NYE COUNTY WATER DISTRICT

WORK PLAN

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CONCURRENCE

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Principal Investigator — Date

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Quality Assurance Officer — Date

TABLE OF CONTENTS

FIGURES

1.0 INTRODUCTION

This work plan (WP) describes strategies, methods, and schedules for groundwater level monitoring, referred to herein as water level monitoring, conducted by the Nye County Water District (NCWD). Water level monitoring is currently conducted in privately owned (domestic, agricultural, and commercial) wells in the Amargosa Desert, Pahrump Valley, and Stewart Valley, and in monitoring wells installed by Nye County as part of the Early Warning Drilling Program (EWDP) and Groundwater Evaluation (GWE) Program.

2.0 PURPOSE

The purpose of this plan is to provide technically defensible strategies, methods, and schedules for the collection, storage, dissemination, and preliminary analysis of water level and related data from wells monitored by the NCWD. This plan will help ensure that data collection and analysis are conducted in accordance with the NCWD Quality Assurance (QA) Program, and will support other related NCWD tasks and objectives.

The data collection and analysis performed according to this work plan will potentially be used to support a number of tasks, including the following:

- Regional groundwater level monitoring
- Groundwater chemistry monitoring
- Aquifer testing
- Construction and revision of conceptual groundwater flow models
- Groundwater planning, management, and development

QA plans and procedures applicable to the activities discussed herein, such as work plans, quality administrative procedures (QAPs), technical procedures (TPs), or test plans (TPNs), will be referenced where appropriate; the most current version of these QA documents will be used.

3.0 BACKGROUND

3.1 Justification

The NCWD was formed in 2007 by the Nevada Legislature as a single governmental entity responsible for developing sustainable sources of water to ensure the well-being of the residents of Nye County, the economic development of Nye County, and the protection of the environment in Nye County (Nevada Revised Statute 542). The mission of the NCWD is to “Provide, protect and preserve water resources in Nye County.”

Most water supplies in Nye County are derived from groundwater wells or groundwater discharging to the surface at springs. These water supplies must be protected to ensure that all public water supplies are in compliance with the requirements of the Safe Drinking Water Act.

This work plan describes the approach the NCWD will take for monitoring water levels to:

1. Provide baseline water level data;

2. Analyze trends or changes in the data (at both the local and regional levels); and

3. Identify the causes of those trends or changes.

There are two types of monitoring described in this WP: 1) baseline data collection and 2) long-term monitoring. Baseline data are collected on a continuous or monthly basis in newly drilled wells, and allow characterization of seasonal and barometric effects on water levels in a particular well. Long-term monitoring is conducted less frequently but allows analysis of trends and changes in water levels over long time periods (years or decades) at the local and regional scale. The methods for each of these monitoring types are described in more detail in later sections of this WP.

3.2 Overview of the Current Water Level Monitoring Program

The existing water level measurement program (WLMP) was started by the Nye County Nuclear Waste Repository Project Office (NWRPO) in 1999 as part of its scientific characterization efforts associated with the Yucca Mountain Project, primarily focused on wells drilled by NWRPO as part of its EWDP. The program was eventually expanded to include private wells in Pahrump, Amargosa, and Stewart Valleys, as well as wells drilled as part of Nye County's GWE program. The WLMP was adopted by the NCWD in 2014. Long-term water level monitoring is currently being conducted on a bimonthly basis in 175 wells in southern Nye County. Wells that are currently part of the WLMP are shown in Figure 1.

Private wells are generally single-screen completions that may or may not have pumps in them. This well category includes domestic wells, former agricultural wells, several US Geological Survey (USGS) Amargosa Integrated Monitoring Network (AIMN) wells located on and off the Nevada National Security Site, and others. Monitoring wells installed as part of the EWDP consist of both single-screen completions and multiple-screen completions. Some of these multiple-screen completions are open to the atmosphere and constructed to isolate discrete intervals in subsurface formations. In addition, seven of the multiple-screen EWDP wells contain Westbay® packer isolation systems, which isolate discreet screened intervals, allow semi-continuous electronic pressure and temperature monitoring, and allow the opening and closing of individual zones for water level monitoring, aquifer testing, etc. Pressure and temperature data from Westbay® wells are used to calculate water levels, which can then be used calculate vertical gradients at a single well or well site, and horizontal gradients between wells. The latter are in turn required to determine the direction and rate of groundwater flow.

Water level measurements are taken during borehole drilling and well construction; however, baseline water level monitoring does not begin until after well construction and development activities have been completed. Water levels in newly drilled wells are initially monitored on a relatively frequent basis (i.e., monthly) for one year or more to provide insight into short-term water level responses related to variations in atmospheric barometric pressure and earth tides, and longer-term responses, if any, related to seasonal climatic changes and/or groundwater pumping. In Westbay® wells, semi-continuous electronic pressure and temperature measurements are made during the first year after the wells are installed. Baseline water level monitoring has been completed in all EWDP (both standard and Westbay® completions) and GWE wells.

3.3 Overview of Potential Level Monitoring Program Expansion

The NCWD is considering expanding the WLMP to the central and northern Nye County. The purpose for this data collection is to establish knowledge of baseline water level conditions against which future changes (e.g., effects of development) can be evaluated.

Hundreds of wells in central and northern Nye County have been monitored in the past by other agencies. Future evaluation of these wells will result in small subset being selected for adoption into the expanded WLMP. Selection criteria for each well will be based on accessibility, availability of historical data, aquifer in which the well is screened, condition of the well, and other considerations.

Figure 2 shows locations of wells in basins of interest in central and northern Nye County where water level data have been collected in the past two years by the USGS, the Nevada Division of Water Resources (NDWR), and the Central Nevada Regional Water Authority (CNRWA). NCWD staff will coordinate with those agencies to ensure wells added to the expanded program will supplement their current data collection efforts and contribute to the regional data set.

4.0 SCOPE OF WORK

This section describes an integrated plan for both baseline and long-term monitoring. The following major tasks are addressed:

- Baseline monitoring;
- Long-term monitoring;
- Data processing, analysis, and presentation;
- Quality Assurance documentation requirements;
- Developing Positional Data Using Global Navigation Satellite System (GNSS) Receivers;
- Responsibilities; and
- Equipment calibration requirements.

4.1 Baseline Monitoring

During well drilling, construction, and development, water levels are measured to assist in the design of the well, to verify that seals are in place, and to measure the degree of development of the well. However, because of the effects of these activities on the water level in a given well or borehole, these initial measurements are recorded not in the baseline data collection program but in the scientific notebook for that well.

Baseline data collection will be conducted in each new well as appropriate in accordance with TP-9.2, *Procedures for Operating Westbay® Mosdax® Groundwater Monitoring Equipment in Nye County Wells* and/or NCWD TP-9.9, *Measurement of Groundwater Levels Using Electric Well Sounders* and will continue for a period of time determined by the Principle Investigator (PI). This time period will generally be a minimum of 12 months, if funding and manpower are not binding constraints. Baseline data-collection frequency and methods will vary depending upon the well type, as described in the following.

4.1.1 Baseline Monitoring in Westbay® Wells

The baseline monitoring program in existing Nye County Westbay® wells is currently complete. No additional Westbay® instrumented wells are anticipated. The major steps in this program included the following:

1. Conducted semi-continuous electronic monitoring and recorded temperature and pressure in each isolated well screen for at least 12 months, or as determined by the PI.
2. Converted pressure and temperature data to values of depth to water below a referenced datum.
3. Made at least two manual water level measurements, separated by a period of approximately 6 months in each isolated well screen. These measurements were used to verify the accuracy of the semi-continuous water level data calculated from electronically measured pressure and temperature data.
4. Plotted hydrographs (i.e., graphs of depth to water or elevation of water versus time) of both electronically and manually measured data.
5. Evaluated hydrographs and Westbay® pressure/temperature sensor calibration data to determine the accuracy of the semi-continuous electronic measurements. Documented acceptable levels of accuracy in the metadata.
6. If electronic data did not exhibit an acceptable level of accuracy, censored the data and/or made necessary changes to increase accuracy to acceptable levels, and continued monitoring until acceptable data were collected over a period of at least 6 months. If it was determined that acceptable levels of accuracy could not be achieved, baseline electronic monitoring was terminated and the justification for this termination documented in the metadata.
7. Evaluated hydrographs to determine the presence of significant trends other than very short-term barometric or earth tide trends. Statistical methods were used to filter out barometric and tidal fluctuations. In some instances, seismic effects were present and an evaluation of seismic events was necessary in the trend assessments.
8. If only very short-term barometric or earth tide trends were observed, terminated baseline monitoring and began long-term monitoring, following the steps listed in Section 4.2.
9. If other significant trends were noted, continued baseline monitoring until such trends were adequately characterized and described the criteria for that characterization in the metadata.
10. When the characterization described above was complete, terminated baseline monitoring and began long-term monitoring.

4.1.2 Baseline Monitoring in EWDP and GWE Wells

The current status of the ongoing baseline monitoring program in EWDP and GWE wells not containing Westbay® systems (i.e., piezometers and conventional monitoring wells) is complete. The major steps of baseline characterization for these well types included:

1. Made monthly manual water level measurements, using a well sounder in each isolated well screen, for at least 12 months or as determined by the PI.
2. Plotted hydrographs of manually measured water level data.
3. Evaluated hydrographs to determine the accuracy of water level data. Censored outliers that were judged to be in error and plotted new hydrographs, if necessary. Documented the justification for censoring data in the metadata.

4. If only very minor variations were observed (e.g., due to short-term barometric or earth tide fluctuations), terminated baseline monitoring and began long-term monitoring, following the steps listed in Section 4.2.
5. If other significant trends were noted, continued baseline monitoring until such trends were adequately characterized and described the criteria for that characterization in the metadata.
6. When the characterization described above was completed, baseline monitoring was transitioned to long-term monitoring.

4.1.3 Baseline Monitoring in Private Wells

Because the private wells added to the WLMP are not new wells, and due to manpower constraints, there is currently no formal baseline program implemented for them. Baseline conditions can be estimated on the basis of long-term USGS water level measurements from wells in the Pahrump Valley and Amargosa Desert, if data from nearby wells is available. This information can be found at the National Water Information System (NWIS) web site (http://waterdata.usgs.gov/nwis).

4.2 Long-Term Monitoring Program

Water level measurements may be less frequent when baseline monitoring and regional water level evaluations have been completed. The PI or designee will determine measurement frequency and methods for each well and will document the rationale in the metadata. In general, long-term water levels will be measured in private, EWDP, and GWE wells on a bimonthly basis, using manual well sounder methods described in NCWD TP-9.9. The major steps in this program include the following:

1. Make water level measurements at accessible private, EWDP, and GWE wells in the communities of Amargosa Valley, Crystal, Pahrump, Stewart Valley, and other selected locations in and near Nye County.
2. Compare the monitoring results with those of other water level monitoring programs conducted by the NDWR, USGS, Department of Energy (DOE), and other entities.
3. Enter water level data into electronic media and calculate groundwater elevations. Plot hydrographs and potentiometric, depth-to-water, and difference maps showing seasonal, annual, and cumulative changes in water levels.
4. Identify, quantify, and evaluate observed spatial and temporal variations in water levels, including long-term trends, seasonal fluctuations, and responses to seismic events.
5. Evaluate qualified water level data, hydrographs, and maps to determine the adequacy of the monitoring network. Incorporate additional wells into the network to fill data gaps or reduce monitoring in areas of high well densities.
6. Continue monitoring and evaluations as appropriate and as funding permits.

4.3 Data Processing, Analysis, and Presentation

All raw data will be entered and processed electronically (e.g., in spreadsheets or a database). Data processing of manually measured water levels will be limited to converting depth of water below measuring point to depth below the ground surface (bgs), and in turn converting depth bgs to elevation above mean sea level (amsl). Location and height of the measuring point will be

determined in accordance with NCWD TP-9.8, *Development of Positional Data using a Resource-Grade Global Navigation Satellite System (GNSS) Unit*. Data processing of semi-continuous Westbay® system pressure and temperature monitoring data will primarily involve converting these data to depth of water bgs and/or elevation amsl.

Water level data analysis for private, EWDP, and GWE wells will primarily be accomplished through careful evaluation of hydrographs for individual well screens. Hydrographs will be examined for outlier data points that are likely in error, short-term fluctuations in data due to earth tides and atmospheric barometric pressure changes, responses to seismic events, and longer trends reflecting changes in groundwater recharge and discharge rates. Standard statistical methods may be used to filter the tidal and barometric effects and to determine whether apparent trends in the water levels are statistically significant. Hydrographs will be compared to determine whether consistent trends are evident, trends show a preferred spatial distribution, or temporal trends can be linked to any known factors, such as seasonal pumping or seismic activity.

Hydrographs will be plotted electronically (e.g., from spreadsheets or a database). Trends identified in these hydrographs will be described in an annual water level summary report. In addition, major modifications to the baseline and long-term monitoring programs will be described in this annual report.

For regional water level evaluations, selected semi-continuous and manual measurement data will be incorporated into data sets from the private, EWDP, and GWE wells. Metadata will be used to justify the selection of well data included. Typically, data with a common monitoring period will be selected for this regional analysis. For example, if water levels in private wells in northern Amargosa Desert are taken on a particular date, the EWDP data for that date will be selected. These data will be augmented as appropriate by data from USGS and DOE monitoring programs for the same period of time. Regional analyses may consist of mapping static water table elevation for a given point in time, mapping changes in water table elevation over a period of time, or other analyses.

4.4 Developing Positional Data Using GNSS Receivers

Determining the horizontal and vertical position of the measuring point is important for ensuring accurate well location and water table elevation. Positional data will be acquired, post-processed, and documented using a resource-grade GNSS receiver, in accordance with NCWD TP-9.8. All positional data will be submitted to and archived at the Quality Assurance Records Center (QARC).

4.5 Quality Assurance Documentation Requirements

Copies of all data recorded will be submitted to the QARC annually following data collection. For water level measurements taken during drilling, data will be entered into the appropriate scientific notebooks and submitted to the QARC. All water level data will be stored in a holding file until data analysis has been completed and the metadata have been prepared. Upon completion of data analysis and graphing, the graphs and associated metadata will be included with the recorded data in a single data package. After QA verification checks have been completed, these data will subsequently be submitted to the QARC and provided to the public on the NCWD website.

4.6 Responsibilities

The NCWD Technical Manager will designate a PI to direct the water level monitoring program, including monitoring temperature and pressure in Westbay® wells, manual water level monitoring in other EWDP wells, and regional water level monitoring. The PI will be responsible for and/or supervise the evaluation of hydrographs, data censoring, and metadata. Finally, the PI will be responsible for integrating, analyzing, interpreting, and reporting data in technical meetings, NCWD technical reports, and peer-reviewed publications and will be responsible for the collection of field data from EWDP wells and the electronic recording of these data. NCWD technical staff and contractors will conduct monitoring activities in accordance with applicable QA plans and procedures.

4.7 Equipment Calibration Requirements

Westbay® system pressure/temperature probes and data loggers will be factory calibrated in accordance with NCWD QAP-12.1, *Control of Measuring and Test Equipment.* Factory calibrations will be verified in the office or in wells as described in TP-9.2. Well sounders used in manual water level measurements will be standardized against a master well sounder at least every 6 months, as described in NCWD TP-9.9. In summary, all measurement equipment will be operational and in compliance with all calibration and standardization requirements specified in QA procedures.

5.0 MANAGEMENT

The Quality Assurance Officer is responsible for the coordination of the internal review of this Work Plan and verifying compliance with the requirements of this plan. The PI is responsible for the preparation and modification of this Work Plan, ensuring the appropriate training of NCWD personnel, and oversight of the performance of the plan. To ensure that the work involved will be quality-controlled and accomplished in accordance with the scope and objectives of the NCWD, the following training and documentation will be accomplished prior to conducting the water level monitoring activities described in this work plan. All individuals performing the activities herein will be trained in the applicable QA procedures listed below, as necessary, and will document that they have read and understand the procedures before conducting work.

- NCWD QAP-12.1, *Procedures for Control of Measuring and Test Equipment.*
- TP-9.2, *Procedures for Operating Westbay® Mosdax® Groundwater Monitoring Equipment in Nye County Wells.*
- NCWD TP-9.8, *Development of Positional Data using a Resource-Grade Global Navigation Satellite System (GNSS) Unit*
- NCWD TP-9.9, *Measurement of Groundwater Levels Using Electric Well Sounders.*

6.0 REFERENCES

Nevada Revised Statute 542, *Nye County Water District Act*. http://www.leg.state.nv.us/SpecialActs/59-NyeCountyWater.html.

NCWD QAP-12.1, *Control of Measuring and Test Equipment*. Pahrump, Nevada: Nye County Water District.

NCWD TP-9.8, *Development of Positional Data using a Resource-Grade Global Navigation Satellite System (GNSS) Unit.* Pahrump, Nevada: Nye County Water District.

NCWD TP-9.9, *Measurement of Groundwater Levels Using Electric Well Sounders.* Pahrump, Nevada: Nye County Water District.

TP-9.2, *Procedures for Operating Westbay® Mosdax® Groundwater Monitoring Equipment in Nye County Wells.* Pahrump, Nevada: Nuclear Waste Repository Project Office.

US Department of Energy (DOE). 2001. *Total System Performance Assessment - Analyses for Disposal of Commercial and DOE Waste Inventories at Yucca Mountain - Input to Final Environmental Impact Statement and Site Suitability Evaluation*, REV 00, ICN 02, December 2001, Las Vegas, Nevada.

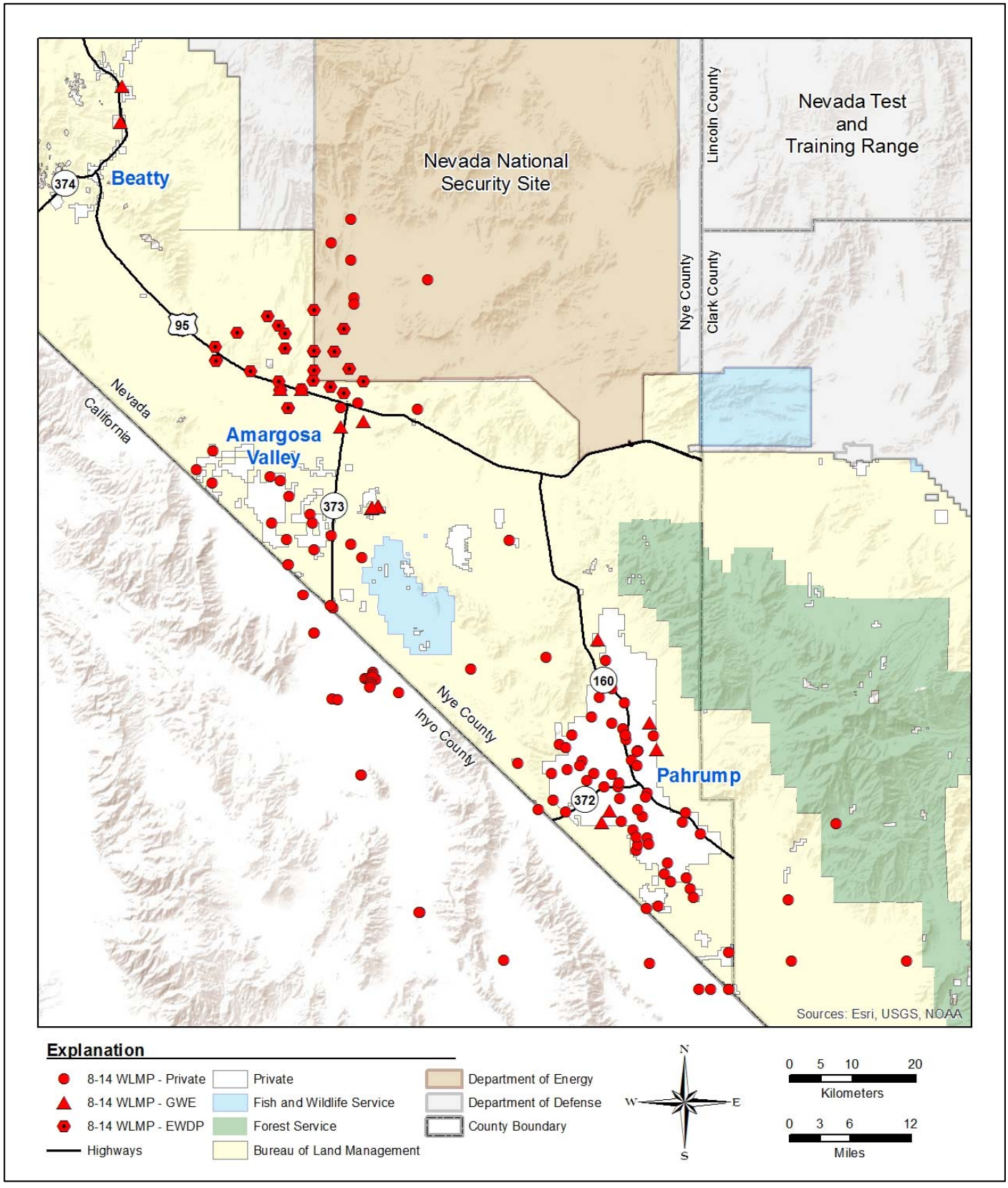

Figure 1. Current WLMP wells.

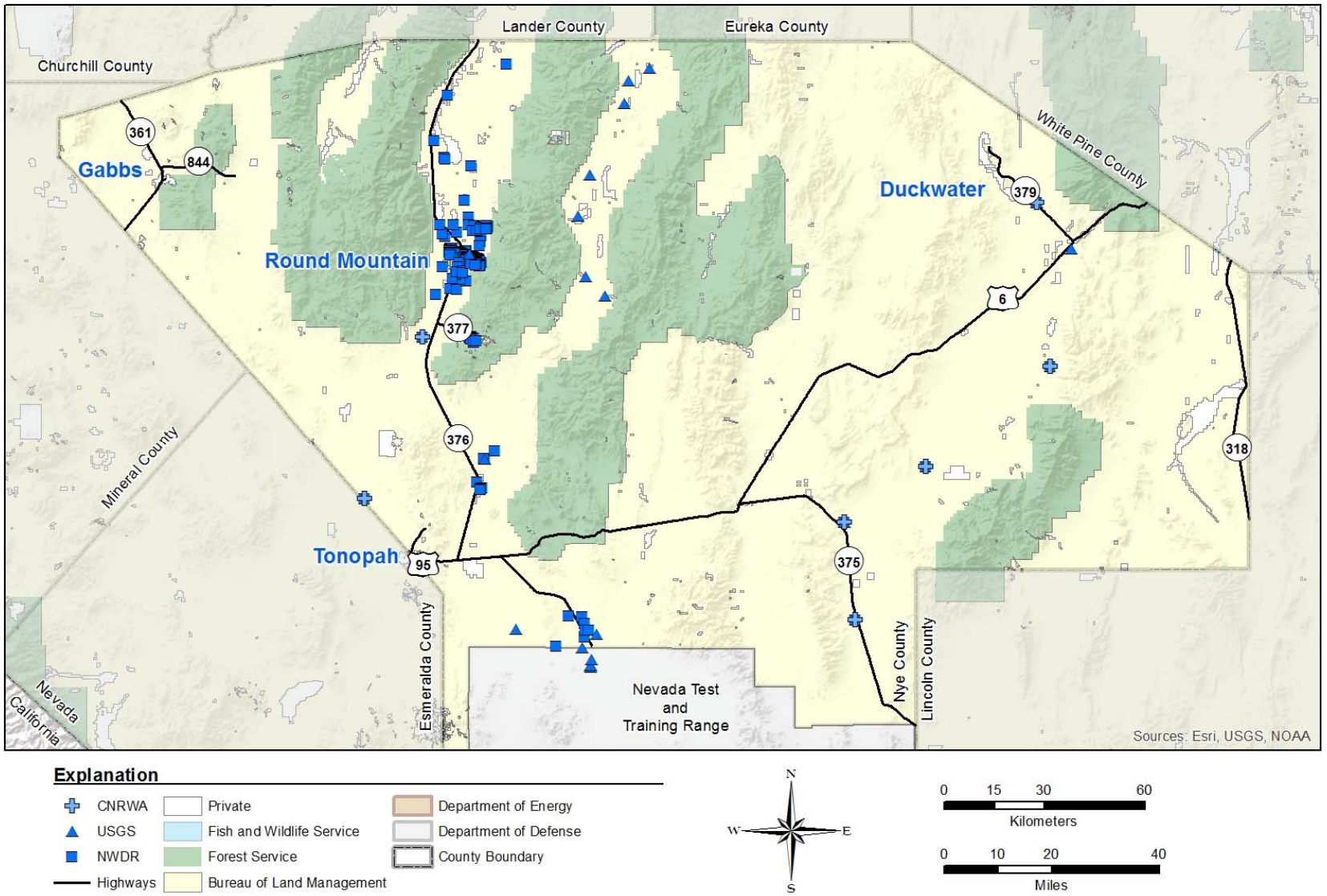

Figure 2. Wells in central and northern Nye County where water level data have been collected by USGS, NDWR, and CNRWA in the past two years.