NYE COUNTY NUCLEAR WASTE REPOSITORY PROJECT OFFICE

TECHNICAL PROCEDURE

TITLE:	REVISION: 3
Measurement of Groundwater Levels Using Electric Well Sounders	DATE: 09-04-03 Page: 1 of 9

TECHNICAL PROCEDURE NUMBER:	SUPERSEDES:
TP-9.9	**Pages 7 and 8**

CHANGE NOTICE NO. 1

EFFECTIVE DATE: February 28, 2006

PURPOSE: Change time frame for transmittal of data to the QARC by the PI or designee.

Page 7, Section 5.3: Change "biannually" to "annually".

Page 8, Section 5.3: Change "biannually" to "annually".

CONCURRENCE:

Dale Hamilton — On-Site Geotechnical Representative — 3/1/06 — Date

T S Ruego — Principal Investigator — 3/1/06 — Date

David Swanson — Quality Assurance Officer — 3-7-06 — Date

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TECHNICAL PROCEDURE NUMBER:	**SUPERSEDES:**
TP-9.9	Rev 2, 01-15-02
APPROVAL 9-15-03 Project Manager Date	**CONCURRENCE** 15 Sep '03 Principal Investigator Date 9/11/03 Project Quality Assurance Officer Date

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) Independent Scientific Investigations Program (ISIP). The 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 ISIP water level monitoring effort include Early Warning Drilling Program (EWDP) boreholes, as well as existing private domestic and agricultural wells in southern Nye County. Specific strategies and schedules for water level monitoring and data evaluation are presented in Work Plan (WP) 10, *Water 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 – A 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 – A commercial-quality electric well sounder used exclusively for standardizing other sounders used in the field. This standardization occurs at least every 6 months. Between standardizations, the master well sounder is stored in an air-conditioned environment and is not used for routine water level measurements.

3.3 Measurement Point (MP) – A 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, defined in Section 3.6, 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 generally recorded in scientific notebooks.

3.5 Principal Investigator – Reports to the On-Site Geotechnical Representative (OSGR) and is responsible for planning, coordinating, performing, and documenting NWRPO work requirements. The specific responsibilities of the PI are detailed in the NWRPO *Quality Assurance Program Plan*, Section 1.3.8.

3.6 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 in the vicinity of the NWRPO ISIP field investigations. 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 a standard field form (Attachment A).

3.7 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 successfully standardized if it produces a water level that deviates in length from that produced by the master sounder by less than 0.1 feet for every 100 feet measured.

4.0 RESPONSIBILITIES

The PI is responsible for the preparation of this TP and for directing all water level measurement and documentation activities. The PI reports to the OSGR.

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

The QA Officer is responsible for the coordination of the review, approval, and change of this TP.

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 Electric Well Sounder Standardization

A master electric well sounder shall be used only to standardize field sounders. Standardization involves comparing water level measurements made with the master sounder (i.e., measurements assumed to be the true water level or standard) 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.

In accordance with QAP-12.1, *Procedures for the 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, the number of the applicable TP (i.e., TP-9.9), and the date that the master sounder was placed into service. In addition, "master sounder" shall be printed in indelible ink on the M&TE standardization sticker.

Standardizations shall be made by making sequential water level measurements with both the master sounder and the field sounder in the same borehole. 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 successfully standardized if it produces a water level that deviates from the master sounder level by less than 0.1 feet for every 100 feet measured. When standardized, an M&TE standardization sticker shall be attached to the field sounder, displaying the NWRPO ID number, the standardization date, and the number of the applicable TP (i.e., TP-9.9).

If the field sounder measurement deviates from the master sounder by more than 0.1 feet for every 100 feet, it shall be retired or returned to the factory for repair and recalibration. All new or repaired sounders shall be standardized prior to use.

All sounder standardization data, including water level measurement deviations from the master sounder tape, shall be documented in the NWRPO QA groundwater level scientific notebook and the M&TE database in accordance with QAP 12.1, *Procedures for the Control and Measuring of Test Equipment*.

5.1.2 External Measurement Corroboration

During cooperative efforts with the USGS, such as groundwater sampling of EWDP wells for chemical analysis or testing at the Alluvial Testing Complex wells, a well may be sounded with both Nye County field and master sounders and a USGS calibrated sounder. If Nye County well sounder measurements are found to differ from USGS measurements made with calibrated sounders by more than 0.1 feet for every 100 feet, Nye County sounders shall be retired or returned to the factory for repair and recalibration. Nye County measurements that do not differ from USGS measurements provide a corroboration of the accuracy of Nye County sounders. All corroborative comparisons shall be documented in the NWRPO QA groundwater level scientific notebook and the M&TE database.

5.1.3 Establishing the Measuring Point

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. In most cases the MP shall be located on the top of the well casing. The elevation of the MP point 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.

A U.S. Department of Energy Yucca Mountain Project surveyor shall generally determine MP elevations for EWDP wells. These data shall be obtained from the Yucca Mountain Project and submitted to the QARC by the PI or designee.

MP elevations shall be determined for private domestic and agricultural wells by NWRPO personnel in accordance with the controls of the most current version of TP-9.8,

GPS Planning, Setup, Data Collection, And Post-Processing For The Trimble PRO/XRS. The PI or designee shall submit both raw and processed 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 some 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 and drafted electronically, then transferred to the QARC as a PDF file and posted on the Internet. 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 additional information shall be collected and recorded in the applicable scientific notebook:

- Date
- GPS filename
- Technician'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 Water Level Measurement Methods

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

5.2.1 Field Data Recording

NWRPO field personnel shall be responsible for recording water level measurements in the field and otherwise documenting the data collection process sufficiently for validation. 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 the custody of the PI or designee 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 in wells using electric well sounders in both EWDP and private wells.

1. Before performing water level measurements, check the operation of the equipment as follows: check the battery, examine the measurement tape connection to the sounder probe to ensure that it is not damaged, adjust the sensitivity level to low to moderate, and insert the sounder probe in water to ensure it is operational. Do not set the sensitivity level too high, as it may cause the sounder to give a false audio 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 estimated 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 feet). Visually interpolate between graduations to the nearest 0.01 feet.
4. Once a consistent reading is established, pull the sounder tape up a few feet and repeat the water level measurement. Comparison of the two measurements provides an estimate of field measurement precision. Generally the two measurements should not deviate by more than 0.02 feet. If the second number deviates by more than this factor, take additional measurements until two consecutive measurements deviate by 0.02 feet or less. Then 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 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, or drilling activities).

5. For routine water level measurements, fill out the Water Level Measurement Field Form, including date, time, depth to water, and initials of the recorder. For non-routine measurements, record the same information 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, *Water Level Monitoring and Evaluation.* An overview of this plan is presented below. Processing and evaluating routine water level data from aquifer pump and tracer tests are described in applicable TPs and test plans.

All raw field data shall be entered into spreadsheets and/or a database. Personnel other than those who entered the data shall verify the data entry. The spreadsheets/database calculate water level elevations above mean sea level and annual, seasonal, and cumulative changes in water levels.

Water elevation shall be calculated by subtracting the depth to water from the ground elevation plus the measuring point stickup. 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. This calculation may be refined in the future at the discretion of the PI on the basis of monthly water level measurements indicating the specific months consistently associated with seasonal highs and lows. 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 shall be censored, 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 annually to the QARC for review, storage, and dissemination. These data shall include raw original data recorded on the Water Level Measurement Field Form (Attachment A), processed data, as described in the preceding section, and metadata. The PI or designee is responsible for ensuring the protection of the data sets prior to their transmittal to the QARC by maintaining both the original and a copy of the Water Level Measurement Field Form, spreadsheets and/or database reports, and scientific notebook, if applicable, for each well.

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 submitted on a periodic basis but no less than annually to the QARC. The scientific notebook shall be submitted to the QARC when full or at the end of the contract or project, at the discretion of the Project Manager.

5.4 Data Uncertainty

Uncertainty attached to the acquisition of water levels includes the variability in sounder tapes, well construction characteristics, 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 the use of 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. However, for private wells, the only data concerning well construction is the Well Drillers Report on file with the Nevada Division of Water Resources and may, in some cases, be inaccurate or not provide detailed well construction information. 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.

6.0 REFERENCES

NWRPO Quality Administrative Procedure: QAP-12.1, *Procedures for Control of Measuring and Test Equipment*.

NWRPO Technical Procedure: TP-9.8, *GPS Planning, Setup, Data Collection, And Post-Processing For The Trimble PRO/XRS*.

NWRPO Work Plan: WP-10, *Groundwater Level Monitoring and Evaluation*.

7.0 RECORDS

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 of water level measurement data and associated metadata.

MP GPS survey data and associated metadata.

8.0 ATTACHMENTS

Water Level Measurement Field Form.

Attachment A
Water Level Measurement Field Form

Water Level Measurement Field Form	
Well ID:	Address:
Well Name:	Telephone:
Owner:	Measuring Point (MP):
Latitude:	MP Stickup:
Longitude:	Ground Elevation:
MP Description:	
Special Notes:	

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