

2014 Groundwater Monitoring Report Central Nevada Test Area Subsurface Corrective Action Unit 443

April 2015

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Abbreviations

bgs	below ground surface
BSZ	bottom of open interval/screen zone
¹⁴ C	carbon-14
CADD	Corrective Action Decision Document
CAP	Corrective Action Plan
CAU	Corrective Action Unit
CNTA	Central Nevada Test Area
DOE	U.S. Department of Energy
ft	feet
ft msl	feet above mean sea level
¹²⁹ I	iodine-129
LM	DOE Office of Legacy Management
LPZ	lower piezometer
µmho/cm	micromhos per centimeter
MV	monitoring/validation
NDEP	Nevada Division of Environmental Protection
pCi/L	picocuries per liter
PZ	piezometer
RDL	required detection limit
ROTC	record of technical change
SGZ	surface ground zero
TOC	top of casing
TSZ	top of open interval/screen zone
UPZ	upper piezometer

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Executive Summary

The Central Nevada Test Area was the site of a 0.2- to 1-megaton underground nuclear test in 1968. The surface of the site has been closed, but the subsurface is still in the corrective action process. The corrective action alternative selected for the site was monitoring with institutional controls. Annual sampling and hydraulic head monitoring of the well network are conducted as part of the subsurface corrective action strategy for the site. The monitoring well network consists of 12 locations (wells and piezometers) in the alluvium, seven locations (wells and piezometers) in the volcanic section, and one well in the collapse chimney that resulted from the underground nuclear test. The site is currently in the conceptual model evaluation phase of the corrective action strategy.

Detection monitoring results indicate that radioisotope levels in groundwater continue to remain below the required detection limits in all sampled wells in the monitoring network. Water level data from wells MV-4 and MV-5 indicate that head levels have recently recovered from the 2010 aquifer testing and the 2011 yearly sampling event during which several thousand gallons of water were purged. Low-flow bladder pumps were installed in wells MV-4 and MV-5 during the November 2013 sampling event to reduce the well purge volumes and the impact purging has on the water levels during sampling. The bladder pumps allow the collection of samples using the low-flow sampling method and allow head levels to remain at steady-state conditions. Hydraulic head data collected from the site continue to support the conceptual model. This is evident in that groundwater levels in UC-1-P-2SR continue to recover from the dewatering effects of the detonation and that horizontal groundwater flow in the upper alluvial aquifer near surface ground zero is toward the detonation chimney. Head data from well UC-1-P-2SR also suggest a downward gradient that continues to increase as the water levels in this well recover. Head data from wells MV-4 and MV-5 completed in the lower part of the alluvial aquifer outside the graben confirm that the southeast-bounding graben fault acts as a barrier to groundwater flow.

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1.0 Introduction

This report presents the 2014 groundwater monitoring results collected by the U.S. Department of Energy (DOE) Office of Legacy Management (LM) for the Central Nevada Test Area (CNTA) Subsurface Corrective Action Unit (CAU) 443. Responsibility for the environmental site restoration of CNTA was transferred from the DOE Office of Environmental Management to LM on October 1, 2006. The environmental restoration process and corrective action strategy for CAU 443 are conducted in accordance with the Federal Facility Agreement and Consent Order (1996, as amended) and all applicable Nevada Division of Environmental Protection (NDEP) policies and regulations. The site is currently in the conceptual model evaluation phase of the corrective action strategy. This report summarizes investigation activities associated with CAU 443 that LM conducted at the site from November 2013 through December 2014.

2.0 Site Location and Background

CNTA is north of U.S. Highway 6, approximately 30 miles north of Warm Springs in Nye County, Nevada (Figure 1). The U.S. Atomic Energy Commission (predecessor to DOE) acquired CNTA in the early 1960s to develop sites for underground nuclear testing that could serve as alternatives to the Nevada National Security Site (formerly known as the Nevada Test Site). Three emplacement boreholes—UC-1, UC-3, and UC-4—were drilled at CNTA for underground nuclear weapons testing. The initial underground nuclear test, Faultless, was conducted in borehole UC-1 at a depth of 3,199 feet (ft) (975 meters) below ground surface (bgs) on January 19, 1968. The yield of the Faultless test was estimated to be 0.2 to 1 megaton. The test resulted in a down-dropped fault block that extends to land surface (Figure 2). No further nuclear testing was conducted at CNTA, and the site was decommissioned as a testing facility in 1973.

2.1 Summary of Corrective Action Activities

Surface and subsurface contamination resulted from the underground nuclear test at CNTA. Contamination at the surface was identified as CAU 417. Surface restoration was completed in 1999, and the remediation activities are described in the *Closure Report for Corrective Action Unit 417: Central Nevada Test Area Surface, Nevada* (DOE 2001). Contamination in the subsurface is identified as CAU 443. The corrective action process for the subsurface CAU 443 has not yet been completed. Site restoration activities associated with CAU 443 are summarized in the remainder of this section.

A Corrective Action Investigation Plan was developed and approved for CAU 443 in 1999 (DOE 1999). The objectives outlined in that document are as follows:

- Determine the characteristics of the groundwater flow system, sources of contamination, and transport processes, to acceptable levels of uncertainty.
- Develop a credible numerical model of groundwater flow and contaminant transport for the UC-1 Subsurface Corrective Action Site and downgradient areas.
- Develop stochastic predictions of the contaminant boundary at an acceptable level of uncertainty.

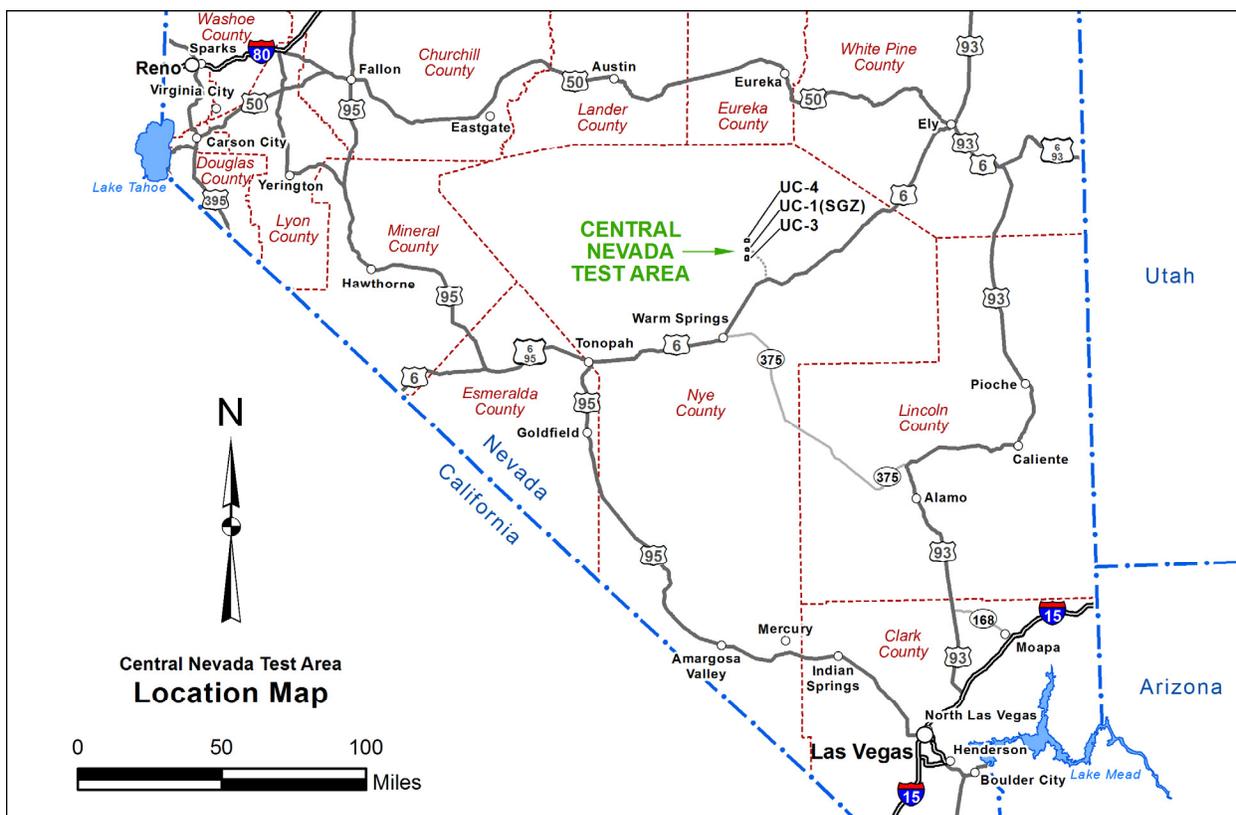
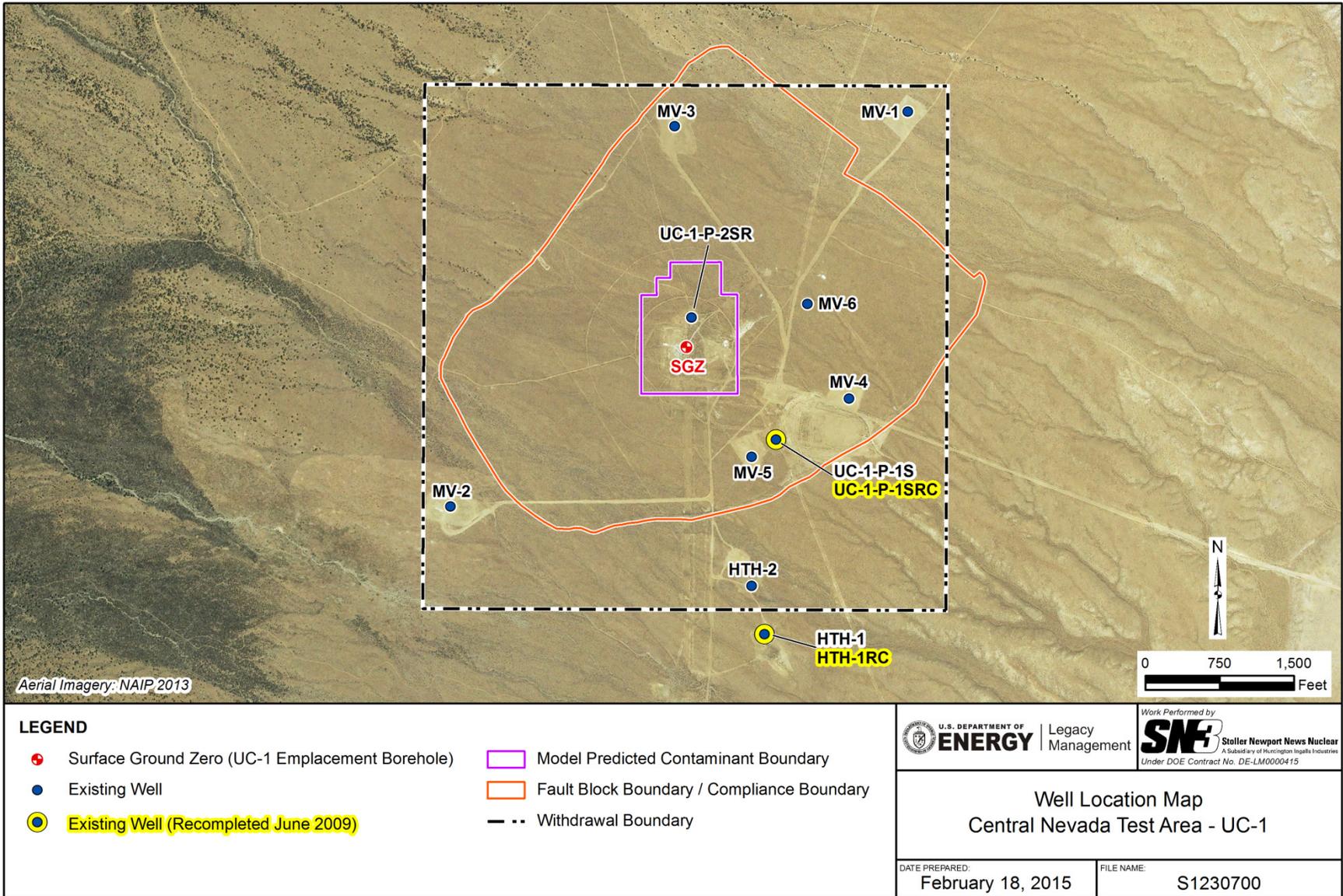


Figure 1. CNTA Location Map

These objectives were accomplished by conducting a corrective action investigation. As part of the investigation, site data were used to develop a numerical flow and transport model, which was then used to calculate a site contaminant boundary (Pohlmann et al. 1999, Pohl et al. 2003).

Results of the corrective action investigation and the corrective action evaluation were presented in the Corrective Action Decision Document/Corrective Action Plan (CADD/CAP) (DOE 2004). Modeling indicated that groundwater velocities at the site were very low (due to very low hydraulic conductivities) and that the contaminant boundary would be very small (within two to three radii of the cavity from the working point [DOE 2004]). A compliance boundary was negotiated that factored in modeling results and associated uncertainties with respect to the nuclear test's potential effects within the down-dropped fault block. The compliance boundary corresponds approximately to the surface expression of the fault block and is almost completely contained within the land withdrawal boundary (Figure 2). The preferred corrective action alternative selected in the CADD/CAP was proof-of-concept and monitoring with institutional controls.

Three monitoring/validation wells (MV-1, MV-2, and MV-3) were installed in 2005 to monitor radioisotope concentrations and hydraulic heads in groundwater and to validate the flow and transport model. Hydraulic heads observed in these wells were in significant disagreement with those predicted by the groundwater flow model, which meant that the model could not be validated. Instead of additional modeling, DOE-LM proposed a revised corrective action/closure process in which the monitoring network would be enhanced by installing two new monitoring



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Figure 2. Location Map of Monitoring Wells and Boundaries at CNTA

wells (MV-4 and MV-5), recompleting the existing wells HTH-1 (in the volcanic section) and UC-1-P-1S¹ (in the upper alluvium), and initiating a new 5-year proof-of-concept monitoring period to validate the compliance boundary (DOE 2007). The revised approach is described in a CADD/CAP addendum (DOE 2008) that was approved by NDEP (NDEP 2008).

The revised corrective action/closure process was designed to enhance the monitoring of the alluvial aquifer. The alluvial aquifer was previously not monitored except for water levels in the upper piezometers of wells MV-1, MV-2, and MV-3. Hydraulic heads from different depths at these locations (upper piezometer, lower piezometer, and well) indicate that the most likely transport direction from the UC-1 detonation zone is down, toward densely welded tuff units below the detonation cavity. The well network was designed to monitor this most likely potential transport pathway. However, given the potential for processes like prompt injection and convective mixing in the nuclear chimney, migration into the alluvial aquifer cannot be ruled out. Alluvial wells are more productive than those in the deeper volcanic section, making the alluvial aquifer the most likely source for future groundwater development and, therefore, the most likely access path to potential receptors.

Two wells (MV-4 and MV-5) were installed, and two existing wells (HTH-1 and UC-1-P-1S) were recompleted in 2009 for the dual purposes of monitoring the alluvial aquifer and validating the compliance boundary at the site. The MV-4 and MV-5 wells were designed and positioned not only to monitor for potential contaminant migration in the alluvial aquifer but also to confirm that the southeast-bounding graben fault acts as a flow barrier. The wells were drilled in locations where they would penetrate the downthrown block within the graben and cross the fault into the upthrown block outside the graben. The wells were installed as dual completions with a piezometer in the shallow alluvial aquifer within the graben (downthrown block) and a well in the lower alluvial aquifer outside the graben (upthrown block). The wells were completed with dedicated electric submersible pumps for collecting groundwater samples and conducting aquifer tests. Monitoring of the existing wells MV-1, MV-2, and MV-3 was also enhanced in 2009 by removing the electric submersible pumps and installing low-flow bladder pumps. Results from the drilling program are provided in the December 2009 Well Completion Report for CAU 443 (DOE 2009b).

Well UC-1-P-1S was recompleted to provide a reliable monitoring location within the upper alluvial aquifer inside the graben (downthrown block). An electric submersible pump was installed in the recompleted well, UC-1-P-1SRC,² for collecting groundwater samples. Well HTH-1 was recompleted with two piezometers (upper and lower alluvial aquifer) and a well (upper volcanic section) to allow monitoring of three hydrostratigraphic units at this location. Hydraulic head data from the well and piezometers can be used to estimate the vertical flow direction at this location within the alluvial aquifer and between the upper volcanic section and lower alluvial aquifer. The horizontal flow direction in the lower alluvial aquifer southeast of the graben can be estimated at this location using head data from the HTH-1 lower piezometer along with head data from the MV-4 and MV-5 wells. A low-flow bladder pump was installed in the HTH-1RC well for collecting water samples from the volcanic section south of the detonation (DOE 2009b). Initial monitoring results from HTH-1RC support a previous identification (based on flow logging) of an upward hydraulic gradient from the volcanic section

¹ *P* designates the post-shot hole; *S*, the substitute hole.

² *RC* indicates that the well has been recompleted.

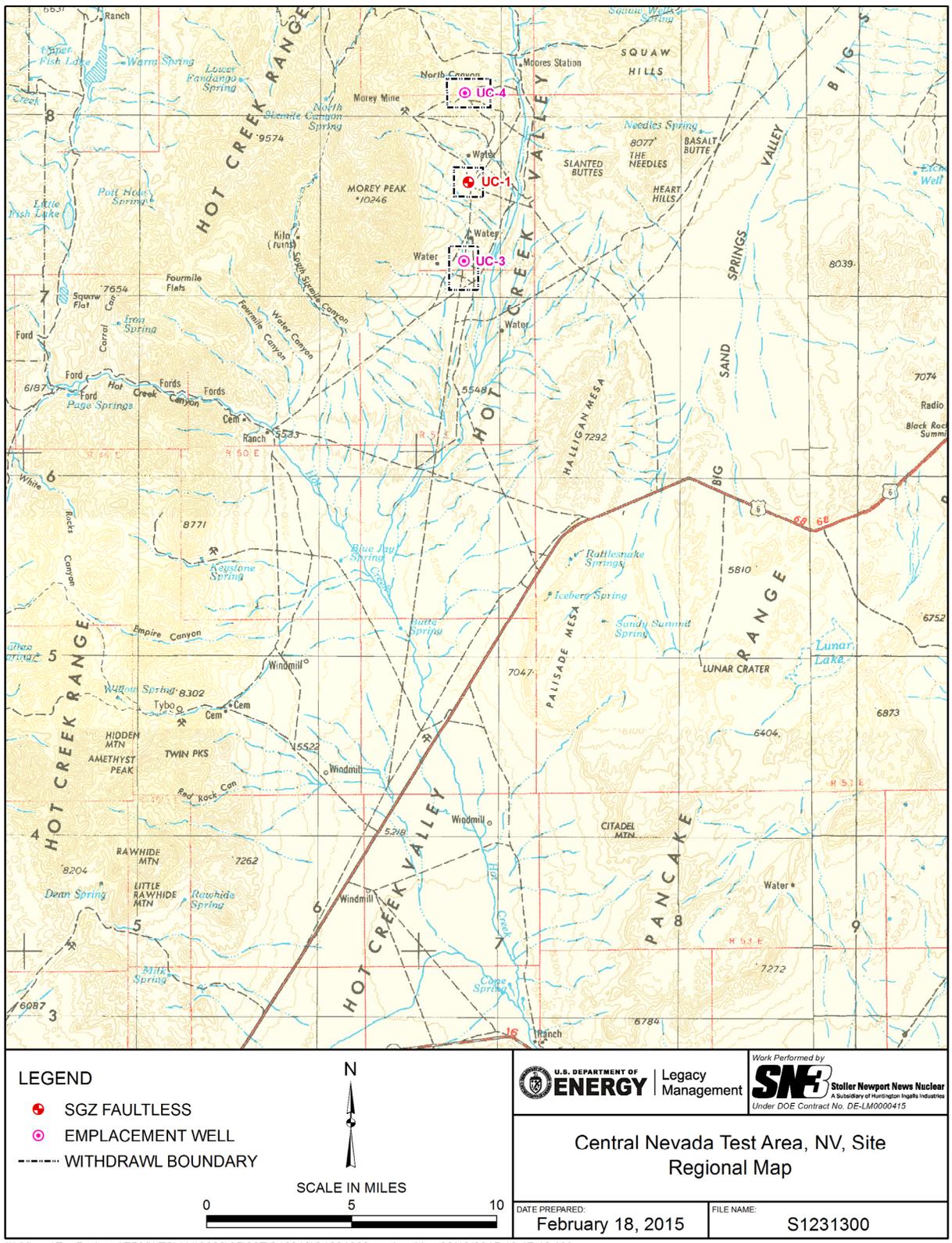
to the alluvium (DOE 2010a). Figure 2 shows a map of the locations included in the enhanced monitoring network.

The revised corrective action/closure process, as outlined in the CADD/CAP addendum (DOE 2008), indicated that aquifer tests would be performed on the new wells MV-4 and MV-5 and on the recompleted well HTH-1RC. This strategy was modified slightly because the original well design for HTH-1RC was changed to include two piezometers and did not allow for the installation of a submersible pump or aquifer testing. To accommodate this change, an aquifer test was conducted on the recompleted well UC-1-P-1SRC. The results from aquifer tests suggest that the hydraulic conductivity of the alluvial aquifer decreases with depth, grading from a productive aquifer in the upper alluvium (hydraulic conductivity of 1.0 meter per day) to a poor producer in the lower alluvium (hydraulic conductivity of 0.00012 to 0.0005 meter per day). The decreasing hydraulic conductivity within the alluvial aquifer may be more a function of depth and overburden compression from the down-dropped fault block rather than sediment grain size. The low hydraulic conductivity of the lower part of the alluvial aquifer is more comparable to the results from densely welded tuff units tested in wells MV-1, MV-2, and MV-3 (8.5×10^{-6} to 6.7×10^{-5} meter per day) and is likely similar to the hydraulic conductivity of the upper part of the underlying volcanic sediments. The Hydrologic Testing Report for CAU 443 (DOE 2010b) provides a more detailed summary of results from the hydrologic testing.

The CADD/CAP addendum was revised in July 2013 with a Record of Technical Change (ROTC) to enhance the monitoring well network with a new well at the site. The ROTC also replaced the terms “proof-of-concept” and “5-year proof-of-concept monitoring” with “conceptual model evaluation” to be more consistent with the corrective action strategy outlined in Appendix VI of the FFACO (DOE 2013). The new well (MV-6) was installed in September 2013 to monitor the upper alluvial aquifer inside the graben. The well was completed with a dedicated electric submersible pump for collecting groundwater samples and conducting aquifer tests. Monitoring of the existing wells MV-4 and MV-5 was enhanced by removing the electric submersible pumps and installing low-flow bladder pumps. The electric submersible pump in well HTH-2, which has historically not been operable, was also replaced in 2013. The new well MV-6 and existing wells/piezometers were surveyed to obtain new top of casing measuring point elevations as part of the drilling program. Results from the 2013 drilling program are provided in the 2013 Well Completion Report for CAU 443 (DOE 2014c).

3.0 Geologic and Hydrologic Setting

CNTA is in Hot Creek Valley (Figure 3), a north-south trending graben that is 68 miles long and located in the Basin and Range physiographic province. Hot Creek Valley varies in width from 5 to 19 miles and contains two major stratigraphic units—a thick sequence of Quaternary- and Tertiary-age alluvial deposits (alluvium) underlain by a thick section of Tertiary-age volcanic rocks (volcanics). Log information from wells MV-1, MV-2, and MV-3 indicates that the thickness of the alluvium in the vicinity of UC-1 (location of the Faultless test) ranges from 1,960 to 2,410 ft. The Tertiary volcanics below the alluvium include tuffaceous sediments, welded and nonwelded tuffs, and rhyolite lavas.

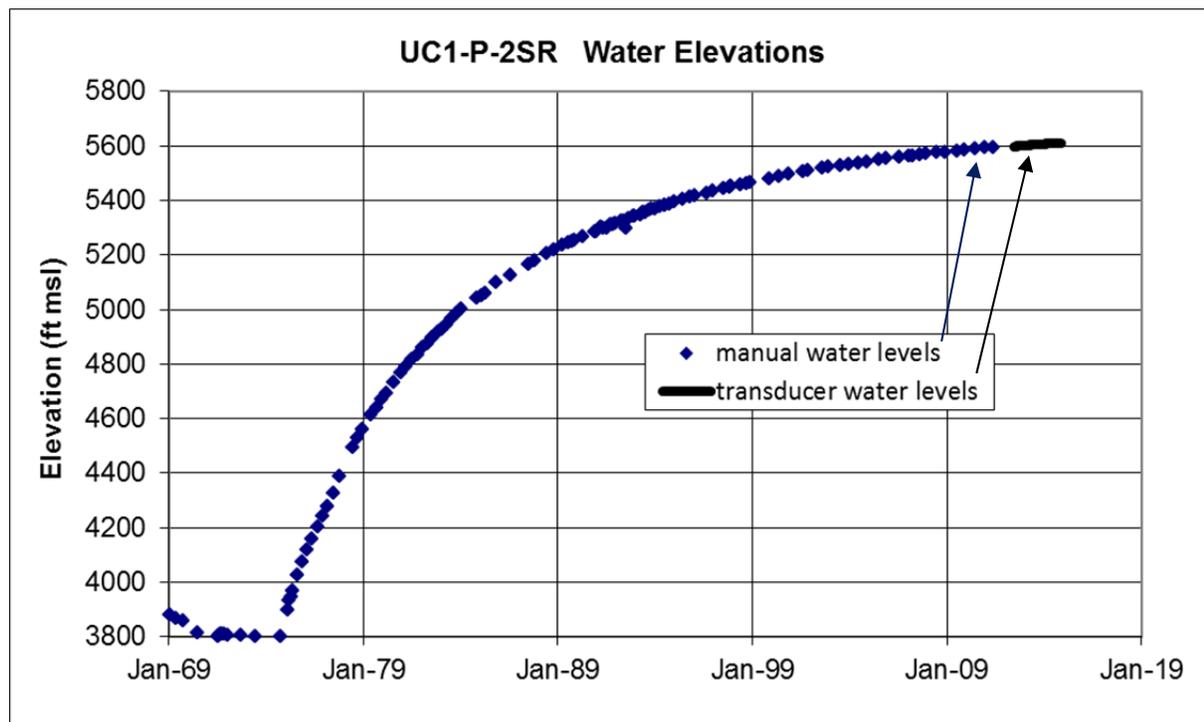


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Figure 3. Central Nevada Test Area, Nevada, Site Regional Map

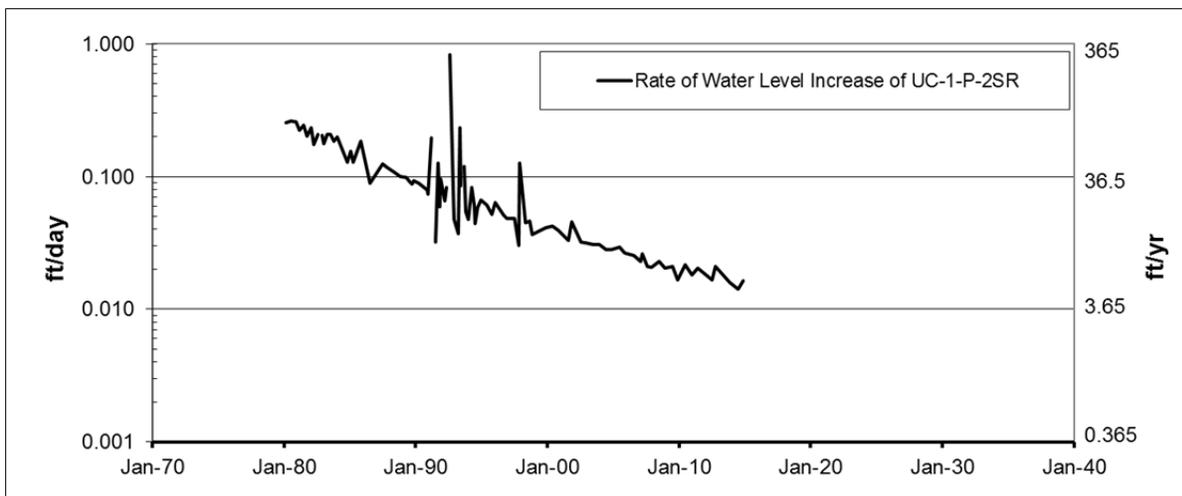
The Faultless test took place in the very low permeability volcanic section, creating a cavity and a subsequent collapse chimney that extends into the overlying alluvium. The reentry well, UC-1-P-2SR, was directionally drilled into the chimney from a surface location approximately 300 ft north of surface ground zero (SGZ) a few weeks after the detonation in 1968. The directional survey indicates that well UC-1-P-2SR began to build angle below 1,500 ft to intersect the chimney. Elevations for well UC-1-P-2SR are not corrected for total vertical depth; consequently, elevations based on measured depth below 1,500 ft (4,600 feet above mean sea level [ft msl]) are low by up to 41 ft at the bottom of the well (3,554 ft bgs) and about 33 ft at the bottom of the perforated interval. Well UC-1-P-2SR was perforated from measured depths of 1,148 to 2,792 ft.

The water levels in UC-1-P-2SR are still recovering from the dewatering effects of the detonation (Figure 4). The water level has increased more than 1,800 ft in the last 40 years and is expected to rise another 160 to 165 ft to the elevation of water levels in the alluvial aquifer in this area (from the elevation of 5,605 ft msl measured in late 2013 to approximately 5,765 to 5,770 ft msl). The rate of water level rise in UC-1-P-2SR is decreasing as the recovery proceeds, indicating that it will be a number of decades before water levels stabilize (Figure 5).



Notes: UC-1-P-2SR elevations not true-vertical-depth (TVD) corrected. The hole is essentially straight to a depth of 1,500 ft (4,600 ft msl). No TVD correction necessary for water levels after 1980 and less than a 14 ft correction for water levels at 3,800 ft msl.

Figure 4. Water Level Elevations in Reentry Well UC-1-P-2SR
http://nevada.usgs.gov/doe_nv/sitepage_temp.cfm?site_id=383806116125951



Notes: The y axis is logarithmic.

Figure 5. Declining Rate of Water Level Increase in Well UC-1-P-2SR

4.0 Monitoring Objectives and Activities

The primary objectives of the monitoring program are to (1) detect any migration of contaminants from the detonation zone and (2) evaluate the overall stability (quasi-steady state) of the groundwater flow system to ensure that monitoring wells are located along potential migration pathways. The monitoring program and objectives were established in the CADD/CAP, and the program was initiated after NDEP approved the CADD/CAP and wells MV-1, MV-2, and MV-3 were installed in 2005. The monitoring program was enhanced after the numerical model could not be validated against data obtained from wells MV-1, MV-2, and MV-3. Enhancements to the monitoring program required an addendum to the CADD/CAP and included the installation of two monitoring wells (MV-4 and MV-5) and the recompletion of two existing wells (HTH-1RC and UC-1-P-1SRC). The CADD/CAP addendum was revised in July 2013 with an ROTC to further enhance the monitoring well network with the installation of well MV-6. The current monitoring activities are specified in the CADD/CAP addendum (DOE 2008) and associated ROTC (incorporated as an attachment to the CADD/CAP addendum) and include the collection of hydraulic head data and groundwater samples for radioisotope analyses. These monitoring activities are consistent with the primary objectives in the original CADD/CAP (DOE 2004).

The 2014 monitoring program was specified in the November 2014 Environmental Sampling notification letter (DOE 2014c) that was provided to NDEP. Groundwater sampling was originally planned for November 2014, but was delayed until December 2014. Sections 4.1 through 4.4 below describe results from the monitoring program, and Section 5.0 provides results from the site inspection.

4.1 Radioisotope Monitoring

Groundwater samples were collected from wells MV-1, MV-2, MV-3, MV-4, MV-5, MV-6, HTH-1RC, HTH-2, and UC-1-P-1SRC as part of the annual monitoring program conducted in December 2014. A sample was collected from well HTH-1RC during this monitoring event because the obstruction that resulted in the well not being sampled last year was removed. Monitoring wells MV-1, MV-2, MV-3, MV-4, MV-5, and HTH-1RC, which are completed with bladder pumps, were purged to remove stagnant water from the pump tubing prior to sample collection. Monitoring wells MV-6, HTH-2, and UC-1-P-1SRC were purged prior to sampling using the dedicated electric submersible pumps. Field parameters (temperature, pH, and specific conductance) were allowed to stabilize before samples were collected. The *Sampling and Analysis Plan for U.S. Department of Energy Office of Legacy Management Sites* (LMS/PRO/S04351) was used to guide quality assurance and quality control, and the *Fluid Management Plan, Central Nevada Test Area Corrective Action Unit 443* (DOE 2009a) was used to guide the handling and discharge of monitoring well purge water during the annual monitoring event. Table A-1 in Appendix A provides the field parameter measurements obtained during well-purging activities.

Groundwater samples collected as part of the annual monitoring event were analyzed for tritium. The CADD/CAP addendum (DOE 2008) specifies that water samples will be analyzed for tritium every year and for carbon-14 (^{14}C) and iodine-129 (^{129}I) in the first and fifth years of the 5-year proof-of-concept period that began with the 2009 sampling event. Tritium is currently the primary analyte of concern because of its initial abundance and mobility. After a few hundred years, tritium (half-life of 12.3 years) will decay to insignificant levels, and the longer-lived radionuclides, ^{14}C and ^{129}I , will become the primary focus of long-term post-closure monitoring. The ^{14}C and ^{129}I analyses will provide baseline levels of these constituents for comparison with long-term monitoring results. Sample volumes collected in 2009 were insufficient for ^{129}I analysis, and as a result, water samples collected in 2010 were analyzed for ^{129}I .

The CADD/CAP (DOE 2004) and CADD/CAP addendum (DOE 2008) established groundwater compliance levels for CNTA of 20,000 picocuries per liter (pCi/L) for tritium, 2,000 pCi/L for ^{14}C , and 1 pCi/L for ^{129}I . Transport modeling (Pohlmann et al. 1999, Pohll et al. 2003) was used to establish a contaminant boundary (DOE 2004) at which predicted concentrations of these constituents would remain below current compliance levels. The contaminant boundary is well within the compliance boundary (Figure 2), the boundary beyond which compliance levels of these constituents are not to be exceeded. Although data from wells MV-1, MV-2, and MV-3 did not validate the flow model, hydraulic conductivity data from these wells support the model-predicted contaminant boundary.

4.2 Radioisotope Results

Table 1 presents radioisotope sampling results for 2014 along with the results from previous sampling events dating back to 2011. Analytical results obtained from when the original CADD/CAP monitoring program began in 2006 through the present are provided in Appendix B (Table B-1). Laboratory analytical results from the 2014 sampling event (Table 1) indicate that tritium concentrations at the sampled locations were below the required detection limit (RDL) of 400 pCi/L. The RDLs for the parameters being monitored were established in the CADD/CAP (DOE 2004) and were maintained in the CADD/CAP addendum (DOE 2008).

Table 1. Radioisotope Sampling Results 2011 through 2014

Monitoring Location	Date	Carbon-14 (pCi/L)	Iodine-129 (pCi/L)	Tritium (pCi/L)
MV-1	5/10/2011	NS	NS	<RDL
	6/26/2012	NS	NS	<RDL
	11/06/2013	<RDL (4.76×10^{-2c})	<RDL (1.75×10^{-10})	<RDL
	12/16/2014	NS	NS	<RDL
MV-2	5/11/2011	NS	NS	<RDL
	6/27/2012	NS	NS	<RDL
	11/07/2013	<RDL (2.20×10^{-2c})	<RDL (1.24×10^{-10})	<RDL
	12/16/2014	NS	NS	<RDL
MV-3	5/10/2011	NS	NS	<RDL
	6/26/2012	NS	NS	<RDL
	11/05/2013	<RDL (6.58×10^{-2c})	<RDL (7.32×10^{-10})	<RDL
	12/17/2014	NS	NS	<RDL
MV-4	5/10/2011	NS	NS	<RDL
	5/10/2011 ^b	NS	NS	<RDL
	6/26/2012	NS	NS	NW
	11/07/2013	<RDL (2.54×10^{-3c})	<RDL (1.80×10^{-11})	<RDL
	12/17/2014	NS	NS	<RDL
MV-4PZ ^a	6/26/2012	NS	NS	<RDL
MV-5	5/11/2011	NS	NS	<RDL
	6/26/2012	NS	NS	NW
	11/07/2013	<RDL (7.81×10^{-3c})	<RDL (8.90×10^{-11})	<RDL
	12/17/2014	NS	NS	<RDL
MV-5PZ ^a	6/26/2012	NS	NS	<RDL
MV-6	11/06/2013	<RDL (4.87×10^{-2c})	<RDL (9.00×10^{-11})	<RDL
	11/06/2013 ^b	NS	NS	<RDL
	12/18/2014	NS	NS	<RDL
HTH-1RC	5/11/2011	NS	NS	<RDL
	6/27/2012	NS	NS	<RDL
	11/08/2013	PF	PF	PF
	12/16/2014	NS	NS	<RDL
	12/16/2014 ^b	NS	NS	<RDL
HTH-2	5/11/2011	NS	NS	PF
	6/27/2012	NS	NS	PF
	11/06/2013	<RDL (8.52×10^{-2c})	<RDL (6.20×10^{-11})	<RDL
	12/17/2014	NS	NS	<RDL
UC-1-P-1SRC	5/10/2011	NS	NS	<RDL
	6/27/2012	NS	NS	<RDL
	11/06/2013	<RDL (9.54×10^{-2c})	<RDL (1.08×10^{-10})	<RDL
	12/17/2014	NS	NS	<RDL

^a Sample was collected using a depth-specific bailer.

^b Duplicate sample (not required for ¹⁴C and ¹²⁹I).

^c Calculated based on the total alkalinity concentration.

NS = not sampled because the radioisotope was not part of the analytical suite.

NW = not sampled to allow water levels in the well time to recover.

PF = pump failed and a sample could not be collected.

<RDL = below required detection limit (laboratory result in parentheses; RDL is 400 pCi/L for tritium, 5 pCi/L for ¹⁴C, and 0.1 pCi/L for ¹²⁹I [DOE 2004]).

An ROTC was submitted to NDEP and approved in March 2012 to change the RDL for tritium from 300 pCi/L to 400 pCi/L in the CADD/CAP and CADD/CAP Addendum (DOE 2012). The minimum detectable concentration values reported by the laboratory for tritium have historically ranged from <313 to <390 pCi/L using the conventional method of tritium analysis. The analytical results were validated in accordance with the *Environmental Procedures Catalog* (LMS/POL/S04325), “Standard Practice for Validation of Environmental Data.” All analyses were completed, and the samples were prepared and analyzed in accordance with accepted procedures that were based on the specified methods. The laboratory radiochemical minimum detectable concentration reported with these data is an a priori estimate of the detection capability of a given analytical procedure, not an absolute concentration that can or cannot be detected. A copy of the Data Validation Package is maintained in the LM records and is available on request.

4.3 Hydraulic Head Monitoring

Transducers are installed in all wells and piezometers in the monitoring network to monitor hydraulic head. The transducer data are calibrated to manual water level measurements taken during sampling events and site inspections. As stated in the CADD/CAP, “Hydraulic head will be used to monitor the quasi-steady state of the groundwater system; i.e., to determine if mean hydraulic head values remain constant through time, given fluctuations caused by natural temporal stresses and stresses related to well drilling, construction, and testing. This requires first determining when heads have stabilized following drilling and testing activities, then quantifying the natural mean and temporal variation in hydraulic head, and comparing subsequent monitoring measurements to that range.”

4.4 Hydraulic Head Results

Table 2 lists the most recent water level data (November 2014) from site wells and piezometers, along with the screened interval elevations and the screened geologic unit. Piezometers are distinguished from the wells at these monitoring locations by the notation “PZ.” For locations with two piezometers, “UPZ” and “LPZ” are used to denote the upper piezometer and lower piezometer, respectively.

Figure 6 through Figure 9 present hydrographs of the hydraulic head data. Head data collected using a water level tape appear as individual symbols, and data collected with transducers appear as lines due to the recording frequency of every few hours. The hydrographs are grouped by comparable monitored interval and location: alluvial wells southeast of the southeast-bounding graben fault, including well HTH-1RC in the upper volcanic section (Figure 6); alluvial wells northwest of the southeast-bounding graben fault (Figure 7); the volcanic section with open intervals near the detonation level (Figure 8); and the volcanic section with open intervals below the detonation level (Figure 9). Data gaps in the hydrographs are the result of transducers being removed for well-site activities or for the replacement of damaged transducers or cable.

Table 2. Construction and 2014 Hydraulic Head Data for Wells in the CNTA Monitoring Network

Well/ Piezometer	TSZ Elevation ^a (ft)	BSZ Elevation ^a (ft)	Geologic Unit	TOC Elevation ^a (ft)	Date	Water Depth (ft)	Water Level Elevation ^a (ft)
MV-1UPZ	5,190.19	5,130.19	Alluvium	6,069.98	11/09/2014	317.22	5,752.76
MV-1LPZ	3,067.19	3,007.19	Volcanics	6,069.91	11/09/2014	47.09	6,022.82
MV-1	2,319.19	2,159.63	Volcanics	6,070.57	11/09/2014	508.05	5,562.52
MV-2UPZ	5,229.73	5,179.73	Alluvium	6,190.66	11/09/2014	402.46	5,788.20
MV-2LPZ	2,643.23	2,583.23	Volcanics	6,190.39	11/09/2014	406.11	5,784.28
MV-2	3,150.24	2,987.49	Volcanics	6,190.66	11/09/2014	369.41	5,821.25
MV-3UPZ	5,286.98	5,226.98	Alluvium	6,167.75	11/09/2014	372.70	5,795.05
MV-3LPZ	2,866.98	2,746.98	Volcanics	6,167.69	11/09/2014	199.52	5,968.17
MV-3	2,120.98	1,959.23	Volcanics	6,168.27	11/09/2014	601.70	5,566.57
MV-4 ^b	4,300.32	3,996.22	Alluvium	6,019.57	11/09/2014	504.65	5,514.92
MV-4PZ ^b	5,101.20	5,041.20	Alluvium	6,019.45	11/09/2014	275.11	5,744.34
MV-5 ^b	4,203.12	3,878.69	Alluvium	6,041.85	11/09/2014	559.75	5,482.10
MV-5PZ ^b	5,023.17	4,963.17	Alluvium	6,040.85	11/09/2014	288.96	5,751.89
MV-6 ^d	5,214.95	5,052.31	Alluvium	6,053.84	11/09/2014	312.68	5,741.16
HTH-1UPZ ^b	5,032.63	4,972.63	Alluvium	6,011.27	11/09/2014	543.36	5,467.91
HTH-1LPZ ^b	4,112.66	4,052.66	Alluvium	6,011.31	11/09/2014	541.48	5,469.83
HTH-1RC ^b	3,653.90	3,353.60	Volcanics	6,011.70	11/09/2014	486.10	5,525.60
HTH-2	5,521.70	5,025.70	Alluvium	6,026.05	11/09/2014	556.50	5,469.55
UC-1-P-1SRC ^b	5,519.55	5,457.81	Alluvium	6,031.58	11/09/2014	281.21	5,750.37
UC-1-P-2SR ^c	4,931 ^c	3,289 ^c	Chimney	6,080.51	11/09/2014	469.31 ^c	5,611.20 ^c

^a All elevations reported in units of feet above mean sea level.

^b Added in 2009.

^c UC-1-P-2SR elevations not true-vertical-depth (TVD) corrected. The hole is essentially straight to a depth of 1,500 ft (no TVD correction necessary for water levels since 1980).

^d Added in 2013.

BSZ = bottom of open interval/screen zone.

TOC = top of casing.

TSZ = top of open interval/screen zone.

Notes: The new well MV-6 and existing wells/piezometers were surveyed to establish new top of casing elevations after the 2013 drilling program.

Water depth = depth to water from TOC.

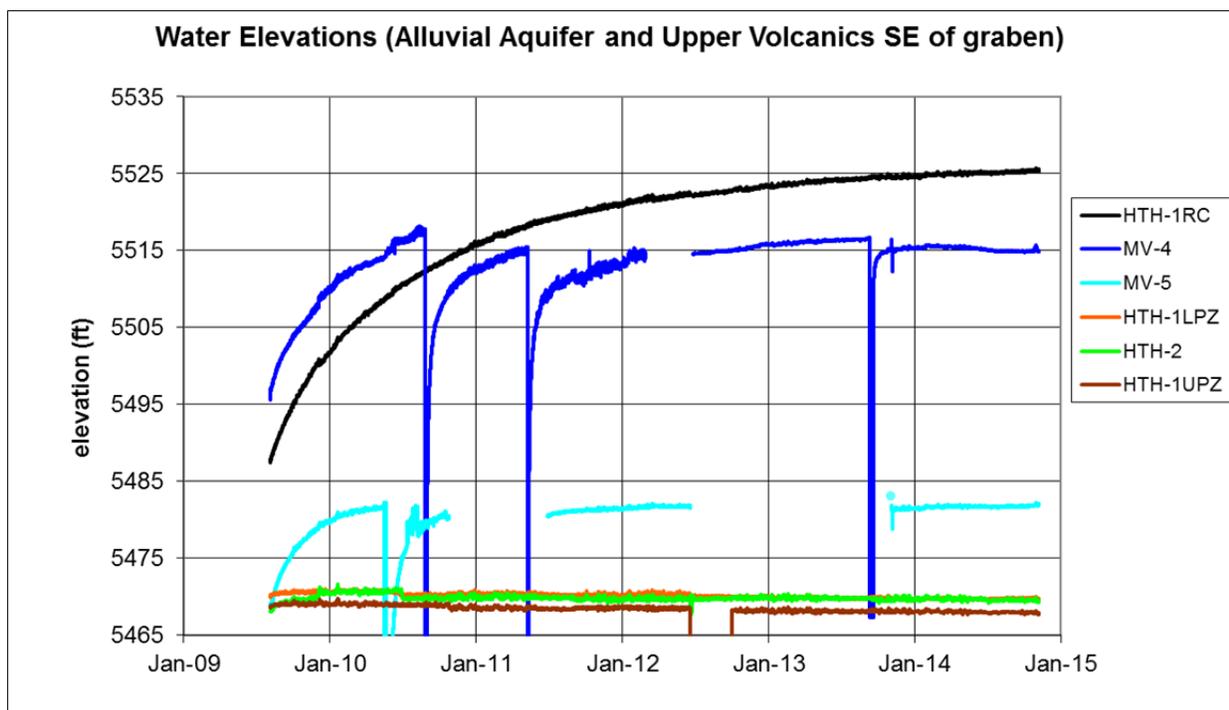


Figure 6. Water Level Elevations for the Alluvial Wells and Well HTH-1RC (Upper Volcanics) Southeast of the Down-Dropped Graben at the Screened Horizon

Figure 6 shows the hydrographs of alluvial wells and piezometers southeast of the graben (MV-4, MV-5, HTH-2, HTH-1UPZ, and HTH-1LPZ) along with well HTH-1RC (screened in the upper volcanic section below the alluvium). These data indicate that head levels in wells MV-4 and MV-5 have recently recovered from the 2010 aquifer testing and from the 2011 yearly sampling event during which several thousand gallons of water were purged. Low-flow bladder pumps were installed in wells MV-4 and MV-5 during the November 2013 sampling event to reduce the well purge volumes and the impact purging has on the water levels during sampling (DOE 2014a). Water levels in well HTH-1RC continue to equilibrate after the recompletion in 2009. Prior to its recompletion, HTH-1 was perforated across its entire saturated section and displayed a composite water level that could not be attributed to one particular hydrogeologic unit. The recompletion isolated zones in the upper and lower alluvium (HTH-1UPZ and HTH-1LPZ) and in the upper volcanic section (HTH-1RC). The hydraulic head in the volcanic portion of HTH-1RC is higher than water levels measured in both the upper and lower alluvial piezometers at this location. This observation confirms that an upward gradient from the volcanic section to the alluvium exists in this area, as indicated by flow logging performed by Desert Research Institute in HTH-1 prior to the well's recompletion (DOE 2008).

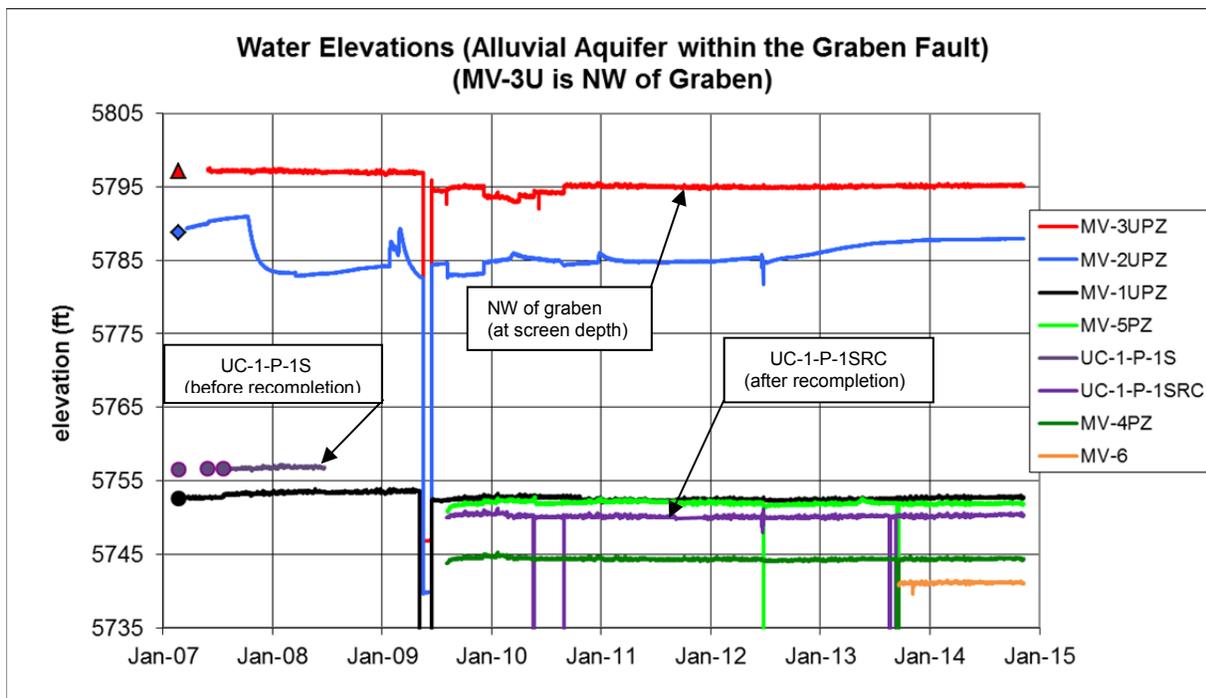


Figure 7. Water Level Elevations for the Alluvial Wells Northwest of the Southeast-Bounding Graben Fault

Figure 7 shows the hydrographs of alluvial piezometers and wells within and northwest of the graben. Erratic water levels in upper piezometer MV-2UPZ (Figure 7) are attributed to damage during its installation. The lower hydraulic heads observed after mid-2009 in the upper piezometers MV-1UPZ and MV-3UPZ are the results of attempts to further develop these piezometers. The recompletion of well UC-1-P-1S resulted in a roughly 7 to 8 ft decrease in hydraulic head (Figure 7). This suggests that the well is now isolated from the influence of deeper horizons where hydraulic heads have been larger. The hydraulic heads in the piezometers MV-4PZ and MV-5PZ (screened inside the down-dropped graben block) are approximately 250 ft higher than those in the wells MV-4 and MV-5 that are screened outside the graben to the southeast (Figure 6). Given these results, alluvial aquifer hydrographs were separated into two groups based on their screened location relative to the southeast-bounding graben fault. Hydraulic head data from the MV-4 and MV-5 wells and piezometers continue to support the conceptual model that the southeast-bounding graben fault acts as a barrier to flow at the site.

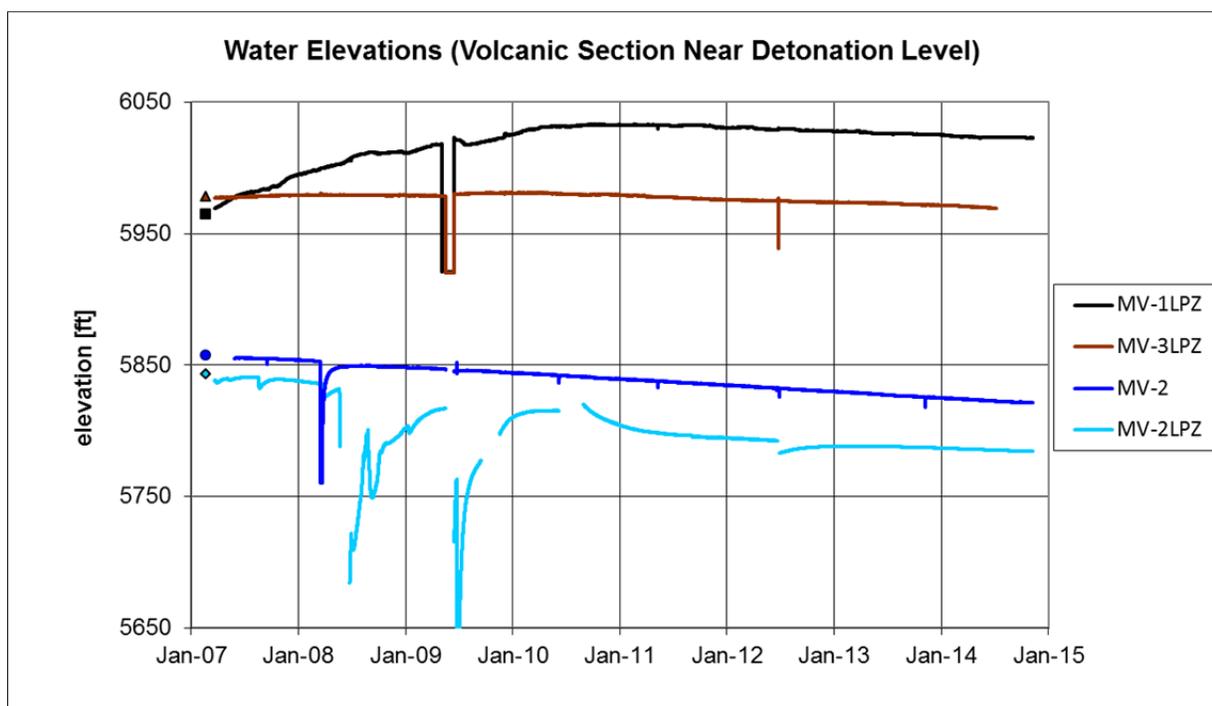


Figure 8. Water Level Elevations for the Well and Piezometers Screened in the Volcanic Section at or near the Level of the Detonation

Figure 8 shows hydrographs of the well and piezometers with open intervals near the detonation level. Water levels in the lower piezometer MV-1LPZ were rising after installation until they stabilized in 2011 and have been slightly declining since 2011. To investigate the cause of rapid water level declines and recoveries at the MV-2LPZ location, the Desert Research Institute ran a temperature log, collected a bailed sample, and measured the depth of the lower piezometer (MV-2LPZ) on August 5, 2008. It was determined that sediment had filled the lower piezometer MV-2LPZ to a depth 75 ft above the top of the screened interval. Additional development of this piezometer in the summer of 2009 lowered the sediment fill to the top of the screened interval. Head levels in MV-2LPZ appeared to recover in 2010 from the development, then steadily declined (at a decreasing rate) through 2011 and into 2012, when the head level dropped approximately 10 ft after well MV-2 was sampled. After this sampling event, the head levels in the lower piezometer MV-2LPZ recovered and have reverted to a decreasing trend. Sediment removal may not have completely solved the erratic head changes in this piezometer. The proximity of the lower piezometer MV-2LPZ screened interval to the northwestern bounding graben fault is the likely cause of its erratic water levels. Gaps in the transducer data from the lower piezometer MV-2LPZ are the result of failures in the transducer. The head levels in the MV-2 well continue to decline at a rate of approximately 5 ft per year. It is expected that heads southeast of this fault (within the graben) are higher than heads to the northwest, outside the graben.

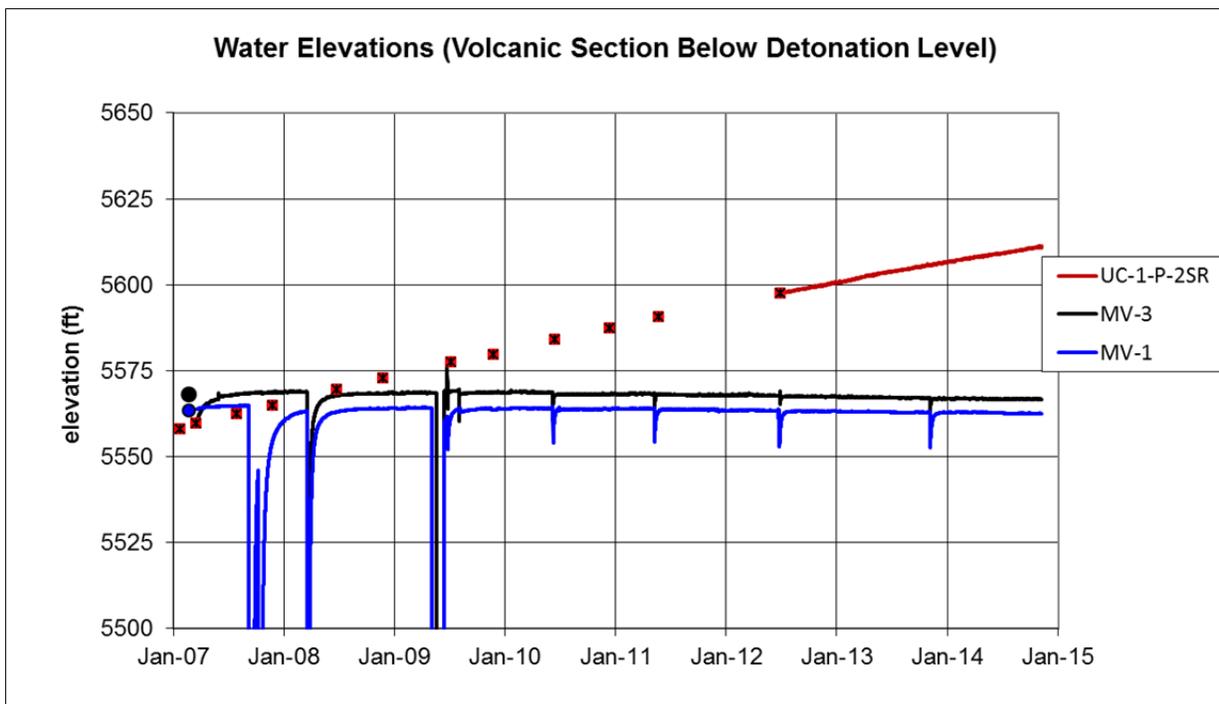
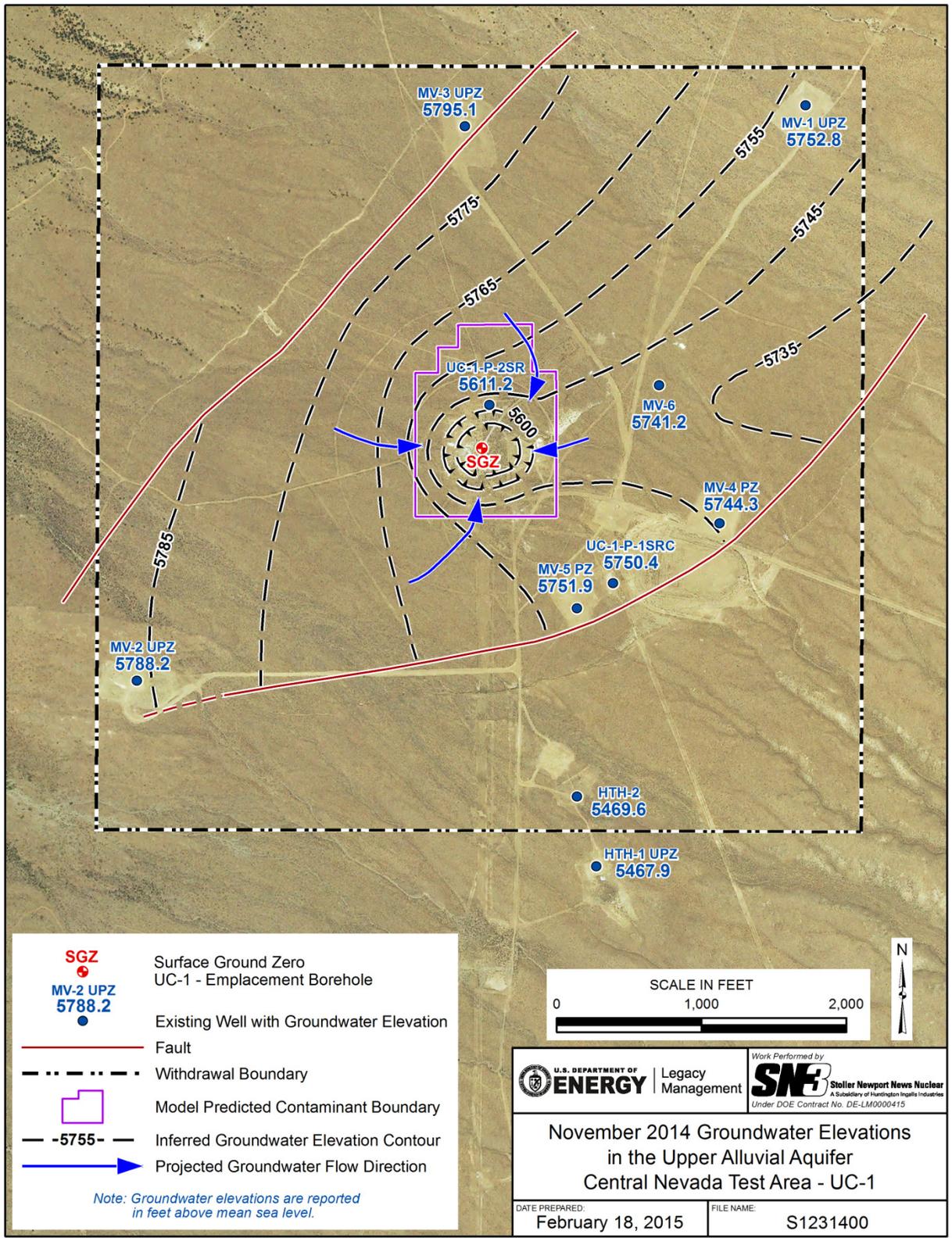


Figure 9. Water Level Elevations for the Wells Screened in the Volcanic Section Below the Level of the Detonation
(Water level elevations for reentry well UC-1-P-2SR [drilled into the chimney] are shown for reference.)

Figure 9 shows the hydrographs of wells with open intervals below the detonation level and reentry well UC-1-P-2SR. The composite head level from UC-1-P-2SR (chimney and alluvium overlying the detonation area) is higher than in the densely welded tuff units below the detonation zone. The composite head level of 5,611.2 ft measured on November 9, 2014 (Table 2) continues to increase, though at a slowing rate over the long term (Figure 5). Well UC-1-P-2SR has perforations as high as 1,148 ft bgs in the alluvium, and its water level is expected to eventually reach a steady-state elevation of approximately 5,750 ft msl (similar to other alluvial wells and piezometers within the graben).

A hand-contoured potentiometric map of the upper part of the alluvial aquifer within the graben (Figure 10) was constructed using the November 2014 head levels from MV-4PZ, MV-5PZ, MV-6, UC-1-P-1SRC, MV-1UPZ, and MV-2UPZ, all of which are screened at depths ranging from 600 to 1,000 ft bgs. Contouring of the potentiometric surface (Figure 10) was restricted to the area within the graben. Contours near SGZ are based on the water level from reentry well UC-1-P-2SR, which is perforated from the depths of 1,148 ft to 2,792 ft (4,931 to 3,289 ft msl) and spans the alluvium into the chimney. The interpretation shown on Figure 10 suggests that horizontal flow in the upper alluvium is toward the chimney near SGZ. Away from the influence of the chimney, horizontal flow is to the east-southeast and is likely deflected by the southeast-bounding graben fault that is acting as a barrier to flow. As drawn, the contours indicate a dip reversal between the detonation and MV-6 that will gradually go away as heads in the alluvium above the detonation zone recover. Groundwater flow within the graben will eventually be to the east-southeast. Depiction of groundwater flow directions within the graben has an inherent degree of uncertainty, given the structural complexity caused by the detonation and the limited data available within the graben.



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Figure 10. November 2014 Groundwater Elevations in the Upper Alluvial Aquifer Central Nevada Test Area—UC-1

Wells MV-4 and MV-5 were completed in the lower part of the alluvial aquifer outside the graben block (at depth) to confirm that the southeast-bounding graben fault acts as a flow barrier and for compliance monitoring at a depth nearer the detonation zone.

5.0 Site Inspection

A site inspection was conducted during the December 2014 sampling event. The site inspection included the inspection of roads, wellheads, and the monument at SGZ for signs of damage. The roads, wellheads, and monument were in good condition at the time of the inspection.

6.0 Summary and Recommendations

The 2009 drilling program enhanced the CNTA monitoring network with seven new monitoring locations (wells and piezometers) in the alluvial aquifer and one in the upper volcanic section. The monitoring well network was further enhanced in 2013 with the installation of well MV-6 completed in the upper alluvial aquifer inside the graben. Detection monitoring results indicate that radioisotope levels in groundwater continue to remain below the RDLs in all sampled wells in the monitoring network. Water level data from wells MV-4 and MV-5 indicate that head levels have recently recovered from the 2010 aquifer testing and from the 2011 yearly sampling event during which several thousand gallons of water were purged. Low-flow bladder pumps were installed in wells MV-4 and MV-5 during the November 2013 sampling event to reduce the well purge volumes and the impact purging has on the water levels during sampling. The new bladder pumps allow the collection of samples using the low-flow sampling method and allow head levels to remain at steady-state conditions. Hydraulic head data collected from the site continue to support the conceptual model. This is evident in that groundwater levels in UC-1-P-2SR continue to recover from the dewatering effects of the detonation and that horizontal groundwater flow in the upper alluvial aquifer near SGZ is toward the detonation chimney. Head data from well UC-1-P-2SR also suggest a downward gradient (Figure 9) that continues to increase as the water levels in this well recover. Head data from wells MV-4 and MV-5 completed in the lower part of the alluvial aquifer outside the graben confirm that the southeast-bounding graben fault acts as a barrier to groundwater flow (Figure 10). Depiction of groundwater flow directions within the graben has an inherent degree of uncertainty, given the structural complexity caused by the detonation and subsequent collapse of the graben.

LM recommends that a Closure Report be prepared for subsurface CAU 443 and that the report be provided to NDEP for review and comment. This recommendation is based on hydraulic head and radioisotope data that continue to support the site conceptual model as seen and confirmed with MV-6 data.

7.0 References

- DOE (U.S. Department of Energy), 1999. *Corrective Action Investigation Plan for the Central Nevada Test Area Subsurface Sites (Corrective Action Unit No. 443)*, DOE/NV-483 Rev. 1, Nevada Operations Office, Las Vegas, Nevada, February.
- DOE (U.S. Department of Energy), 2001. *Closure Report for Corrective Action Unit 417: Central Nevada Test Area Surface, Nevada*, DOE/NV-743 Rev. 1, National Nuclear Security Administration/Nevada Site Office, Las Vegas, Nevada, November.
- DOE (U.S. Department of Energy), 2004. *Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 443: Central Nevada Test Area (CNTA)—Subsurface*, DOE/NV-977 Rev. 0, National Nuclear Security Administration/Nevada Site Office, Las Vegas, Nevada.
- DOE (U.S. Department of Energy), 2007. *Corrective Action Plan Path Forward Proposal, Central Nevada Test Area*, Office of Legacy Management, Grand Junction, Colorado, April.
- DOE (U.S. Department of Energy), 2008. *Addendum to: Corrective Action Decision Document/Corrective Action Plan (CADD/CAP) for Corrective Action Unit (CAU) 443: Central Nevada Test Area (CNTA)—Subsurface Central Nevada Test Area, Nevada*, DOE/NV-977, DOE-LM/1555-2007, Office of Legacy Management, Grand Junction, Colorado, January.
- DOE (U.S. Department of Energy), 2009a. *Fluid Management Plan Central Nevada Test Area Corrective Action Unit 443*, LSM/CNT/S03736, Office of Legacy Management, Grand Junction, Colorado, January.
- DOE (U.S. Department of Energy), 2009b. *Well Completion Report for Corrective Action Unit 443 Central Nevada Test Area Nye County, Nevada*, LMS/CNT/S05827, Office of Legacy Management, Grand Junction, Colorado, December.
- DOE (U.S. Department of Energy), 2010a. *2009 Groundwater Monitoring Report Central Nevada Test Area, Corrective Action Unit 443*, LMS/CNT/S05935, Office of Legacy Management, Grand Junction, Colorado, September.
- DOE (U.S. Department of Energy), 2010b. *Hydrologic Testing Report Central Nevada Test Area, Corrective Action Unit 443*, LMS/CNT/S06916, Office of Legacy Management, Grand Junction, Colorado, November.
- DOE (U.S. Department of Energy), 2012. *Record of Technical Change to the Addendum to: Corrective Action Decision Document/Corrective Action Plan (CADD/CAP) for Corrective Action Unit (CAU) 443: Central Nevada Test Area (CNTA)—Subsurface Central Nevada Test Area, Nevada*, DOE/NV-977, Office of Legacy Management, Grand Junction, Colorado, March.
- DOE (U.S. Department of Energy), 2013. *Record of Technical Change to the Addendum to: Corrective Action Decision Document/Corrective Action Plan (CADD/CAP) for Corrective Action Unit (CAU) 443: Central Nevada Test Area (CNTA)—Subsurface Central Nevada Test Area, Nevada*, DOE/NV-977, Office of Legacy Management, Grand Junction, Colorado, July.

DOE (U.S. Department of Energy), 2014a. *2013 Groundwater Monitoring Report Central Nevada Test Area, Subsurface Corrective Action Unit 443*, LMS/CNT/S11448, Office of Legacy Management, Grand Junction, Colorado, May.

DOE (U.S. Department of Energy), 2014b. *2013 Well Completion Report for Corrective Action Unit 443 Central Nevada Test Area Nye County, Nevada*, LMS/CNT/S10873, Office of Legacy Management, Grand Junction, Colorado, June.

DOE (U.S. Department of Energy), 2014c. *November 2014 Environmental Sampling at Central Nevada Test Area, Nevada*, Office of Legacy Management, Grand Junction, Colorado, October.

DRI (Desert Research Institute), 2006. *Central Nevada Test Area Monitoring Report*, Publication No. 45222, DOE/NV/13609-52, September.

Environmental Procedures Catalog (LMS/POL/S04325), continually updated, prepared by Stoller Newport News Nuclear, Inc., a wholly owned subsidiary of Huntington Ingalls Industries, Inc., for the U.S. Department of Energy Office of Legacy Management.

NDEP (Nevada Division of Environmental Protection), 2008. *Approval of Corrective Action Decision Document/Corrective Action Plan (CADD/CAP) Addendum to: Corrective Action Unit (CAU) 443: Central Nevada Test Area (CNTA)—Subsurface Central Nevada Test Area, Nevada*, DOE/NV-977, DOE-LM/1555-2007, January 17.

Pohll, G., K. Pohlmann, J. Daniels, A. Hassan, and J. Chapman, 2003. *Contaminant Boundary at the Faultless Underground Nuclear Test*, Desert Research Institute Publication No. 45196, U.S. Department of Energy, Nevada Operations Office Report DOE/NV/13609-24, Las Vegas, Nevada.

Pohlmann, K.F., J. Chapman, A. Hassan, and C. Papelis, 1999. *Evaluation of Groundwater Flow and Transport at the Faultless Underground Nuclear Test, Central Nevada Test Area*, Publication No. 45184, U.S. Department of Energy, Nevada Operations Office report DOE/NV/13609-13, Las Vegas, Nevada: Desert Research Institute, Division of Hydrologic Sciences.

Sampling and Analysis Plan for U.S. Department of Energy Office of Legacy Management Sites (LMS/PRO/S04351), continually updated, prepared by Stoller Newport News Nuclear, Inc., a wholly owned subsidiary of Huntington Ingalls Industries, Inc., for the U.S. Department of Energy Office of Legacy Management.

Appendix A
Well Purge Data

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Table A-1. Monitoring Well Purge Data

Well Identification	Date Sampled	Purged Volume (gallons)	Temperature (°C)	pH (s.u.)	Specific Conductance (µmho/cm)
HTH-1RC	12/16/2014	6.7	14.2	8.35	590
HTH-2	12/17/2014	1,870	18.6	7.66	303
			18.7	7.65	302
			18.5	7.67	303
MV-1	12/16/2014	9.4	13.8	9.47	670
MV-2	12/16/2014	8	13.4	11.04	1815
MV-3	12/17/2014	10.5	13.3	7.06	950
MV-4	12/17/2014	4.9	13.0	10.01	480
MV-5	12/17/2014	5.3	13.0	10.64	630
MV-6	12/18/2014	13,210	20.7	7.74	238
			20.7	7.72	238
			20.7	7.71	238
UC-1-P-1SRC	12/17/2014	500	17.85	7.62	318
			17.79	7.51	312
			17.93	7.50	310

s.u. = standard unit

µmho/cm = micromhos per centimeter

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Appendix B

Analytical Data: 2006 Through the Present

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Table B-1. Radioisotopic Sample Results

Monitoring Location	Date	Carbon-14 (pCi/L)	Iodine-129 (pCi/L)	Tritium (pCi/L)
MV-1	2/14/2006 ^b	<RDL (1.12 x 10 ⁻²)	<RDL (1.51 x 10 ⁻⁷)	<RDL
	9/21/2006 ^b	<RDL (5.61 x 10 ⁻²)	<RDL (2.90 x 10 ⁻⁷)	<RDL
	2/22/2007	NS	NS	NS
	10/10/2007	<RDL (7.40 x 10 ^{-3d})	<RDL (5.70 x 10 ⁻¹¹)	<RDL
	3/19/2008	NS	NS	PF
	6/26/2009	<RDL (2.46 x 10 ^{-2d})	NR	<RDL
	6/09/2010	NS	<RDL (10.4 x 10 ⁻¹⁰)	<RDL
	6/09/2010 ^c	NS	<RDL (10.8 x 10 ⁻¹⁰)	<RDL
	5/10/2011	NS	NS	<RDL
	6/26/2012	NS	NS	<RDL
	11/06/2013	<RDL (4.76 x 10 ^{-2e})	<RDL (1.75 x 10 ⁻¹⁰)	<RDL
	12/16/2014	NS	NS	<RDL
MV-2	3/16/2006 ^b	<RDL (9.92 x 10 ⁻²)	<RDL (2.58 x 10 ⁻⁷)	<RDL
	9/22/2006 ^b	<RDL (1.30 x 10 ⁻²)	<RDL (2.60 x 10 ⁻⁷)	<RDL
	2/22/2007	<RDL (1.54 x 10 ^{-3d})	<RDL (9.70 x 10 ⁻¹¹)	<RDL
	2/22/2007 ^c	<RDL (1.84 x 10 ^{-3d})	<RDL (11.1 x 10 ⁻¹¹)	<RDL
	3/19/2008	NS	NS	<RDL
	6/26/2009	<RDL (5.55 x 10 ^{-3d})	NR	<RDL
	6/08/2010	NS	<RDL (10.9 x 10 ⁻¹⁰)	<RDL
	5/11/2011	NS	NS	<RDL
	6/27/2012	NS	NS	<RDL
	11/07/2013	<RDL (2.20 x 10 ^{-2e})	<RDL (1.24 x 10 ⁻¹⁰)	<RDL
	12/16/2014	NS	NS	<RDL
	MV-2LPZ ^a – Sample depth 490 ft	8/5/2008	NS	NS
MV-2LPZ ^a – Sample depth 3,471 ft	8/5/2008	NS	NS	<8,000
MV-3	3/16/2006 ^b	<RDL (3.95 x 10 ⁻²)	<RDL (2.10 x 10 ⁻⁷)	<RDL
	9/22/2006 ^b	<RDL (5.11 x 10 ⁻²)	<RDL (2.20 x 10 ⁻⁷)	<RDL
	2/22/2007	<RDL (1.01 x 10 ^{-2d})	<RDL (14.0 x 10 ⁻¹¹)	<RDL
	3/19/2008	NS	NS	<RDL
	6/25/2009	<RDL (3.87 x 10 ^{-2d})	NR	<RDL
	6/08/2010	NS	<RDL (14.2 x 10 ⁻⁹)	<RDL
	5/10/2011	NS	NS	<RDL
	6/26/2012	NS	NS	<RDL
	11/05/2013	<RDL (6.58 x 10 ^{-2e})	<RDL (7.32 x 10 ⁻¹⁰)	<RDL
	12/17/2014	NS	NS	<RDL
MV-4	6/24/2009	<RDL (9.17 x 10 ^{-4d})	NR	<RDL
	8/30/2010	NS	<RDL (7.50 x 10 ⁻¹¹)	<RDL
	5/10/2011	NS	NS	<RDL
	5/10/2011 ^c	NS	NS	<RDL
	6/26/2012	NS	NS	NW
	11/07/2013	<RDL (2.54 x 10 ^{-3e})	<RDL (1.80 x 10 ⁻¹¹)	<RDL
	12/17/2014	NS	NS	<RDL

Table B-1 (continued). Radioisotopic Sample Results

Monitoring Location	Date	Carbon-14 (pCi/L)	Iodine-129 (pCi/L)	Tritium (pCi/L)
MV-4PZ ^a	6/26/2012	NS	NS	<RDL
MV-5	6/25/2009	<RDL (2.30 x 10 ^{-3d})	NR	<RDL
	5/26/2010	NS	<RDL (5.70 x 10 ⁻¹¹)	<RDL
	5/11/2011	NS	NS	<RDL
	6/26/2012	NS	NS	NW
	11/07/2013	<RDL (7.81 x 10 ^{-3e})	<RDL (8.90 x 10 ⁻¹¹)	<RDL
	12/17/2014	NS	NS	<RDL
MV-5PZ ^a	6/26/2012	NS	NS	<RDL
MV-6	11/06/2013	<RDL (4.87 x 10 ^{-2e})	<RDL (9.00 x 10 ⁻¹¹)	<RDL
	11/06/2013 ^c	NS	NS	<RDL
	12/18/2014	NS	NS	<RDL
HTH-1RC	6/25/2009	<RDL (2.75 x 10 ^{-3d})	NR	<RDL
	6/09/2010	NS	<RDL (11.0 x 10 ⁻¹¹)	<RDL
	5/11/2011	NS	NS	<RDL
	6/27/2012	NS	NS	<RDL
	11/08/2013	PF	PF	PF
	12/16/2014	NS	NS	<RDL
	12/16/2014 ^c	NS	NS	<RDL
HTH-2	6/25/2009	<RDL (7.98 x 10 ^{-2d})	NR	<RDL
	6/09/2010	NS	PF	PF
	5/11/2011	NS	NS	PF
	6/27/2012	NS	NS	PF
	11/06/2013	<RDL (8.52 x 10 ^{-2e})	<RDL (6.20 x 10 ⁻¹¹)	<RDL
	12/17/2014	NS	NS	<RDL
UC-1-P-1SRC	6/24/2009	<RDL (1.07 x 10 ^{-1d})	NR	<RDL
	5/22/2010	NS	<RDL (5.20 x 10 ⁻¹¹)	<RDL
	5/10/2011	NS	NS	<RDL
	6/27/2012	NS	NS	<RDL
	11/06/2013	<RDL (9.54 x 10 ^{-2e})	<RDL (1.08 x 10 ⁻¹⁰)	<RDL
	12/17/2014	NS	NS	<RDL

^a Sample was collected using a depth-specific bailer; sample depths from lower piezometer of MV-2 are provided with the well name.

^b Sample results for tritium were obtained by the enriched tritium method, and the analytical results are from the Desert Research Institute Monitoring Report (DRI 2006).

^c Duplicate sample (not required for ¹⁴C and ¹²⁹I).

^d Estimated based on sample volume of 200 milliliters.

^e Calculated based on the total alkalinity concentration.

NR = not analyzed because of insufficient sample volume.

NS = not sampled because the radioisotope was not part of the analytical suite.

NW = not sampled to allow water levels in the well time to recover.

PF = pump failed and a sample could not be collected.

<RDL = below required detection limit (laboratory result in parentheses; RDL is 400 pCi/L for tritium, 5 pCi/L for ¹⁴C, and 0.1 pCi/L for ¹²⁹I [DOE 2004]).

Appendix C

**NDEP Correspondence with Record of Review
and Response to Comments
(to be added later)**

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March 25, 2015



Mr. Mark Kautsky
Site Manager
U. S. Department of Energy
Office of Legacy Management
2597 Legacy Way
Grand Junction, CO 81503

RE: Draft 2014 Groundwater Monitoring Report Central Nevada Test Area Subsurface
Corrective Action Unit (CAU) 443
Federal Facility Agreement and Consent Order

Dear Mr. Kautsky:

The Nevada Division of Environmental Protection, Bureau of Federal Facilities (NDEP) has reviewed the U. S. Department of Energy, Office of Legacy Management's *Draft 2014 Groundwater Monitoring Report Central Nevada Test Area Subsurface CAU 443* received on March 9, 2015. While this letter serves as a Notice of Completion for the March 16, 2015 Milestone Deadline for the "Draft 2014 Monitoring Report," the NDEP has the following comments on the Report which should be addressed in the Final version:

1. Page V, Executive Summary, Second Paragraph, First sentence and Page 18, Section 6.0, First Paragraph, Third sentence, "... in all wells in the monitoring network.": This is not a true statement; change to "...in all *sampled* wells in the..." to correct the statement.
2. Page 2, Section 2.1, Third Paragraph, Third sentence: "DOE proposed ..." This should be DOE/LM.
3. Page 4, Section 2.1, End of First incomplete sentence on Top of Page: Please change this phrase back to what historically occurred at this point in time, which was "initiating a new 5-year proof-of-concept monitoring period to validate the compliance boundary" (see the 2013 report).
4. Page 4, Section 2.1, Third full Paragraph, Fourth sentence: Please change "... determine the vertical flow direction..." to "... estimate the vertical flow direction at this location.."

Mr. Mark Kautsky
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5. Page 4, Section 2.1, Third full Paragraph, Fifth sentence: Please change "... can be estimated ..." to "... can be estimated at this location..."
6. Page 5, Section 2.1, Last Paragraph: Please include a statement that describes the July 2013 ROTC, in particularly the "conceptual model evaluation period." Also include any new events since the 2013 well drilling.
7. Page 5, Section 2.1, Last Paragraph, First sentence: The ROTC for July 2013 is not in the references; please add it.
8. Page 8, Section 4.0, First Paragraph, Third sentence, "... could not be verified against data ...": Please change verified to validated to be consistent with use on Page 2.
9. Page 9, Section 4.1, Second Paragraph, Second sentence: Please remain true to the site history and change the phrase "conceptual model evaluation period" back to "5-year proof-of-concept period."
10. Page 11, Section 4.2, First Paragraph, First sentence: The ROTC for March 2012 is not in the references; please add it.
11. Page 13, Section 4.4, First Paragraph, Seventh sentence: Should the HTH-1 in this sentence be HTH-1RC?
12. Page 18, Section 6.0, Second Paragraph: Please replace "as stated above" at the end of the last sentence with "as seen and confirmed with MV-6 data."

If you would like to discuss these comments, please contact me at 702-486-2850, ext. 232, or Mark McLane at ext. 226.

Sincerely,



Christine D. Andres
Chief
Bureau of Federal Facilities

CDA/MM

Mr. Mark Kautsky

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ec: EM Records, AMEM, NNSA/NFO, Las Vegas, NV
Navarro Central Files, MS, NSF 156, Las Vegas, NV

cc: EM Records, NNSA/NFO, Las Vegas, NV
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Record of Review

Due Date 4/30/15	Review No. 1	Project CNTA	Type of Review Draft Report - Technical Review
Document Title and/or Number and Revision Draft 2014 Groundwater Monitoring Report, Central Nevada Test Area, Subsurface Corrective Action Unit 443			Reviewers' Recommendation <input type="checkbox"/> Release Without Comment <input type="checkbox"/> Consider Comments <input checked="" type="checkbox"/> Resolve Comments and Reroute for Review <div style="text-align: right;">Comments provided in NDEP letter dated March 25, 2015</div> <hr style="width: 100%;"/> <div style="text-align: right;"><i>Signature of Reviewer and Date</i></div> <input checked="" type="checkbox"/> Comments Have Been Addressed <div style="text-align: right;"><i>Mark Kautsky</i> Digitally signed by Mark Kautsky Date: 2015.04.09 09:05:42 -06'00'</div> <hr style="width: 100%;"/> <div style="text-align: right;"><i>Signature of Author and Date</i></div> <input checked="" type="checkbox"/> Comment Resolution Satisfactory <input type="checkbox"/> Comment Resolution Unsatisfactory <div style="text-align: right;"><i>Mark McJone</i></div> <hr style="width: 100%;"/> <div style="text-align: right;"><i>Signature of Reviewer and Date</i></div>
Author Mark Kautsky			
Author's Organization Department of Energy Office of Legacy Management		Author's Phone (970) 248-6018	
Reviewer Nevada Division of Environmental Protection			
Reviewer's Organization Nevada Division of Environmental Protection		Reviewer's Phone (702) 486-2850	

Item No.	Reviewer's Comments and Recommendation	Reqd. (Y/N)	Item No.	Author's Response (if required)
1	Page V, Executive Summary, Second Paragraph, First sentence and Page 18, Section 6.0, First Paragraph, Third sentence, "... in all wells in the monitoring network.": This is not a true statement; change to "...in all sampled wells in the..." to correct the statement.	Y	1	The change was made in both sections as requested.
2	Page 2, Section 2.1, Third Paragraph, Third sentence: "DOE proposed ..." This should be DOE/LM.	Y	2	The change was made as requested.
3	Page 4, Section 2.1, End of First incomplete sentence on Top of Page: Please change this phrase back to what historically occurred at this point in time, which was "initiating a new 5-year proof-of-concept monitoring period to validate the compliance boundary" (see the 2013 report).	Y	3	The change was made as requested.
4	Page 4, Section 2.1, Third full Paragraph, Fourth sentence: Please change "... determine the vertical flow direction..." to "... estimate the vertical flow direction at this location.."	Y	4	The change was made as requested.

U.S. Department of Energy Office of Legacy Management

Record of Review (continuation)

Review No.	Project			
Item No.	Reviewer's Comments and Recommendation	Reqd. (Y/N)	Item No.	Author's Response (if required)
5	Page 4, Section 2.1, Third full Paragraph, Fifth sentence: Please change "... can be estimated ..." to "... can be estimated at this location..."	Y	5	The change was made as requested.
6	Page 5, Section 2.1, Last Paragraph: Please include a statement that describes the July 2013 ROTC, in particularly the "conceptual model evaluation period." Also include any new events since the 2013 well drilling.	Y	6	A sentence was added to describe the July 2013 ROTC as requested. No additional changes were made to the paragraph because no new events, other than the typical monitoring events, have occurred since the 2013 drilling.
7	Page 5, Section 2.1, Last Paragraph, First sentence: The ROTC for July 2013 is not in the references; please add it.	Y	7	The reference was added as requested.
8	Page 8, Section 4.0, First Paragraph, Third sentence, "... could not be verified against data ...": Please change verified to validated to be consistent with use on Page 2.	Y	8	The change was made as requested.
9	Page 9, Section 4.1, Second Paragraph, Second sentence: Please remain true to the site history and change the phrase "conceptual model evaluation period" back to "5-year proof-of-concept period."	Y	9	The change was made as requested.
10	Page 11, Section 4.2, First Paragraph, First sentence: The ROTC for March 2012 is not in the references; please add it.	Y	10	The reference was added as requested.
11	Page 13, Section 4.4, First Paragraph, Seventh sentence: Should the HTH-1 in this sentence be HTH-1RC?	Y	11	The sentence was revised to include the well identification "HTH-1RC".
12	Page 18, Section 6.0, Second Paragraph: Please replace "as stated above" at the end of the last sentence with "as seen and confirmed with MV-6 data."	Y	12	The sentence was revised as requested.

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