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Environmental Program Directorate

Standard Operating Procedure

For **MANUAL GROUNDWATER LEVEL MEASUREMENTS**

APPROVAL SIGNATURES:

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1. PURPOSE AND SCOPE

This procedure states the responsibilities and describes the process for manually measuring the depth to groundwater and determining the groundwater elevation in an open borehole or cased monitoring well.

This standard operating procedure (SOP) applies to all Los Alamos National Laboratory (LANL) Water Stewardship Group (ENV-RCRA) and contract personnel who manually measure groundwater levels.

2. BACKGROUND AND PRECAUTIONS

2.1 Background

Groundwater-level measurements are generally used to construct potentiometric surface maps. Groundwater-level data are also used to determine sample purge volumes, hydraulic conductivity, groundwater flow direction, flow velocity, hydraulic gradients, impacts from pumping, or other groundwater stresses.

[NOTE: Actions specified within this procedure, unless preceded with “should” or “may,” are to be considered mandatory guidance (i.e., “shall,” “must”).]

2.2 Precautions

Water-level meters should not be used to measure groundwater level in a deep (>500 ft) borehole, well, or access tube where a transducer or other equipment is installed on a cable unless a separate access tube is present to deploy the water-level meter. Use of a water-level meter in a well or tube with a transducer or other type of cable or tubing may lead to tangling of the water-level meter probe with the cable. Shallow alluvial wells may be measured for groundwater levels with a transducer or pump installed where space in the well allows insertion of the water level probe.

3. EQUIPMENT AND TOOLS

Suggested equipment for groundwater level measurements includes the following:

- Electric water-level meter with tape marked in 1-foot (ft) intervals and graduated to 0.01-ft length appropriate to well(s) being measured
- Attachment 2, Groundwater Level Measurement Form
- Waterproof pen
- Electrical tape
- Well location file notebook, measuring point diagram, and as-built diagram of well construction with Land Surface Datum (LSD)
- Deionized (DI) water and Kimwipes
- AA batteries or 9-volt batteries, as needed
- Keys for the well
- Small generator (if electric reel is being used)
- Field notebook
- Hand-held calculator

- Protective gloves and safety glasses with side shields
- Nitrile gloves
- Paper towels
- Well head tape roller guide

4. STEP BY STEP PROCESS DESCRIPTION

4.1 Establishing Working Condition of Water-Level Meter

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|-------------------|---|
| Field Team Member | <ol style="list-style-type: none"> 1. Establish the working condition of the meter before use by filling a bucket, length of tubing, or similar container with fresh tap water. <hr/> 2. Insert the water-level meter into the container, and check that the audible tone device and/or the lighted signal device operate properly when the sensor contacts the water. <hr/> 3. If there is no response by the water-level meter, follow manufacturer instructions for checking and replacing the batteries, and repeat the test. <hr/> 4. If there is still no response, check for corrosion in the battery compartment and all electrical connections and contacts between the reel and the tape, and the tape and the sensor unit. <hr/> 5. Follow manufacturer's instructions for cleaning and maintenance of the water-level meter. |
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4.2 Checking and Calibrating Water-Level Meters

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|----------------------------------|--|
| Field Team Member | <ol style="list-style-type: none"> 1. Check and calibrate all water-level meters any time after a meter has been hung up, stretched, or kinked during use, or whenever a meter is producing water-level data inconsistent with pressure-transducer measurements or previous manual measurements. All water-level meters in use by the LWSP should be checked and field-calibrated at least annually. Record calibration on Attachment 3, Water-Level Meter Calibration and Maintenance Form and maintain form in the equipment files. Attach a calibration tag to the water-level meter with any measurement-offset instructions. To perform calibration, the FTM shall perform the following steps. <hr/> 2. Measure the distance from the top of a container to the water with a steel tape measure traceable to National Institute of Standards and Technology (NIST), graduated in 0.01-ft increments. Record results on the Water-Level Meter Calibration and Maintenance Form (Attachment 3). <hr/> 3. Measure the distance from the top of the container to the water with the water-level meter, and record results on the Water-Level Meter Calibration and Maintenance Form (Attachment 3). |
| Field Team Member
(continued) | <ol style="list-style-type: none"> 4. Measure the distance from the top of a container to the bottom of the container with a steel tape measure traceable to NIST. Record results on the Water-Level Meter Calibration and Maintenance Form (Attachment 3). |

5. Measure the distance from the top of the container to the bottom of the container with the water level meter, adding the distance from the water-level meter sensor (0 ft) to the tip of the probe to the measured value for total depth. Record results on the Water Level Meter Calibration and Maintenance Form (Attachment 3).

6. If the measured distance between the water-level meter does not correspond with the measurements taken with the steel tape:
 - Note the measurement discrepancy(ies) on the Water-Level Meter Calibration and Maintenance Form (Attachment 3)
 - Mark and affix a tag to the water level meter with the measurement calibrated offset distance in ft.

7. If the measured distance between the water-level meter corresponds with the measurements taken with the steel tape, mark the date of the calibration on a calibration tag or sticker, and affix to water level meter.

8. Check all water-level meters for accuracy of measurement by measuring the depth to water in a well of suitable depth (>300 ft) using water-level meters currently used by LWSP. Record the measurement from each meter on the Groundwater-Level Measurement Form (Attachment 2). Determine if any measurement tapes have been stretched or compromised by use or misuse and remove nonconforming water-level meters from service. Clearly mark water-level meters removed from service with a tag, indicating the date it was removed from service.

4.3 Maintaining Water-Level Meter

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| Field Team Member | 1. Periodically check the tape for breaks, kinks, and possible stretching. |
| | 2. Prohibit tape from rubbing across the top or sides of the casing where possible. |

4.4 Minimizing Cross Contamination

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|-------------------------------|--|
| Field Team Member | 1. Clean the water-level tape and probe as they are being retrieved from the well in order to minimize the potential for cross-contamination between wells. Pull the tape and probe through a clean cloth dampened with DI water. |
| | 2. Keep water-level meters used in open boreholes during drilling operations separate from the water-level meters used for routine groundwater-level measurements. These meters tend to get caked with mud and are extremely difficult to clean. |
| Field Team Member (continued) | 3. Do not use water-level meters used for collecting routine groundwater level measurements in water supply wells with turbine pumps, as the oil used to lubricate the pump will contaminate the water-level meter probe and tape. |
- [NOTE: The turbine pump oil is extremely difficult to remove from the water-level tape and probe.]

4.5 Establishing a Measuring Point (MP)

Field Team Member

1. Make the following assumptions when establishing a permanent MP:
 - For consistency, manual groundwater level measurements are routinely taken from the same MP.
 - The LSD of the well is determined by geodetic survey when the well is installed or is estimated by a project leader responsible for the initial groundwater-level measurement in the well.
 - Because the MP of a well may change over time, routinely check the height of the MP above or below the LSD and document the MP height on the Groundwater Level Measurement Form (Attachment 2).
 - MPs should not normally change; if a new MP must be established, indicate why the point was moved and the location of the new point on Attachment 1, Measuring Point Diagram.
 - The accuracy with which the MP measurement is established corresponds to the accuracy of the resulting groundwater elevation measurements. Where groundwater levels are measured to 0.01 ft, establish the MP to an accuracy of 0.01 ft.

2. Establish an MP at the completion of installation of a monitoring well, or when inventorying an existing monitoring well. The MP must be as permanent as possible, clearly defined, marked, and easily located. The MP is measured in reference to land-surface datum (LSD) and is the most convenient point from which to measure the groundwater level in a well. To establish a permanent MP, perform the following steps.

3. Designate a convenient point at the top of the outer-most casing or riser-casing as the MP.

4. Position the MP at an accessible point on the casing.

5. Clearly mark the MP. Do not allow engravings or filings to enter the well.

6. Measure the height of the MP in feet above or below the LSD (Attachment 1).

7. Record the height of the MP on the Groundwater Level Measurement form (Attachment 2) and in the field logbook.

Field Team Member (continued)

8. Record the date the MP was established, the height of the MP above or below the LSD, and a detailed description of the MP on the Measuring Point Diagram (Attachment 1) and in the field logbook.

9. Depending on the purpose of the groundwater level measurements, it may be desirable to obtain a geodetic survey for the LSD and the MP.

10. Establish at least one clearly marked reference point (RP) somewhere near the well. At most wells, the brass cap in the concrete pad will be used as the RP.

11. Make a detailed sketch of the MP and the RP on the Measuring-Point Diagram (Attachment 1) and if possible, take a photograph. Mark the MP and the RP on the photograph.

4.6 Measuring Groundwater Level with a Water-Level Meter

Field Team Member

1. Use an electric water-level meter to measure groundwater levels in the following:
 - Open boreholes
 - Cased monitoring wells
 - Piezometers.

2. Water-level meters may be used with less precision and accuracy in the following circumstances:
 - When water is dripping into the well or condensing on the inside casing walls.
 - In wells that are being pumped, particularly with large-discharge pumps.
 - When a series of measurements are needed in quick succession, such as during aquifer tests.

3. Measure the groundwater level in a deep well equipped with a transducer and no separate access tube for groundwater level measurement by removing the transducer from the well before measuring the water level. Reinstall the transducer in the well after obtaining the groundwater level measurement (see Precautions above).

4. Use a down-hole video camera in place of a water-level meter as necessary to measure the groundwater level in a borehole or well. Complete the Manual Groundwater Level Measurement Form (Attachment 2) noting the precision with which the winch mechanism used with the down-hole video camera is capable of measuring depth.

5. Make the following assumptions when preparing to use an electric water level meter for groundwater level measurements:
 - An established MP exists and the distance from the MP to LSD is known (see Attachments 1 and 2).
 - Tape stretch is negligible for groundwater level measurements.

Field Team Member (continued)

6. Measure groundwater level with a water-level meter by performing the following steps.
7. Unlock the protective steel well-head cover and remove the well cap. Record the well name, date, and time of day in Mountain Standard Time (MST) in the field notebook or on the Groundwater Level Measurement Form (Attachment 2).
8. Locate the MP of the well and document the MP and the LSD on the Groundwater-Level Measurement Form.
9. Measure the MP height from the LSD and record the height on the Groundwater-Level Measurement Form (Attachment 2) or reference well location file for MP height.

10. Record in the comments field of the Groundwater-Level Measurement Form if air is moving in or out of the well.

11. Clean the probe with DI water and dab dry before it is inserted into the well.

12. Turn on the water-level meter and check that the audible/visual signal operates.

13. Lower the water-level meter probe slowly into the well until the audible/visual signal indicates that the water surface is encountered.

[NOTE: For wells equipped with a pump assembly and a water-level access tube, insert the water-level meter probe into the small diameter access tube at the wellhead assembly.]

[NOTE: Pump assemblies should NOT be temporarily raised or lowered to perform water-level measurements. If the water level is below “top of pump,” record information accordingly. Do not force a water-level probe past pumps or other obstructions in a well. If a pump assembly needs to be removed from a well in order to measure the groundwater level, record the removal information on the Groundwater-Level Measurement Form.

14. Slowly raise and lower the probe in the well when the groundwater surface is contacted, noting at the MP the measured depth where the signal sounds. Repeat this step of the measurement until the depth results are reproduced at least three times. Reference Section 4.7, Assessing Data Accuracy and Limitations below.

- If the check measurement does not agree with the original measurement within the accuracy given in the data accuracy section, continue to make check measurements until the reason for the lack of agreement is determined or until the results are shown to be repeatable.
- Document unusual occurrences such as water cascading into the well, recent pumping of the well or pumping of a nearby well, etc. on the Groundwater Level Measurement form (Attachment 2).

[NOTE: When measuring the groundwater level of water supply wells, document when the well was last operated.]

Field Team Member (continued)

15. Record the measured depth to water (MDTW) at the MP in the “Measured Depth to Water” column of the Groundwater-Level Measurement form (Attachment 2).

[NOTE: Measurement should be recorded to 0.01 ft, or provide comment why the measurement was not obtainable to this precision.]

16. If appropriate with the equipment available and completion of the well, measure total depth (TD) of well by lowering the weighted water level probe (or video camera) to the bottom of the well. Record the TD of the well on the Groundwater-Level Measurement form (Attachment 2).

17. If the TD is not measured because of well construction or interference with the pump, indicate that the TD was not measured on the Groundwater Level Measurement form (Attachment 2) by writing NA.

18. Disable the water-level sensing signal before lowering the probe.

19. Measure TD by manually raising and lowering the probe and determining the depth where the weight of the probe is no longer sensed.

[NOTE: Be sure to add additional probe length from sensor to bottom of probe as this is not accounted for on the measuring tape.]

[NOTE: Measurement of TD is not appropriate for wells deeper than about 300 ft. Refer to the well construction diagram or well summary sheet for as-built well TD information.]

20. Turn off the water-level meter and carefully remove the water-level meter tape from the well by winding onto the meter reel when measurements are complete. Clean the water-level meter tape and probe using DI water and dabbing dry with a paper towel.

[NOTE: Use caution when retrieving the water level probe from the well. Retrieve the tape and probe in the center of the casing, do not allow the tape or probe rub on the side of the casing.]

21. Calculate groundwater elevation from measurement data and enter groundwater elevation on the Groundwater Level Measurement form (Attachment 2).

Groundwater Elevation = LSD + MP Height above LSD – MDTW from MP.

22. Refer to the well-construction diagram for the depth and elevation of the bottom of the screen interval (note that well construction diagrams are usually referenced to the LSD, not the MP) and perform the following:

- Check that the measured groundwater level is above or within the screen interval or the range of prior measurements.
- If the groundwater elevation is below the bottom the screen, note on the Groundwater Level Measurement form that water is present in the sump but not present in the well.

Field Team Member (continued)

23. Properly dispose of any contact waste generated during this procedure by following the requirements in the applicable waste characterization strategy form (WCSF) or waste profile form (WPF) for each well.

4.7 Assessing Data Accuracy and Limitations

- Field Team Member 1. Assess data accuracy by using the following criteria:
- Groundwater level measurements should be repeated at least three times to establish the repeatability, precision, and accuracy of the measurement. Repeat the measurement by raising the tape about 0.5 ft and lowering until the water-level meter senses contact with the water.
 - Repeated measurements of a groundwater level should generally be within 0.01% of the measurement.
 - Repeated measurements of groundwater level using the same electric water-level meter tape should agree within ± 0.02 ft for groundwater depths less than about 200 ft.
 - Repeated measurements of static water level using the same electric water level meter tape should agree within ± 0.05 ft for groundwater depths of 500 ft.
 - Repeated measurements of static water level using the same water level meter tape should agree within ± 0.1 ft for groundwater depths of 1,000 ft.

4.8 Recording Data

- Field Team Member 1. Maintain calibration and maintenance data associated with each water-level meter in the Water-Level Meter Calibration and Maintenance Form files. All groundwater measurement data are recorded in the Groundwater Level Measurement form to the appropriate accuracy for the depth being measured.

4.9 Records Management

- Field Team Member 1. Maintains and submits the following records and/or documents generated to the Records Processing Facility according to EP-DIR-SOP-4004, Records Transmittal and Retrieval Process:
- Measuring Point Diagram form
 - Groundwater-Level Measurement form
 - Water-Level Meter Calibration and Maintenance form.

5. DEFINITIONS

Electric water-level meter – A device designed for measuring depth to water in wells using a flat, graduated measurement tape attached to a weighted stainless-steel probe containing a water-sensitive electrode. The meter emits an audible and visible signal when contact is made with water. This is the most common and preferred device for manually measuring groundwater levels.

Land-surface datum (LSD) – The elevation in feet mean sea level (msl) of the ground surface at the well. Normally determined by survey methods but may be estimated from topographical maps in the absence of a geodetic survey.

Measuring point (MP) – Reference point on a well casing from where groundwater levels are measured. This point may be the top of casing or may be a location permanently marked on the well casing. Because the MP may change from time to time, the MP must be documented for each groundwater level measurement.

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Field Team Member (FTM) – LWSP or contractor personnel trained to this procedure and authorized to conduct the work prescribed in this procedure.

Reference point (RP) – An arbitrary datum established by permanent marks, and used to check the MP or to reestablish the MP should the MP be destroyed or changed. Usually the brass cap marker set in cement at the base of a well.

Piezometer – An observation well with a short screened interval used to measure groundwater level. Piezometers are usually narrow diameter wells that do not allow for the collection of groundwater samples and may have multiple well casings with screens nested at different depths within one well boring.

Potentiometric surface – The level at which water stands in a well for a specific saturated zone; also called piezometric surface.

6. PROCESS FLOW CHART

Not applicable.

7. ATTACHMENTS

- Attachment 1 Measuring-Point Diagram
- Attachment 2 Groundwater-Level Measurement Form
- Attachment 3 Water-Level Meter Calibration and Maintenance Form

8. REVISION HISTORY

Revision No. <i>(Enter current revision number, beginning with Rev.0)</i>	Effective Date <i>(DCC inserts effective date for revision)</i>	Description of Changes <i>(List specific changes made since the previous revision)</i>	Type of Change <i>(Technical [T] or Editorial [E])</i>
0	6/20/05	New document. Supersedes RRES-WQH-SOP-045.0	T
0	10/29/08	New procedure. Supersedes ENV-DO-202, R0.	T

[Using a CRYPTOCard, click here to record "self-study" training to this procedure.](#)

If you do not have a crypto card with A-level Access, contact creichel@lanl.gov for instructions on credit.

ATTACHMENT 1: MEASURING POINT DIAGRAM

SOP-5223-1

Measuring Point Diagram

Records Use Only



Well Name = _____

MP Description = _____

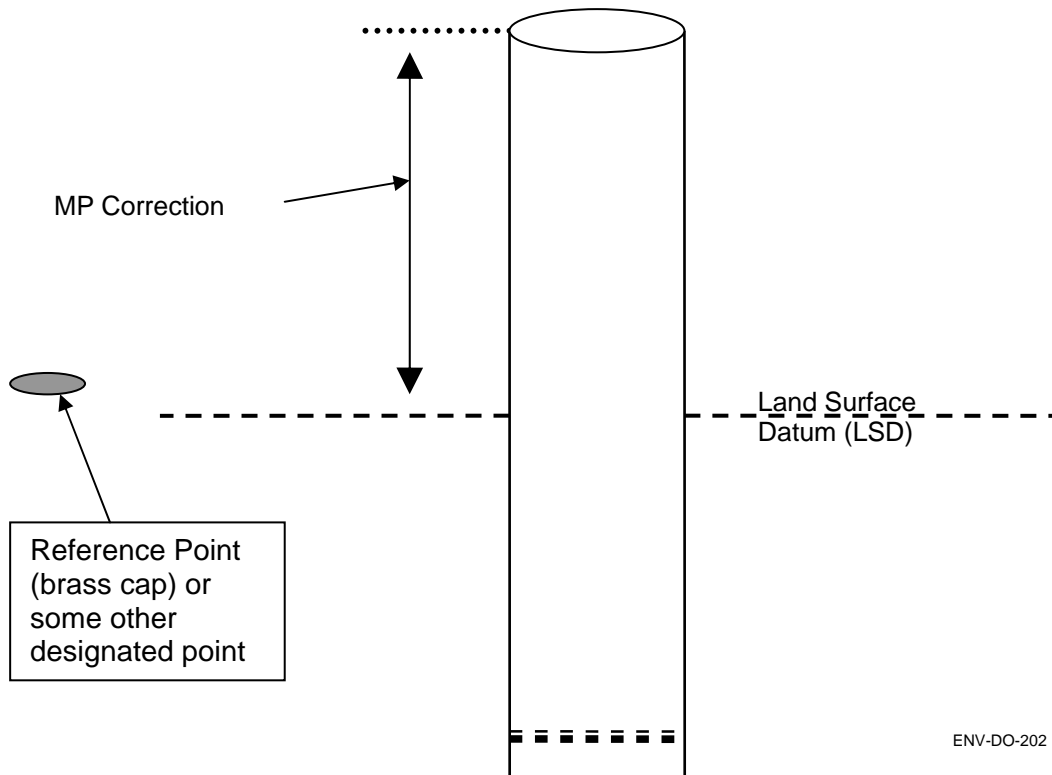
MP Height (ft) = _____
(note: (+) = above LSD, (-) = below LSD)

LSD (ft) = _____ LSD Description: _____

RP = _____

Example

Measuring Point (MP)



ATTACHMENT 2: GROUNDWATER LEVEL MEASUREMENT FORM	
SOP-5223-2 Groundwater Level Measurement Form	Records Use Only

Los Alamos National Laboratory Water Stewardship Program Groundwater Level Measurement Form											Sheet ___ of ___	
Technical Area: _____			Project Name: _____						Signature: _____			
Location/Field: _____			Personnel: _____									
Well Name	Date	Time (Mountain Standard Time)	A Land Surface Datum (LSD) (Ft MSL) ¹	Measuring Point (MP)			Water Level		Total Depth		Water Level Meter Serial Number	Comment ³
				B Document MP (LSD or TOC) ²	C MP above (+) or below (-) LSD (Ft)	D Measured Depth to Water (DTW) (Ft)	= C - B DTW from LSD (Ft)	= A + B - C Groundwater Elevation (Ft MSL)	= D - B Total Depth of Well from LSD (ft)			
Example												
Additional Comments:												

¹) Note the Land Surface Datum (LSD) of the well, usually the elevation of the brass cap or ground elevation
²) MP = Measuring Point; TOC = Top of Casing; State MP if other
³) Include any pertinent information about the water level measurement

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ATTACHMENT 3: WATER-LEVEL METER CALIBRATION AND MAINTENANCE FORM

SOP-5223-3

Records Use Only

Water-Level Meter Calibration and Maintenance Form



**Los Alamos National Laboratory
Water Stewardship Program**

Water Level Meter Calibration and Maintenance Form

		Water Level Meter					Calibration				Equipment Condition, Comments, Describe Maintenance
Date	Time	Inspector Name	Manufacturer	Serial Number	Total Length (ft)	Alarm Operates (Y/N)	DTW with NIST Tape (ft)	DTW with WLM (ft)	TD with NIST Tape (ft)	TD with WLM (ft)	

Example