Landowner Monitoring Guide

Groundwater Level Monitoring: What is it? How is it done? Why do it?

MONITORING ESSENTIAL TO PROTECT GROUNDWATER RESOURCE

THE PURPOSE OF THIS GUIDE

This guide provides general background and information about groundwater monitoring in Glenn County and provides instructions on how to perform groundwater monitoring on your own well.

COMPONENTS OF GROUNDWATER MONITORING

Effective groundwater management will protect the quantity of groundwater and ensure a dependable and affordable supply of groundwater into the future. It will also protect the water quality to ensure that the groundwater remains suitable for domestic, industrial, agricultural, and environmental uses. In addition, monitoring is one of the tools that can help detect land subsidence from groundwater overdraft that can damage expensive public and private infrastructure such as water conveyance and flood control facilities, and water wells.

TECHNICAL ASPECTS OF MONITORING GROUNDWATER LEVELS

There are several factors that should be considered before measuring groundwater levels. Some of the factors are more readily recognized and understood than others. They include:

1) The elevation of the ground surface at each monitoring location;
2) Using either production or observation wells to measure groundwater levels;
3) Knowing how deep the well is and where the well is screened;
4) Using a well-sounding device to measure the depth to groundwater below the ground surface;
5) Deciding where to monitor and the number of locations to monitor;
6) Determining when to measure levels relative to seasons and relative to whether a pump is or is not operating; and
7) Record keeping.

Dedicated monitoring well.

Establishing Ground Surface Elevations

Measuring the depth to groundwater below the ground surface is more informative if the elevation of the ground surface is known. This can either be measured by surveying from a benchmark of a known elevation to a reference point on the well or estimated from topographic maps. The elevation of the groundwater surface then can be calculated by subtracting the depth to groundwater from the measurement point on the well. Then, comparisons of groundwater elevations can be made between monitoring well locations and the direction and gradient of groundwater flow can be determined.

Using Production or Observation Wells to Measure Groundwater Levels

Agricultural and domestic production wells or observation (dedicated monitoring) wells can be used for measuring groundwater levels. Observation wells provide the most useful information during monitoring. Observation wells have key information such as the well depth, the screened interval, and a description of the aquifer materials surrounding the well that were identified during drilling. Groundwater is not extracted from observation wells. In pre-existing domestic and irrigation wells, often well construction information is not known, which provides less useful information during monitoring. In addition, production wells may be pumping or have pumped recently prior to a measurement, resulting in possible inaccurate measurements.

Observation wells are typically built to have more than one monitoring zone per well. An example observation well would be configured with three separate, two-inch diameter well columns extending to three different depths, a shallow zone, a middle zone, and a deep zone, all in one larger borehole, and separated from each other with cement. Each well column is constructed with perforated well casing (screening) near the bottom of the well column so groundwater levels within each of the aquifer systems can be measured independently of the other. The advantage of using observation wells is that they can help determine the effects of groundwater extraction or recharge on each aquifer system and determine interconnections between them.

Landowners and operators are generally interested in the measurement of pumping lift because it has important implications on the cost of extracting water. However, a measurement of pumping lift is not a reliable indicator of the overall condition of the groundwater aquifer systems. The pumping lift can increase inside a well due to pump and well design factors not related to groundwater levels outside the well column. Therefore, measurements from static (not recently pumped) water levels inside a production well or measurements from an observation well will better reflect the groundwater level in the well. Groundwater levels from multiple wells is used to help describe groundwater levels in the region.

A

B

Typical devices to measure groundwater levels:

a) steel tape; and

b) electric sounder.

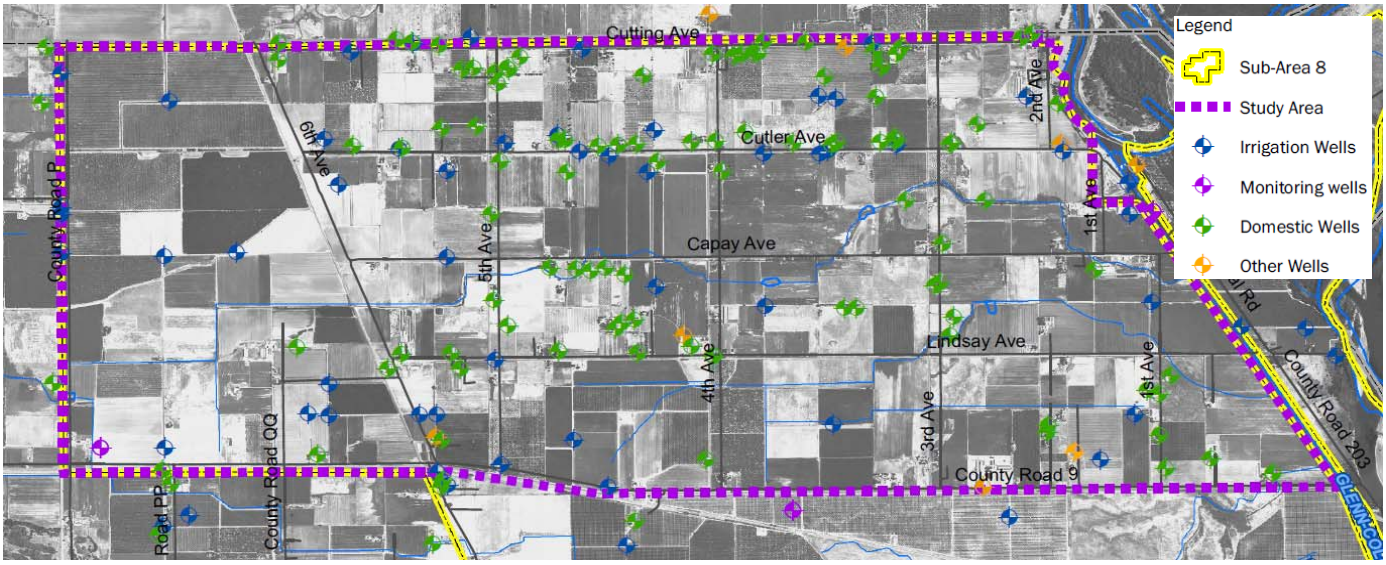
Well Sounding Devices

Generally, there are three types of devices available to measure groundwater levels. Typical sounding devices include steel tapes, electrical well sounding devices, and pressure transducers. A steel tape can be used to measure groundwater levels by inserting it between the well casing and pump column until it contacts water. It may require pulling the tape out repeatedly to verify that it has contacted the groundwater surface.

The depth of water is then determined by subtracting the length of tape that was submersed in water from the total length of tape inserted in the well. An electric well sounding device beeps when it contacts water. The length of cable lowered down the well when it touches water is then noted as the depth to groundwater. Pressure transducers can be connected to a data logger enabling continuous groundwater level measurements, although this method is more expensive, and typically only used in scientific studies.

Determining Where to Monitor Groundwater Levels

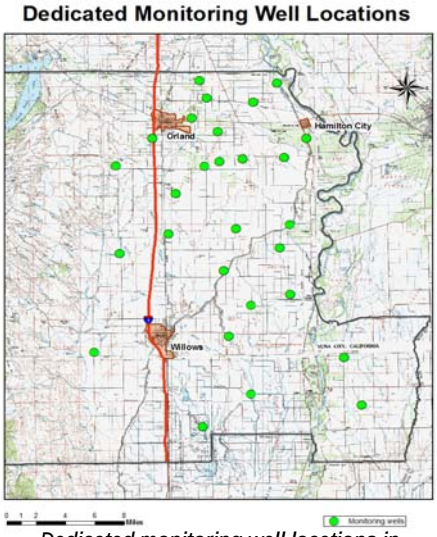
In a formal groundwater monitoring network, several factors including hydrology, geology, and land and water use settings all influence where and how many locations are needed to establish the groundwater level monitoring network. Hydrologic factors such as presence of surface water supplies for irrigation, sole reliance upon groundwater for irrigation, or a combination of both surface water and groundwater should be considered. Geologic factors should be considered such as known characteristics of the aquifer system being monitored and whether geologic faults, if present, that may influence groundwater movement. Changes in land and water use such as new residential, industrial, agricultural, environmental uses, and participation in water transfer programs are examples of land and water use considerations that may influence where and how many locations are established for groundwater level monitoring. A thorough groundwater monitoring network has monitored wells in both shallow, middle, and deep aquifers spread throughout the monitoring area.



General locations of agricultural and domestic wells in the north-east portion of Glenn County.

Deciding When To Monitor Groundwater Levels

At a minimum, measurements should be taken in the spring and in the fall in order to obtain the highest and lowest seasonal groundwater levels. Spring and fall measurements generally occur before or after most of the irrigation season so static groundwater levels are usually measured in production wells. Because static levels are measured, elevation gradients between monitored wells can be determined as well as groundwater flow direction within the aquifer system. Springtime measurements also indicate the extent that the storage in the aquifer systems has recharged from winter precipitation. Static fall groundwater levels may give insight about the amount of groundwater removed from aquifer storage during the irrigation season.



Dedicated monitoring well locations in Glenn County in 2011.

Record Keeping

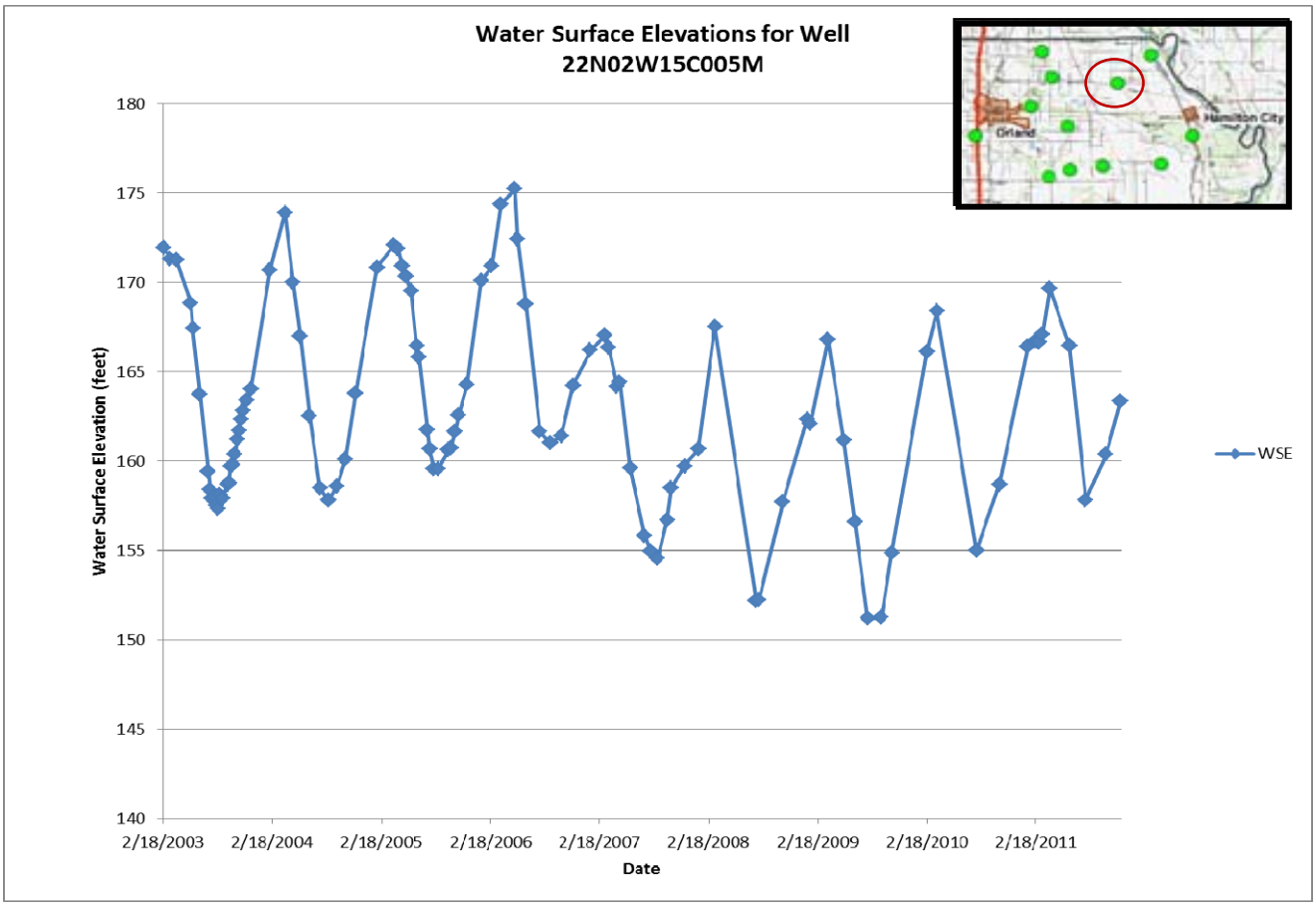
Record keeping can sometimes be overlooked as an important aspect of groundwater monitoring. However, without a commitment to record keeping to facilitate data analysis, the value gained from efforts to monitor groundwater may greatly diminish. The important components for recordkeeping include:

- Name of well
- Location of well
- Ground surface elevation
- Date of measurement
- Depth to groundwater
- Elevation of groundwater surface
- Reference point elevation which is used to consistently measure depth of groundwater, and it's distance from ground surface
- Well status (pumping or non-pumping) and any surrounding conditions that might affect groundwater levels

Applying Groundwater Level Monitoring Results

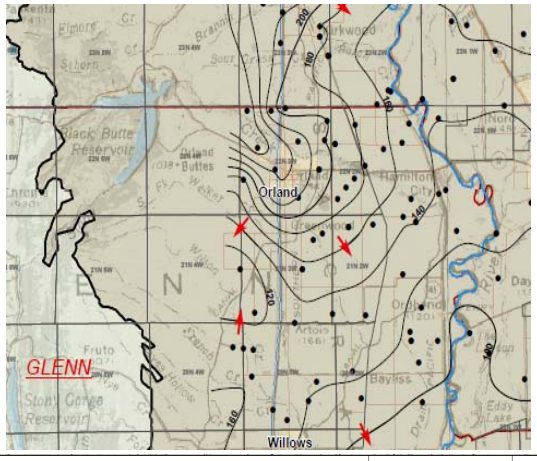
Hydrographs give an example of other applications of the monitoring data. They can be used to understand changes in the groundwater resource over time resulting from changing water and land uses, hydrology, and climate. The hydrograph below shows annual fluctuations in the measurements of a groundwater well. Groundwater levels are typically highest in the spring and lowest in the summer.

Contour maps are an example of how groundwater level monitoring data can be applied to help understand and protect the groundwater aquifer systems. The contour lines represent groundwater elevations, similar to the lines of a ground surface topographic map. The red arrows indicate the direction of groundwater flow. Comparisons of groundwater elevations and groundwater flow directions on an annual, semi-annual, or more frequent basis can identify early indicators of changes in the groundwater resource and help understand how to protect against or correct unwanted impacts. More information about groundwater is available at: http://www.water.ca.gov/groundwater/.



Above is a hydrograph for an observation well in north-eastern Glenn County. The high points of each annual cycle coincide with the spring time measurements, and the low points are typically summer or fall measurements. The hydrograph shows that groundwater levels have, in general, declined about 5 feet from 2003 to 2011 in this monitoring well.

The map to the right is a groundwater contour map of Glenn County provided by Department of Water Resources, Northern Region Office. The map shows that in the vicinity of Orland, groundwater primarily moved to the south and south east in spring of 2011.



Well Monitoring Form

"Must Have" information:	"Nice to have" information:
Well Name: Field 05	Well Depth: 400 feet
Well Location/Description: Near shed, green pump	Screened Interval: 250-375
Measurement Point: bolt on north side of casing	Ground Surface Elevation: 200
Well type: (_) Domestic (X) Irrigation (_) Other (_) Observation	Measurement Point Elevation: 202.4
	GPS Coordinates:
	Other Notes:

1. Measurement Date	2. Depth to Water (feet)	3. Comments/Questionable Measurement	4. Measurement Point Elevation (feet above sea level)	5. Water Surface Elevation (feet above sea level)
5/3/2013	34.5	none	202.4	167.9
6/4/2013	34.1	none	202.4	168.3
7/4/2013	33.1	none	202.4	169.3
8/1/2013	30.4	none	202.4	172
9/5/2013	31.8	none	202.4	170.6

An example of a groundwater measurement record.

Benefits of Monitoring Groundwater Levels:

- Determine annual and long-term changes of groundwater in storage
- Estimate recharge rates
- Determine direction and gradient of groundwater flow
- Understand how aquifer systems work
- Gain insight for well construction and where to set pump bowls for efficient extraction

Instructions for Monitoring

HOW TO MONITOR YOUR OWN WELLS

THE MEASUREMENT FORM

Fill in the information at the top of the form including:

Name of the well- The name will be an identifier regularly used by the users and measurers of the well.

Well Location– Describe the physical location of the well.

Measurement Point– Describe measurement point for future reference. This is important for consistency in measurements and for calculation of water surface elevation. The measurement point is the location on the well or well casing in which all measurements will be taken (usually the access point to the well). Clearly mark the measurement point on the well. A photo of the monitoring point can also be helpful. The **measurement point elevation** is determined by measuring the point's height above the ground surface, and then adding that distance to the ground surface elevation. For example, if the measurement point is 2 feet above the ground surface, and the ground surface is 200 feet above sea level, the measurement point is 202 feet above sea level.

Well Type– Mark well type.

If other records are available, such as a driller's well log, construction documents, survey information, topographic maps (for estimating ground surface elevation), or GPS, the following information should be added to the form:

Well depth, Screened interval, Ground Surface Elevation, Measurement Point Elevation, and GPS coordinates

If well information is unavailable, well logs may be available from the Department of Water Resources, Northern Region Office (DWR). DWR may be contacted by visiting their website at: http://www.water.ca.gov/groundwater/well_info_and_other/well_completion_contacts.cfm

TAKING A MEASUREMENT

There are two main methods available for water level measurements, the steel tape method and the electronic sounding tape method. The steps to perform a measurement with each tool are slightly different and are presented below:

1. Record the **measurement date**, including the day, month, and year.
2. Measure and record **depth to water**. If using an electronic sounder, use the guidance in **Section A – Electronic Sounder** below, if using a steel tape, use the guidance in **Section B – Steel Tape** below.
3. Record any **comments** or factors that affect the measurement under the **questionable measurement** field, which may include:
   - The well being measured is pumping
   - A nearby well is pumping
   - The casing of the well is wet, or leaking
   - The well being measured was pumping recently
   - Oil is in the casing and is detected on the measuring device

A general recommendation of the Department of Water Resources is to measure the well 24 hours or longer after it has ceased pumping, or the measurement should be marked in the measurement form as "pumped recently".

4. Record the **measuring point elevation** (this will not change between measurements)
5. Subtract the depth to water (step 2) from the measuring point elevation (step 4). This will determine the **water surface elevation**, in feet above sea level.

Section A – Electronic Sounder

1) Check the circuitry of the electric sounding tape before lowering the electrode probe into the well to be sure the indicator (typically sound and/or light) is functioning properly.
2) Wipe off the electrode probe and the lower 5 to 10 feet of the tape with a disinfectant wipe, rinse with distilled or tap water, and dry. This prevents any contaminants from coming in contact with the well's water.
3) Use any previous measurements as a starting point to estimate how far to lower the probe.
4) Lower the electrode probe slowly into the well until the indicator sounds and/or lights. Read the measurement tape where it touches the measurement point to the nearest 0.1 foot. Record this value as depth to water. Lift the electrode probe slowly up a few feet and then make an additional measurement to confirm the accuracy of the measurement.
5) Retract the electrode and inspect for oil. If an oil layer is present the sounder will still send a signal. Use a steel tape instead, if available, and be sure to indicate a questionable measurement due to oil in the well casing. If you know a well has oil in it or is pumping, do not use an electric sounder.
6) Wipe down the electrode probe and the section of the tape that was submerged in the well water, using a disinfectant wipe and rinse thoroughly with distilled or tap water. Dry the tape and probe and rewind the tape onto the tape reel.

Section B – Steel Tape

1) Wipe off the lower 5 to 10 feet of the tape with a disinfectant wipe, rinse with distilled or tap water, and dry. This prevents any contaminants from coming in contact with the well's water.
2) Use any previous measurements as a starting point to estimate how far to lower the tape.
3) Chalk the lower few feet of the tape with blue carpenter's chalk or sidewalk chalk.
4) Lower the tape into the well until it a few feet past the last measurement taken. Read the measurement tape where it touches the measurement point to the nearest 0.1 foot, then retract the tape and note how much of the chalked portion is wet. Subtract the wet chalked portion from the measurement. Record this value as depth to water.
5) Inspect the tape for oil. If oil is present, note it on the measurement form.
6) Re-chalk and repeat step 4 to make an additional measurement to confirm the accuracy of the measurement.

Well Monitoring Form

"Must Have" information:

Well Name:

Well Location/
Description:

Measurement Point:

Well type: (_) Domestic (_) Irrigation

( ) Other ( ) Observation

"Nice to Have" information:

Well Depth:

Screened Interval:

Ground Surface Elevation:

Measurement Point Elevation:

GPS coordinates:

Other Notes:

1. Measurement Date	2. Depth to Water (feet)	3. Comments/Questionable Measurement	4. Measurement Point Elevation (feet above sea level)	5. Water Surface Elevation (feet above sea level)

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