \text{ ft/psi}) - 3 \text{ ft} = \mathbf{187 \text{ feet}}$$

What is the drawdown of this well?

$$\text{Drawdown (DD)} = 187 \text{ ft} - 198.5 \text{ ft} = \mathbf{11.5 \text{ feet}}$$

Water Level Meters

There are two main types of water level meters: coaxial and flat-tape meters. A coaxial meter uses a thin, round wire to transmit a signal to the buzzer. Coaxial meters are preferred when measuring water levels from pumping wells, as the weighted tip on the coaxial wire helps it move past internal components. A flat tape meter looks similar to a standard measuring tape. It's important to become familiar with the measuring system on your water level meter before you lower it into the water.

An important difference between using installed air lines and water level meters is the necessity for water level meters to have a clear access point to the internal components of the well.

Tips for Removing Different Types of Well Caps

Turtle Back well cap with access plug:

The access plug is typically on top of the well cap. Use a wrench to remove the plug in this well cap. WD-40 may help if the plug is rusted shut. If it still cannot be removed, the entire cap can be removed (see the next section). Once the plug is removed, set it in a sanitary location. The top of the hole in the cap is the measuring point. Once you are finished measuring, return the plug to the cap and tighten it.



Example of a turtle back well with an access plug.

Turtle Back well cap without access plug:

To access this type of well, the entire cap must be removed. Use a wrench to remove the bolts and nuts. Remove the well cap, tapping it gently if it's stuck. Set the cap someplace where it won't be stepped on or contaminated, and place the nuts and bolts inside. Be careful not to drop anything down the well, and avoid touching any bare wires visible within the well.

Make your measurements from the top of the well casing. When you are finished, replace the cap and line up the bolt holes and the power outlet. Finish closing the cap by returning the nuts and bolts and tightening them.

Sanitary Seal well cap with access plug:

Unscrew the plug (it should be on the opposite side of the cap from the power outlet) from the cap using a wrench. Set the plug in a sanitary location. The measuring point is the top of the hole in the cap. After you have finished your measurements, return the plug to the cap and tighten it.



Example of a sanitary seal well cap with access plug.

10-Step Measurement Instructions

1. Clean the line before you put it in the water. Don't use any cleaner that could contaminate the water.
2. Test the battery using the test switch. Turn the meter on to your preferred setting, and then turn the sensitivity switch up.
3. Release the line slowly over an outstretched hand. Check the weight of the meter periodically, to make sure it remains unstuck.
4. If the line becomes stuck, slowly raise it back up until you feel the full weight. Gently raise and lower the line until you feel you've moved past the obstruction.
5. When the water level meter indicates water, check that it's not cascading water by seeing a steady signal on the meter rather than a flickering one.
6. When you are certain that you've reached the water surface, slowly raise the line back up until the signal turns off.
 - a. For a static water level test, hold the line right above the water level for at least 3 minutes to determine if your water level is static or rising. If the light turns back on, then the water level is still rising from recent pumping of the well.
 - b. For a pumping water level test, lower it again until the light turns back on. Hold the line steady for 3 minutes, to determine if your water

level is static or falling. If the light turns back off, then the water level is still falling.

7. If you encounter rising or falling water, you can:
 - a. Wait to continue testing until you find that the water level is stable
 - b. Take your measurements some other time.
 - c. Record the current water level, and clearly indicate it is not steady.
8. When you are ready to read the measurement, pinch the line just above the top of the casing. This will allow you to keep track of your measurement as you pull the line back. When you are satisfied with your reading, begin slowly rewinding the reel.
9. Once you have removed the line and probe from the well, turn off the water level meter. Replace well caps or plugs, and sanitize your water level meter.
10. Measure the distance from the measuring point to the ground surface, and mark if it is above or below the surface. Make sure to record this data.

Common Problems Measuring Water Levels

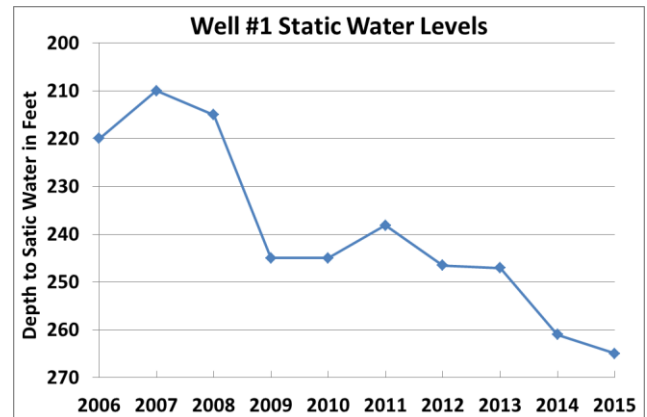
Meter lines often get hung-up while on their way down the well casing. There are many things inside a well that could cause hang-ups, including pump components, well liners, and casing joints. Measurements taken between the liner and the well casing will often be inaccurate. Common signs that a meter is outside the liner include dirt on the meter and shallower than expected water levels.

Additionally, cascading water can drip down from higher up in the well, sometimes hitting the water level meter and giving a false reading. To get a better idea if cascading water is present, try holding your ear to the opening and listening for running water.

Interpreting Water Levels

A quick and easy method to interpret ground water measurements is to plot the data through time. This type of figure is known as a hydrograph. After enough measurements have been taken, you can compare the water levels in your well(s) to see if there are any long term declines, or seasonal/drought responses. The example

hydrograph below shows a real well in Iowa with declining static water levels.



Example of a hydrograph indicating water levels declining over time.

Submitting Water Levels

There are two methods for submitting water levels to IDNR Water Supply. All water use permit holders can submit the paper annual report form, or electronically through the Water Use online application (WACOP). The online application address is:

<https://programs.iowadnr.gov/wateruse/>

The WACOP application requires a username and password, which can be set up through the start page. Although we strongly encourage all water use permittees to take water level measurements more often, the Water Use program only requires an annual measurement, or a yearly average.

For More Information

If you have any questions regarding water use or water level measurements and requirements, please contact water use staff through any of the following methods:

Email: wateruse@dnr.iowa.gov

Phone: 515-725-0341 (Charlotte Henderson) or
515-725-3407 (Chad Fields)

Mail: Chad Fields, Water Use Program
Water Supply Engineering Section
Wallace State Office Building
502 E. 9th St. Des Moines, IA 503019-0034