NYE COUNTY NUCLEAR WASTE REPOSITORY PROJECT OFFICE

TECHNICAL PROCEDURE

TITLE: **Measurement of Groundwater Levels Using Electric Well Sounders**	Revision: **4** Date: **08-06-09** Page: **1 of 9**
TECHNICAL PROCEDURE NUMBER: **TP-9.9**	SUPERSEDES: **Revision 3, 09-04-03**
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1.0 PURPOSE

This technical procedure (TP) provides instructions for using electric well sounders to manually measure groundwater levels for the Nye County Nuclear Waste Repository Project Office (NWRPO). Implementation of this TP ensures that groundwater level measurements, herein referred to as water level measurements, shall be made following technically defensible methods and that the resulting data shall be traceable to the origination point in the field.

2.0 SCOPE

Wells in the NWRPO water level monitoring effort include Early Warning Drilling Program (EWDP) boreholes, as well as existing private, domestic, and agricultural wells in southern Nye County, Clark County, and Inyo County. Specific strategies and schedules for water level monitoring and data evaluation are presented in Work Plan (WP) 10, *Groundwater Level Monitoring and Evaluation.*

2.1 Applicability

This TP applies to NWRPO principal investigators (PIs) and designated staff and contractors making both routine and non-routine manual water level measurements. These individuals shall be referred to collectively as NWRPO field personnel.

2.2 Training

NWRPO field personnel shall be trained to this TP before conducting work, and shall document that they have read and understand this TP.

3.0 DEFINITIONS

3.1 Electric Well Sounder – water level measuring device that uses light, sound, or display to show that the probe on the end of a graduated measurement line (i.e., tape or wire) has entered the water. The water in the well completes an electric circuit that, in turn, activates the light/sound or, for some sounders, may move an indicator needle on a volt meter display.

3.2 Master Well Sounder – commercial-quality electric well sounder used exclusively for standardizing other sounders used in the field. When not being used for standardizations, the master well sounder is stored in a temperature controlled environment and is not used for routine water level measurements.

3.3 Measurement Point (MP) – clearly defined point from which the depth to water in a well is measured. In most cases, the MP is located at the wellhead on the top of the casing to facilitate the water level measurements. However, the MP may be on the pump plate, well seal, or another location, depending on the attachments installed on the well. The MP will change if the well casing is cut off or extended or other wellhead apparatus are modified. The MP elevation is determined by either survey methods or by measuring with a steel tape from a permanent fixed reference point located on or near the wellhead. When steel tape is used, the reference point elevation is determined by survey methods.

3.4 Non-Routine Water Level Measurements – measurements that differ from routine water-level measurements in that they are not generally repeated on a predetermined schedule. These measurements may be used to support field activities, such as groundwater sampling for water chemistry analysis, or the installation and removal of Westbay® packers and monitoring instrumentation. Data from these non-routine measurements are recorded in scientific notebooks.

3.5 Routine Water Level Measurements – measurements that are repeated on a predetermined schedule and used to determine both groundwater elevation and changes in elevation over time. These measurements may be used to support large-scale hydrogeologic characterization as well as smaller scale aquifer pump test and cross-hole tracer test characterization. Data from these routine measurements are recorded on the Water Level Measurement Field Form (Attachment A).

3.6 Standardization of Electric Well Sounders – comparison of depth-to-water measurements determined with field electric well sounders to similar measurements made with a master well sounder. A master well sounder measurement is assumed to be the "standard" or "true value." A field electric sounder will be considered standardized if it produces a water level that deviates in length from that produced by the master sounder by 0.1 ft or less for every 100 ft measured.

4.0 RESPONSIBILITIES

The PI reports to the Geoscience Manager (GSM) and is responsible for the preparation of this TP and for directing all water level measurement and documentation activities. The PI is also responsible for transmitting all data to the Quality Assurance Records Center (QARC).

NWRPO field personnel are responsible for performing all routine water level measurement activities as directed by the PI.

5.0 PROCESS

Procedures described in the following sections apply to manual water level measurements and documentation in both EWDP wells and private, domestic, and agricultural wells.

5.1 Preliminary Requirements

5.1.1 Master Electric Well Sounder Standardization

A master electric well sounder shall undergo standardization by NIST every five years, or more often if deemed necessary by the PI or GSM. A typical standardization for a 1,000 ft sounder shall be a seven point check at 25, 50, 100, 300, 500, 800, and 1,000 ft. A master electric well sounder shall be used only to standardize field sounders.

In accordance with QAP-12.1, *Control of Measuring and Test Equipment*, the master sounder shall have a valid measuring and test equipment (M&TE) standardization sticker affixed in a visible location. The sticker shall display the NWRPO ID number (CALIB###), the date the and by whom (NIST) the master sounder was standardized, and the next standardization date. In addition, "Master Sounder" shall be printed in indelible ink on the M&TE standardization sticker.

5.1.2 Field Sounder Standardization

Standardization involves comparing water level measurements made with the master sounder with those used for field measurements at least every 6 months. Additional standardizations shall be conducted if field sounder measurement tapes undergo greater than normal stress during use. For example, if a sounder becomes stuck in a well and is freed by excessive force, it shall be re-standardized using the master sounder before its next use or sent to the manufacturer for repairs if necessary.

Standardizations shall be conducted by making sequential water level measurements with both the master sounder and the field sounder in the same well. The measurements shall be made in a well deep enough to accommodate the maximum length of sounder measurement tape possible.

The field electric sounder shall be considered standardized if it produces a water level that deviates from the level measured with the master sounder by 0.10 ft or less for every 100 ft measured. When standardized, an M&TE standardization sticker shall be attached to the field sounder, displaying the NWRPO ID number, the standardization date, next standardization date, and initials of the person performing the standardization.

If the field sounder measurement deviates from the master sounder by more than 0.10 ft for every 100 ft measured, it shall be tagged “Do Not Use” per QAP-12.1 and removed from service or returned to the manufacturer for repair. All new or repaired sounders shall be standardized against the master sounder prior to use and have a new standardization sticker affixed.

Standardization data shall be entered into a spreadsheet and compared to the master sounder as soon as possible after data collection to determine whether field sounders can be considered standardized with respect to the master sounder. In no case shall a field sounder be used until standardization calculations have been performed and a new standardization sticker attached.

All sounder standardization data, including water level measurement deviations from the master sounder tape, shall be documented in the appropriate groundwater level scientific notebook and the M&TE database, in accordance with QAP-12.1. The spreadsheet used to determine sounder standardizations shall be submitted to the QARC.

5.1.3 Establishing the MP

An MP for determining depth to water shall be established near the top of the wellhead or on a well seal, pump plate, or similar aboveground device. If possible, the MP shall be located on the top of the well casing. The elevation of the MP shall be accurately established by surveying methods, or alternatively, by measuring with a steel tape from a surveyed permanent fixed reference point located on or near the wellhead.

In general, a licensed surveyor shall determine MP elevations for EWDP wells. These data shall be transmitted to the QARC by the PI. Temporary well location data may be obtained by NWRPO personnel using the NWRPO Trimble® GeoXH GPS, in accordance with TP-9.8, *Development of GPS Data using the Trimble® GeoXH GPS*. MP elevations shall be determined for private, domestic, and agricultural wells by NWRPO personnel using the Trimble® GeoXH GPS in accordance with TP-9.8. The PI or designee shall submit both raw and processed GPS data, along with required metadata, to the QARC.

MPs shall be clearly marked and easily identified by paint or by scribing with a file or other scribing tool. For private wells, the MP location shall be described in the applicable scientific notebook, along with a sketch of the wellhead and MP. For EWDP wells, this information shall be recorded on the Wellhead Protection Diagram template as a field as-built diagram. The diagram shall be approved, drafted electronically, then transmitted to the QARC as a PDF file and posted to the NWRPO website and Licensing Support Network, in accordance with QAP-17.1, *Records Management*. A written description of the MP shall also appear on the Water Level Measurement Field Form (Attachment A) for wells where these forms are used.

5.1.4 Additional Preliminary Data Required from Private Wells

Before water level data are collected from private wells, the following information shall be collected and recorded, as available, in the applicable scientific notebook:

- Date
- GPS filename
- Collector’s name
- Well owner
- Address
- Telephone number
- Depth to water
- Well depth
- Casing stickup
- Casing type
- Comments

Additionally, field personnel shall draw a vicinity map indicating the nearest cross streets, any geographic or cultural features, and a geographic north arrow.

5.2 Field Data Collection and Processing

NWRPO field personnel shall be responsible for following the procedures listed in the following sections to record and process water level measurements consistently and accurately.

5.2.1 Field Data Recording

NWRPO field personnel shall be responsible for recording water level measurements in the field. The data recording method shall differ depending on whether routine or non-routine water level measurements are made.

For routine water level measurements, data from each well shall be recorded on the Water Level Measurement Field Form (Attachment A) dedicated to that well. These forms shall be kept in a fireproof QA file cabinet (i.e., the holding file) prior to transmittal to the QARC as described in Section 5.3. For non-routine water level measurements, data shall be recorded in the scientific notebook used to document the field activity.

5.2.2 Field Measurement Methods

NWRPO field personnel shall follow the steps listed below to measure water levels using electric well sounders in both EWDP and private wells.

1. Before performing water level measurements, ensure that the sounder is standardized and check its operation as follows: check the battery, examine the measurement tape connection to the sounder probe to ensure that it is not damaged, and adjust the sensitivity level to the level predetermined as being optimal as indicated by the mark on the sensitivity scale. Do not set the sensitivity level too high, as it may cause the sounder to give a false positive signal if cascading water or condensation on the well casing occurs above the water table.
2. Lower the sounder probe and attached measurement tape into the well. While the tape is being lowered, it should be checked for breaks or scrapes that may short out on the inside of the casing. The tape should not be allowed to run over the sharp edge of the casing, nor be allowed to “freewheel” down the well to prevent “backlashing” on the reel or getting tangled on any equipment in the well. The tape should be pulled upward at frequent intervals as it is being lowered down the well to ensure that it is moving freely downward. The approximate depth to water should be known from prior water level recordings so that the probe is not lowered any deeper than necessary.
3. Lower the probe until it is submerged and the indicator light and/or sound or voltage meter display indicate submergence. Slowly pull the tape up until the indicator goes off. Shake the tape lightly to dislodge any water drops on the tape and probe. Slowly re-submerge the probe by lowering the tape until the indicator is on. Repeat this back-and-forth motion in smaller cycles until a consistent reading is attained from the tape graduation at the MP (i.e., within 0.02 ft).
4. Once a consistent reading is established, pull the sounder tape up approximately 2.5% of the depth to water (i.e., pull the tape up 10 ft if the depth to water is 200 ft) and repeat the water level measurement. Comparison of the two measurements provides an estimate of field measurement precision. The two measurements should not deviate by more than 0.02 ft. If the second number deviates by more than 0.02 ft, take additional measurements until two consecutive measurements deviate by 0.02 ft or less. Record the tape graduation at the MP as depth to water below MP in either the Water Level Measurement Field Form or the applicable scientific notebook, as described in Section 5.2.1. If more than two sets of measurements were required, record this information as a comment. Comments should also include notes regarding conditions or activities that might affect water levels (i.e., oil on water, nearby wells pumping, irrigation, or drilling activities).
5. For routine water level measurements, fill out the Water Level Measurement Field Form, including date, time, zone (if applicable), depth to water, sounder used, and

initials of the person measuring the water level. For non-routine measurements, record the same information, including the MP, in the applicable scientific notebook.

5.2.3 Preliminary Data Processing and Evaluation

A detailed plan for processing and evaluating routine water level monitoring data from EWDP and private wells, excluding data collected during aquifer pump and tracer tests, is presented in WP-10. An overview of this plan is presented below. Processing and evaluation of routine water level data from aquifer and tracer tests are described in applicable TPs and test plans (TPNs).

All raw field data shall be entered into a database. Personnel other than those who entered the data shall verify the data entry. The database calculates groundwater level elevations above mean sea level (amsl) and annual, seasonal, and cumulative changes in water levels, as described below.

Groundwater elevation, as feet amsl, shall be calculated by subtracting the depth to water from the MP elevation. The annual change shall be calculated by subtracting the depth to water from the measurement taken in the same month the previous year. The summer seasonal change, usually a decline in water level, shall be calculated by subtracting the maximum summer or fall depth measurement from the preceding minimum winter or spring measurement. The winter seasonal change, usually a rise, shall be calculated by subtracting the minimum winter or spring depth measurement from the maximum measurement for the preceding summer or fall. Cumulative changes shall be calculated by subtracting the current water level measurement from the first measurement taken at a given well, regardless of the season.

Hydrographs of raw or elevation data shall be plotted and examined for outlier data points. Outlier data may be censored if appropriate, and justification for censoring shall be provided in metadata, along with other data limitations.

5.3 Transmittal of Data to the QARC

At a minimum, routine water level monitoring data shall be transmitted biannually to the QARC for review, storage, and dissemination. These data shall include original data recorded on the Water Level Measurement Field Form, processed data (as described in the preceding section), and metadata.

For non-routine measurements, copies of pages from the scientific notebooks or the individual PI’s scientific notebook, if no notebook has been issued for that activity, shall be transmitted on a periodic basis but no less than biannually to the QARC.

6.0 DATA ACQUISITION METHODOLOGY AND LIMITATIONS

Uncertainty associated with the acquisition of water levels includes variability in sounder tapes, well construction characteristics, well depth, the nature of the water-bearing unit (i.e., confined versus unconfined), and the skill and judgment of the individual taking the measurements. Variations in sounder tapes shall be reduced to acceptable levels through standardization against the master sounder.

Uncertainties associated with well construction include composite heads in wells that tap multiple aquifers, measurements taken prior to well development or in undeveloped wells, and other factors. These uncertainties shall be reduced by evaluating the construction details for wells that appear to yield anomalous water level measurements. The uncertainty associated with skill and judgment factors shall be reduced by using only skilled personnel who have been trained in this TP and by assigning the same personnel, whenever possible, to perform the measurements.

7.0 REFERENCES

QAP-12.1, *Control of Measuring and Test Equipment*. Quality Administrative Procedure. Nye County Nuclear Waste Repository Project Office (NWRPO). Pahrump, Nevada.

QAP-17.1, *Records Management*.

TP-9.8, *Development of GPS Data using the Trimble® GeoXH GPS*. Technical Procedure. Nye County NWRPO. Pahrump, Nevada.

WP-10, *Groundwater Level Monitoring and Evaluation*. Work Plan. Nye County NWRPO. Pahrump, Nevada.

8.0 RECORDS

Standardization spreadsheets

Water Level Measurement Field Forms, for recording routine water level measurements

Scientific notebooks, for recording non-routine water level measurement data and preliminary information from private wells as listed in Sections 5.1.3 and 5.1.4

Electronic files containing water level measurement data and associated metadata

MP GPS data and associated metadata

9.0 ATTACHMENTS

A: Water Level Measurement Field Form

Attachment A
Water Level Measurement Field Form

Form TP-9.9-1 Rev 1
August 06, 2009

Water Level Measurement Field Form

Location:

Well ID:

Address:

Well Name:

Telephone:

Owner:

MP Elevation:

Latitude:

MP Stickup:

Longitude:

Ground Elevation:

MP Description:

Special Notes:

Date	Time	Zone	Depth to Water below MP (feet)	Sounder	Initials	Comments