

Post-Closure Inspection and Monitoring Report for Surface Corrective Action Unit 417 at the Central Nevada Test Area, Nevada, Site

January 2015

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Contents

Abbreviations.....	iii
Executive Summary.....	v
1.0 Introduction.....	1
1.1 Purpose.....	1
1.2 Site Location and Background.....	1
1.3 Geologic Setting.....	2
2.0 Post-Closure Monitoring Requirements.....	5
2.1 Site Inspections.....	5
2.2 Maintenance and Repair.....	5
2.3 Cover Moisture Monitoring.....	6
2.4 Cover Moisture Compliance Criteria.....	8
2.5 Reporting Requirements.....	8
3.0 Site Inspections, Surveys, and Maintenance.....	9
3.1 Biennial Site Inspection Results.....	9
3.1.1 UC-1 Inspection.....	9
3.1.2 UC-3 Inspection.....	9
3.1.3 UC-4 Inspection.....	9
3.2 Subsidence Survey Results.....	9
3.2.1 UC-1 Survey.....	9
3.2.2 UC-4 Survey.....	12
3.3 Vegetation Survey Results.....	12
3.4 Precipitation and Soil Moisture Monitoring Results.....	16
3.4.1 UC-1 Soil Moisture Results.....	16
4.0 Summary, Conclusions, and Recommendations.....	21
4.1 Summary.....	21
4.2 Conclusions.....	21
4.3 Recommendations.....	22
5.0 References.....	23

Figures

Figure 1. CNTA Location Map.....	2
Figure 2. Surface Map of CAU 417 at the CNTA.....	3
Figure 3. UC-1 CMP Cover Monitoring Instrumentation.....	7
Figure 4. Location of UC-1 Significant Features.....	10
Figure 5. Location of UC-3 Significant Features.....	10
Figure 6. Location of UC-4 Significant Features.....	11
Figure 7. UC-1 CMP Cover Settlement.....	11
Figure 8. UC-4 West and East Monuments.....	13
Figure 9. UC-4 Cover Settlement.....	14
Figure 10. View southeast of UC-1 CMP from middle of gate along north fence line.....	15
Figure 11. View east of UC-4 Mud Pit Cap from west survey marker.....	15
Figure 12. July 1, 2012, through June 3, 2014, Site Precipitation Data.....	16
Figure 13. UC-1 Soil Moisture Content, East TDR Nest A.....	17
Figure 14. UC-1 Soil Moisture Content, East TDR Nest B.....	17

Figure 15. UC-1 Soil Moisture Content, West TDR Nest A 18
Figure 16. UC-1 Soil Moisture Content, West TDR Nest B 18

Appendixes

Appendix A Inspection Checklists and Photographs—2014
Appendix B Historical Survey, Precipitation, and Moisture Data
Appendix C Vegetation Survey—2014
Appendix D NDEP Correspondence and Record of Review

Abbreviations

bgs	below ground surface
CAU	Corrective Action Unit
cm	centimeters
CMP	Central Mud Pit
CNTA	Central Nevada Test Area
DOE	U.S. Department of Energy
FFACO	Federal Facility Agreement and Consent Order
ft	feet
km	kilometers
LM	Office of Legacy Management
m	meters
mm	millimeters
NDEP	Nevada Division of Environmental Protection
SGZ	Surface ground zero
SM	subsidence monument
SOARS	System Operation and Analysis at Remote Sites
TDR	time domain reflectometry
VMC	volumetric moisture content

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Executive Summary

This report presents results of data collected during the biennial post-closure site inspections conducted in July 2014 at the surface Corrective Action Unit (CAU) 417 at the Central Nevada Test Area, Nevada, site. The every-other-year post-closure site inspections included inspections of the UC-1, UC-3, and UC-4 sites in accordance with the Post-Closure Monitoring Plan provided in the CAU 417 Closure Report (NNSA/NV 2001).

The biennial inspection conducted at the UC-1 Central Mud Pit (CMP) indicated that the site and soil cover were in good condition. No new fractures or extensions of existing fractures were observed and no issues with the fence or gate were identified. The vegetation on the cover continues to be healthy. Precipitation measured from July 1, 2012, through June 30, 2013, totaled 179.6 millimeters (mm) or 7.1 inches. Precipitation measured from July 1, 2013, through June 3, 2014, totaled 157.0 mm or 6.2 inches. Soil moisture content data show that the UC-1 CMP cover is performing as designed, and evapotranspiration is effectively removing water from the cover.

The biennial subsidence survey was conducted at the UC-1 CMP and the UC-4 Mud Pit C in November 2013. The results of the subsidence surveys indicate that the covers are performing as expected, and no unusual subsidence was observed.

The inspection at UC-3 indicated that the site is in good condition. All monuments and signs showed no displacement or damage, and none have been removed. No other issues or concerns were identified.

The inspection at UC-4 indicated that the site is in good condition. All monuments and signs showed no displacement or damage, and none have been removed.

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1.0 Introduction

This report presents data collected during the biennial post-closure site inspection conducted by the U.S. Department of Energy (DOE) Office of Legacy Management (LM) at the surface Corrective Action Unit (CAU) 417 at the Central Nevada Test Area (CNTA), Nevada, site. This report has been prepared in accordance with the Post-Closure Monitoring Plan contained in the CAU 417 Closure Report (NNSA/NV 2001) and Federal Facility Agreement and Consent Order (FFACO) (FFACO 1996). Responsibility for environmental site restoration of the CNTA was transferred from the DOE Office of Environmental Management to LM on October 1, 2006.

This report provides an analysis and summary of the every-other-year site inspection and subsidence survey, meteorological information, vegetation survey, and soil moisture monitoring data collected since the last biennial inspection in July 2012. In 2011, LM and the Nevada Division of Environmental Protection (NDEP) agreed that the post-closure inspections and surveying of the subsidence monuments would be performed every other year with the first biennial monitoring event to be performed in 2012. A Record of Technical Change to the CAU 417 Closure Report was prepared to document the change. A post-closure inspection was conducted in 2014 to document the physical condition of the CAU 417 soil covers, monuments, signs, fencing, and restricted-use areas. The inspection included subsidence surveys of the UC-1 Central Mud Pit (CMP) and UC-4 Mud Pit C covers and an evaluation of soil moisture data collected from the upper 1.2 meters (m) (4 feet [ft]) of the UC-1 CMP cover.

1.1 Purpose

The purpose of the post-closure inspection at CAU 417 is to determine if:

- The UC-1 CMP or UC-4 Mud Pit C cover, fences, or diversion channels need maintenance or repairs.
- The UC-1 CMP or UC-4 Mud Pit C cover is subsiding.
- The UC-1 CMP cover is performing as designed, by evaluating soil moisture data to determine if infiltration of precipitation is being limited by evapotranspiration from vegetation on the cover.
- Vegetation on the UC-1 CMP cover is healthy.
- The aboveground monuments or warning signs at UC-1, UC-3, and UC-4 need maintenance or repairs.
- The administrative controls need modifications.

1.2 Site Location and Background

The CNTA is approximately 22.5 kilometers (km) (14 miles) north of U.S. Highway 6 and approximately 110 km (68 miles) northeast of Tonopah in Nye County, Nevada (Figure 1). Three emplacement boreholes, UC-1, UC-3, and UC-4, were drilled at the CNTA for underground nuclear weapons testing. On January 19, 1968, the Faultless underground nuclear test was conducted in borehole UC-1 at a depth of 975 m (3,200 ft) below ground surface (bgs). The other two emplacement boreholes (UC-3 and UC-4) were not used, and no further testing was conducted at the CNTA. Boreholes UC-1, UC-3, and UC-4 are located on three separate land

withdrawals that range in size from approximately 2.6 to 3.9 square kilometers (1 to 1.5 square miles) (Figure 2). All three land withdrawals are accessible to the public.

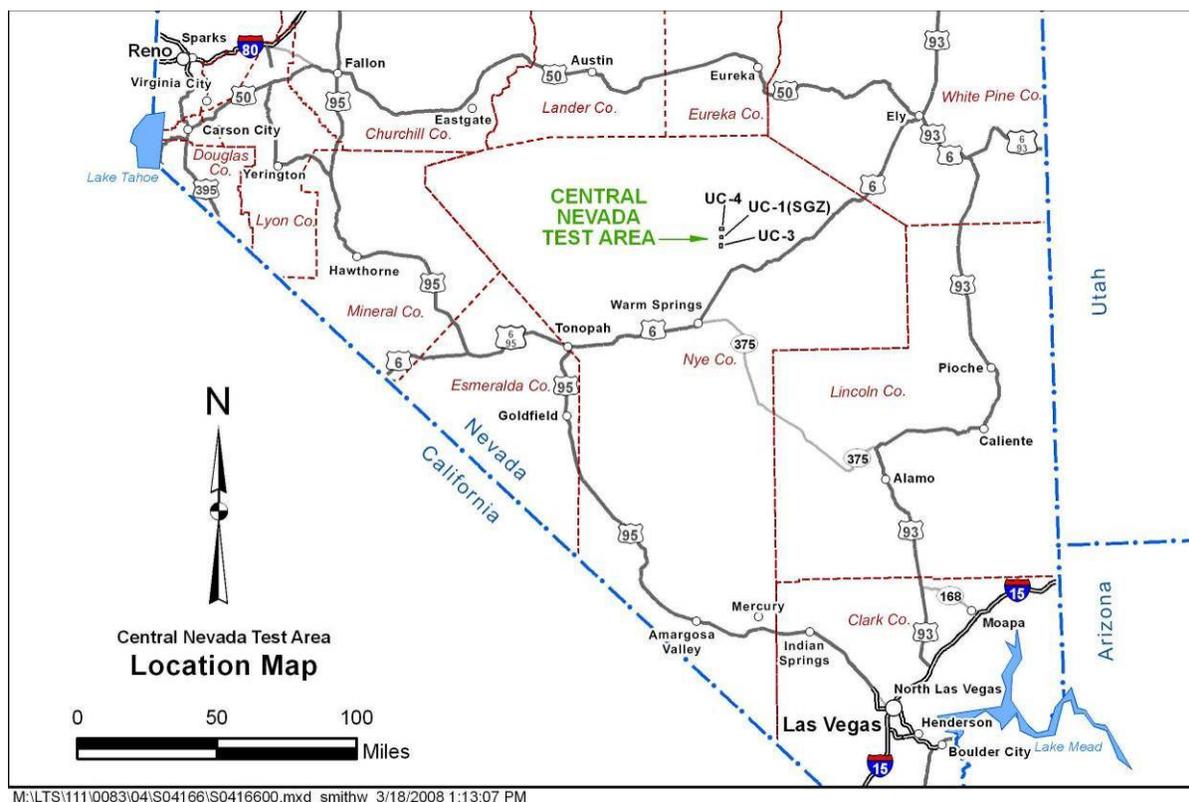
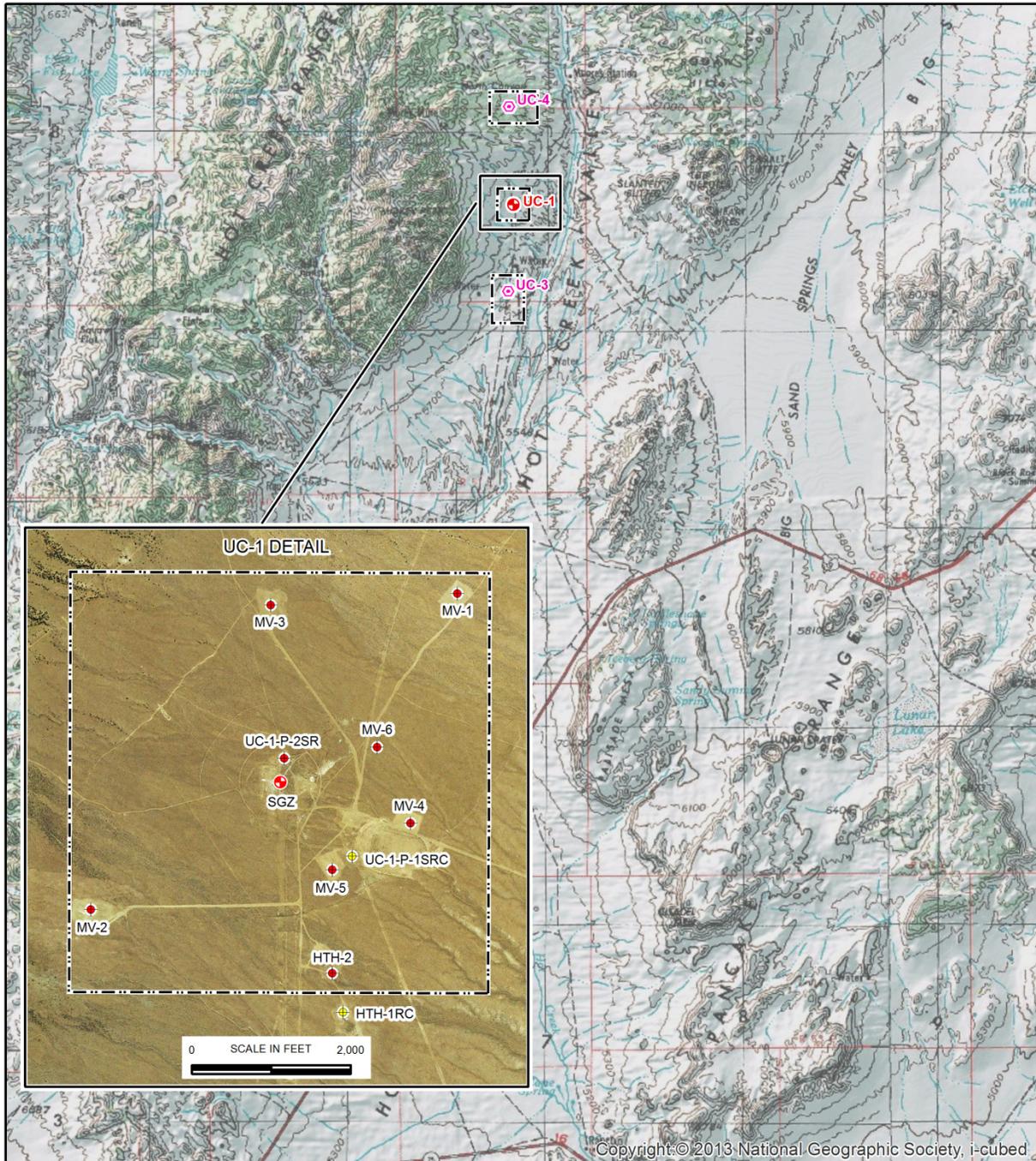


Figure 1. CNTA Location Map

1.3 Geologic Setting

The CNTA is in the north-central portion of the Hot Creek Valley within the Basin and Range physiographic province. This province consists of roughly north-south-trending mountain ranges separated by alluvial valleys. The UC-1 site lies at an elevation of 1,860 m (6,100 ft) above mean sea level and is bordered by the Hot Creek Range to the west and the Pancake Range to the east. The Hot Creek Range is composed of Paleozoic sedimentary rocks and Tertiary volcanic rocks. The Paleozoic rocks consist of sandstone, quartzite, limestone, and dolomite, and the Tertiary volcanic rocks consist of welded tuff; nonwelded, bedded tuff; argillized and zeolitized tuff; conglomeratic, tuffaceous sandstone; carbonaceous siltstone; and rhyolite (Healey 1968). The alluvium at UC-1 is approximately 730 m (2,400 ft) thick and is underlain by tuffaceous sediments and zeolitized tuffs to a depth of approximately 998 m (3,275 ft) (Barnes 1968). The Morey Peak–Hot Creek Caldera is thought to be buried by deposits of tuff and alluvium beneath the northern portion of Hot Creek Valley (Healey 1968).



LEGEND SGZ FAULTLESS EMPLACEMENT WELL WELL LOCATION RECOMPLETED IN JUNE 2009 WITHDRAWAL BOUNDARY		U.S. DEPARTMENT OF ENERGY GRAND JUNCTION, COLORADO <small>Work Performed by S.M. Stoller Corporation Under DOE Contract No. DE-LM0000415</small>
SCALE IN MILES 0 5 10 		Central Nevada Test Area, NV, Site Regional Map
DATE PREPARED: October 23, 2014		FILENAME: S1230200

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Figure 2. Surface Map of CAU 417 at the CNTA

The Faultless test resulted in the subsidence of an irregularly shaped area of approximately 1.5 square kilometers (0.6 square mile). One northeast-trending fault scarp extends beneath the southeastern corner of the UC-1 CMP, with as much as 4.6 m (15 ft) vertical displacement. The formation of this scarp disrupted normal drainage patterns, so flood diversion channels were constructed to protect the cover and prevent infiltration along the fault scarp (NNSA/NV 2001). The depth to water at the UC-1 CMP is approximately 84 m (275 ft) bgs based on measurements obtained from well UC-1-P-1SRC¹ prior to and after its recompletion in June 2009 (Figure 2). Water levels measured before the recompletion of UC-1-P-1S had been suspect because difficulties were encountered during the well's drilling and construction in 1968. Historically, the reported depth to water of 168 m (550 ft) bgs at the CMP was based on measurements obtained from well HTH-2. Well HTH-2 is outside the down-drop graben block, nearly 457 m (1,500 ft) southwest of the CMP. Well UC-1-P-1SRC is inside the down-drop graben block, less than 61 m (200 ft) west of the CMP. The differing depths to water inside and outside the graben block (northwest and southeast of the southeast bounding fault) were confirmed by the 2009 drilling program. Wells MV-4 and MV-5 were drilled through the southeast graben fault and were dual completions with a piezometer inside the graben and a well outside the graben. The depth to water of the piezometers is consistent with that of well UC-1-P-1SRC, approximately 84 m (275 ft) bgs. The depth to water of the wells outside the graben is consistent with that of well HTH-2, approximately 168 m (550 ft) bgs. Well HTH-1RC (outside the graben block) was also recompleted in 2009 with two piezometers (upper and lower alluvial aquifer) and a well (upper volcanic section). The depth to water of both HTH-1RC piezometers is approximately 168 m (550 ft) bgs.

¹ RC indicates that the well has been recompleted.

2.0 Post-Closure Monitoring Requirements

This section outlines the post-closure monitoring requirements for the biennial inspections at the CNTA. The post-closure monitoring requirements were originally provided in the Post-Closure Monitoring Plan, provided in the CAU 417 Closure Report (NNSA/NV 2001).

2.1 Site Inspections

Quarterly inspections were conducted from the time of the site's closure (in 2000) through 2006. From 2007 through 2010, post-closure inspections of CAU 417 were performed annually. Beginning in 2012, the post-closure inspections are conducted biennially. This inspection report contains the information collected during the biennial monitoring period that started in July 2012 and ended in July 2014. Each biennial site inspection is documented on an inspection checklist, with site photographs and, if applicable, field notes. A post-closure inspection consists of the following:

- Inspecting the UC-1 CMP cover and UC-4 Mud Pit C cover and fencing. This includes walking the entire perimeter of the fence and documenting the condition of the barbed-wire and chicken-wire fencing, warning signs, and entrance gate.
- Inspecting all aboveground monuments, attached warning signs, and affixed survey pins placed at the UC-1, UC-3, and UC-4 sites for signs of wear, disturbance, vandalism, animal burrows, and other damage. Damaged monuments and attached signs are repaired during site inspections or, if necessary, later in the calendar year.
- Inspecting the condition of the 2 subsidence monuments (SMs) on the UC-4 Mud Pit C cover and the 12 SMs on the UC-1 CMP cover. A subsidence survey of all SMs is conducted during the biennial monitoring period to determine if the covers have subsided.
- Documenting any changes to the covers or fenced areas, including but not limited to the presence of trash and debris inside the fenced areas, animal burrows on the covers or under the perimeter fences, erosion features on the covers or diversion channels, and any change in the health and stability of the UC-1 CMP cover vegetation.
- Documenting the soil water content profile of the UC-1 CMP cover to evaluate if infiltration of precipitation is being limited by evapotranspiration on the cover, as designed.
- Biennially reporting on the health and stability of the UC-1 CMP cover vegetation.

2.2 Maintenance and Repair

If a site inspection detects that either the UC-1 CMP cover or the UC-4 Mud Pit C cover is not in compliance, if conditions requiring major repairs are noted, or if any other problems in critical areas are noted, then issues will be evaluated and reported to NDEP within 60 days of detection (in compliance with the FFAO). The following guidelines apply to CAU 417 maintenance and repairs:

- Cracks, settling features, erosion rills, and animal burrows more than 15 centimeters (cm) (6 inches) deep that extend 1 m (3 ft) or more and that do not compromise the UC-1 CMP or UC-4 Mud Pit C covers will be evaluated and repaired within 90 days of detection.

- Noncritical cracks, settling features, erosion rills, and animal burrows less than 15 cm (6 inches) deep that extend less than 1 m (3 ft) will be repaired during the site inspection visit.
- Damage to the fencing surrounding the UC-1 CMP cover or the UC-4 Mud Pit C cover, warning signs, or monuments will be evaluated and repaired within 90 days of detection.
- Major damage to use-restriction warning signs or monuments will be evaluated and repaired during subsequent site inspections.
- All repair work will preserve the original as-built design and will be documented in the biennial Post-Closure Inspection and Monitoring Report.

2.3 Cover Moisture Monitoring

The CNTA UC-1 CMP monolayer cover is designed to limit infiltration of moisture into the disposal unit by evapotranspiration from vegetation that was established on the cover. The cover performance is monitored using time domain reflectometry (TDR) sensor data to provide a profile of the water content in the cover. The soil water content profile determines whether the cover is performing as designed and if it complies with the closure plan and agreements.

The soil moisture content data are obtained using a Campbell Scientific TDR100 time domain reflectometer and recorded by a Campbell Scientific CR1000 datalogger and a radio housed in an instrument vault located just off the southern edge of the cover. The radio transmits data to an onsite telemetry station. Soil moisture data are being recorded twice daily, and they are imported into and saved in the SOARS (System Operation and Analysis at Remote Sites) system at the LM office at Grand Junction, Colorado. The post-processing software that SOARS uses automatically produces graphs, creates tables, and backs up data daily.

TDR sensors were buried in the cover at two locations (West TDR and East TDR) during cover construction. At both locations, two TDR sensors were placed below the surface of the cover at the following depths: 0.15, 0.46, 0.76, and 1.07 m (0.5, 1.5, 2.5, and 3.5 ft) (Figure 3). The TDR nests are located approximately 48 m (157 ft) northwest and 48 m (157 ft) northeast of the instrument vault.

The TDR probes were calibrated to volumetric moisture content (VMC) using a dry-down method with native soil and full-length cable. The results of the calibration indicated that a site-specific calibration equation should be used instead of the standard Topp equation (Topp et al. 1980). It was also found that long cable lengths and soil conductivities caused the TDR reflection end points to become extremely flat under saturated and near-saturated conditions, resulting in unreliable data in these regions.

A fourth-order polynomial fit of the calibration data, over the range of 5 to 35 percent VMC, yielded the following calibration equation:

$$\text{VMC (\%)} = -308.701 + 373.1803(L/L) - 163.644(L/L)^2 + 31.82972(L/L)^3 - 2.25548(L/L)^4$$

Where L/L is the ratio of cable length to probe length as recorded by the data logger.

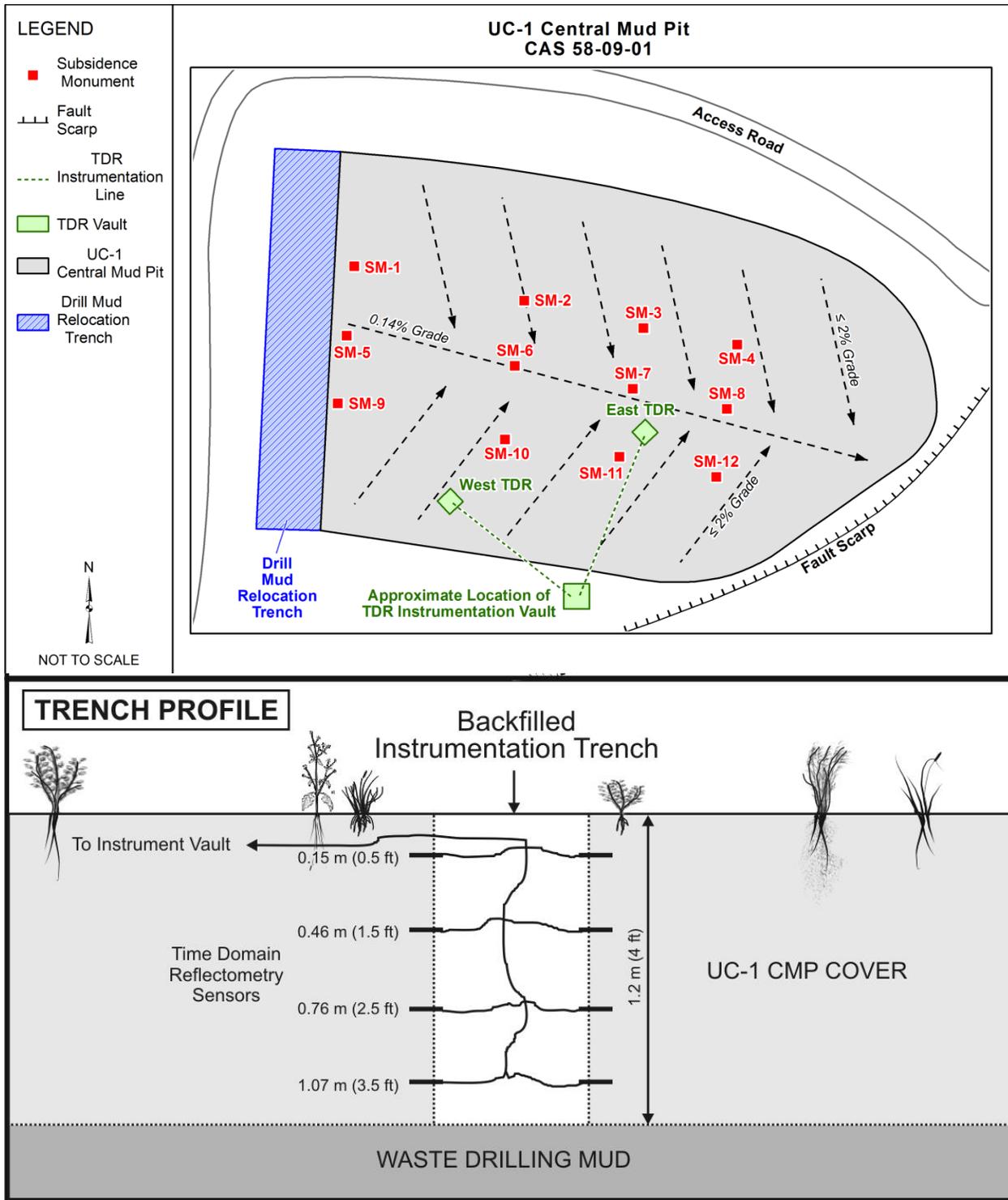


Figure 3. UC-1 CMP Cover Monitoring Instrumentation

2.4 Cover Moisture Compliance Criteria

The depth of the deepest TDR soil moisture probe is the point of compliance for the UC-1 CMP cover, which is approximately 1.07 m (3.5 ft) below ground surface. Cover compliance will be based on the soil moisture content of the cover once steady-state conditions are reached. Cover performance modeling presented in the CAU 417 Corrective Action Plan (DOE/NV 2000) predicted that steady-state conditions would be achieved within 10 years of cover construction, which was completed in September 2000.

If soil moisture data indicate that the cover is not operating according to established compliance criteria, NDEP will be notified of the noncompliance within 14 days. After NDEP has been notified of the noncompliance, LM will submit a work plan to NDEP within 90 days; the work plan will outline the proposed remediation/investigation plan. All corrective actions will be documented in the biennial Post-Closure Inspection and Monitoring Report.

2.5 Reporting Requirements

All inspection and maintenance activities conducted during the biennial monitoring period are documented and included in the biennial Post-Closure Inspection and Monitoring Report. LM submits the report to NDEP and includes the following information:

- A brief narrative and discussion of all post-closure inspection activities and observations.
- Copies of all completed inspection checklists and maintenance records.
- UC-1 CMP soil moisture content profiles for the current monitoring period.
- Subsidence survey data.
- Specific recommendations for nonstandard maintenance or changes in post-closure requirements.

All closure and post-closure monitoring documentation is maintained in project files and is available upon request.

3.0 Site Inspections, Surveys, and Maintenance

This section contains the results of the inspections and surveys that were done during the biennial monitoring period at the CNTA. It also includes a description of any maintenance that was performed.

3.1 Biennial Site Inspection Results

The biennial inspections of the three sites were performed on July 16, 2014. Copies of the inspection checklists and photographs are included in Appendix A. The following sections summarize the inspection results.

3.1.1 UC-1 Inspection

The locks, fencing, SMs, and signs associated with the CMP were in good condition. No new cracks or fractures, and no extension of existing cracks or fractures, were identified in the soil cover at the time of the inspections. The vegetation on the cover continues to look healthy and stable. All other signs and monuments at Mud Pits A and E (Figure 4) were in excellent condition.

3.1.2 UC-3 Inspection

The site was in excellent condition (Figure 5). No issues with the monuments or signs were identified at the time of the inspections, and no maintenance or repairs were recommended.

3.1.3 UC-4 Inspection

The Mud Pit C fence and SMs were in good condition at the time of the inspections. No erosion rills were identified, and previously identified rills showed no further signs of activity. No new erosion concerns were apparent at the time of the inspections. No issues that affected the integrity of the cover and appurtenances were noted. Mud Pits A, B, and D were in excellent condition, and no issues were identified with Area S or Area X (Figure 6).

3.2 Subsidence Survey Results

Surveys of the SMs for UC-1 and UC-4 were performed on November 6, 2013, to correspond with the well head survey after installation of the groundwater monitoring well MV-6 at the site. The following sections summarize the survey results.

3.2.1 UC-1 Survey

Twelve SMs were installed on the UC-1 CMP cover to provide elevation control and to measure subsidence of the cover and relocation trench (NNSA/NV 2001). Figure 3 shows these SMs. The baseline subsidence survey was completed on December 4, 2000, and is used as the reference to calculate subsidence for each subsequent survey. Beginning in 2007, annual subsidence monitoring replaced the semiannual subsidence monitoring that had taken place since 2002. In 2011, the annual subsidence monitoring was replaced by biennial subsidence monitoring that was conducted for the first time in 2012. The UC-1 baseline survey locations and elevations are provided in Table B-1 in Appendix B, and are presented in graphical form in Figure 7.

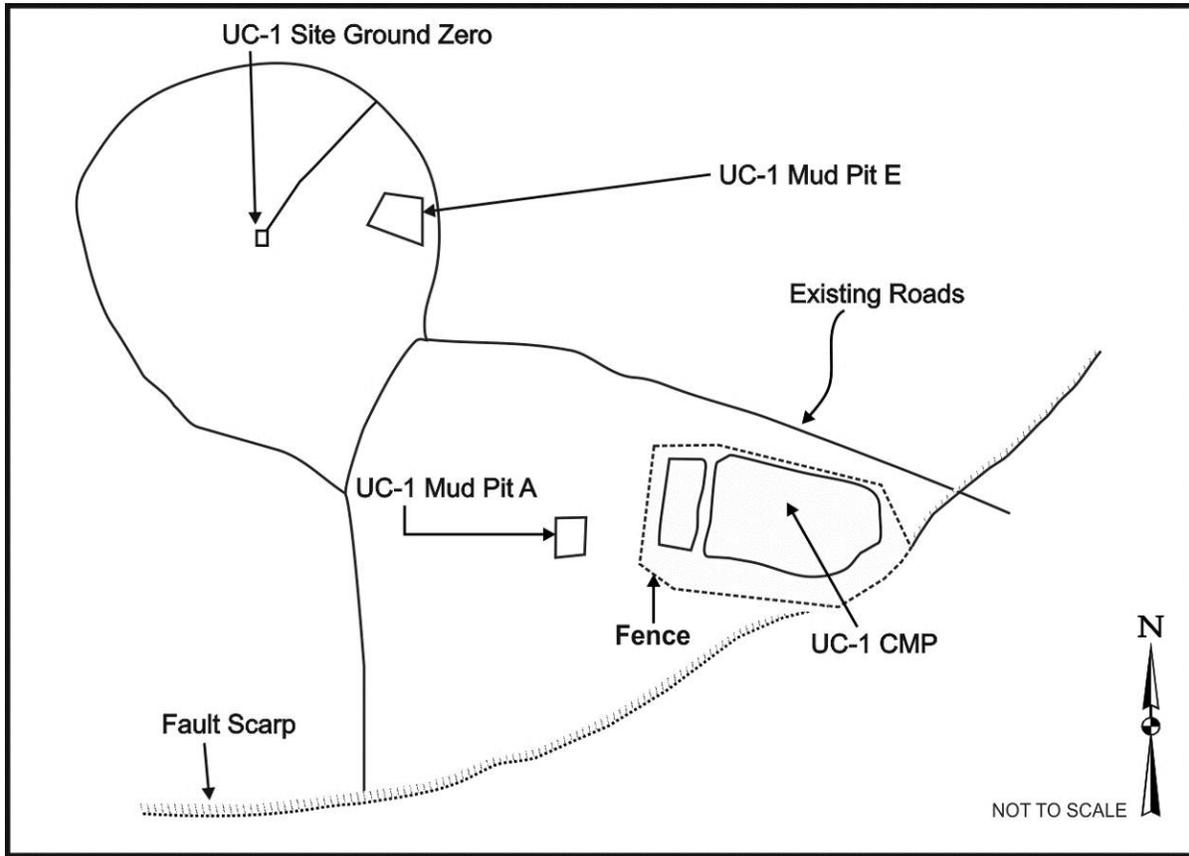


Figure 4. Location of UC-1 Significant Features

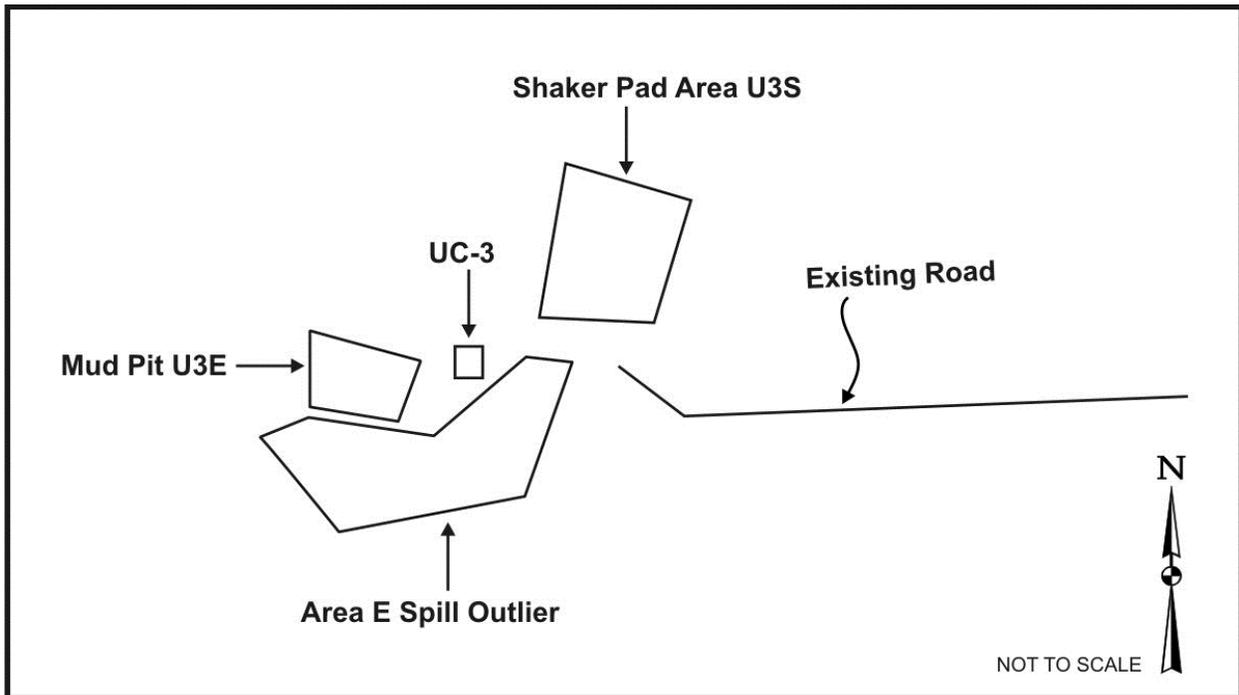


Figure 5. Location of UC-3 Significant Features

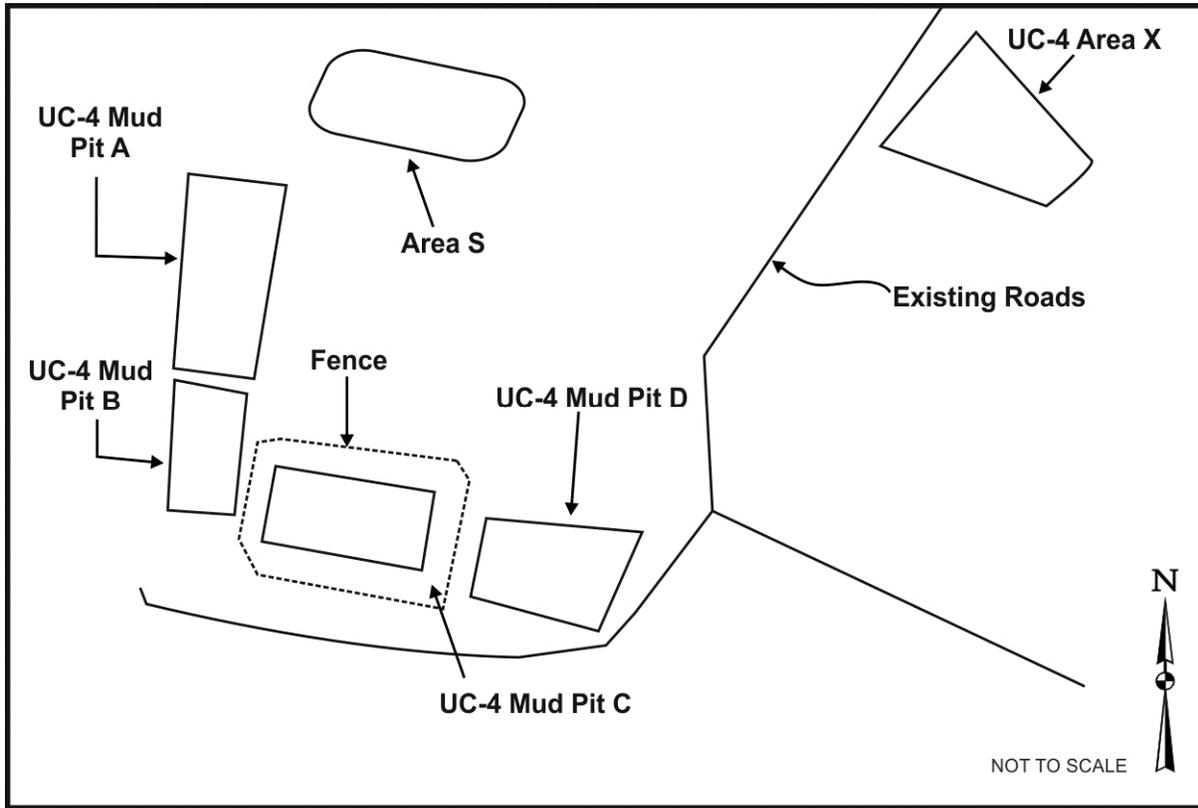


Figure 6. Location of UC-4 Significant Features

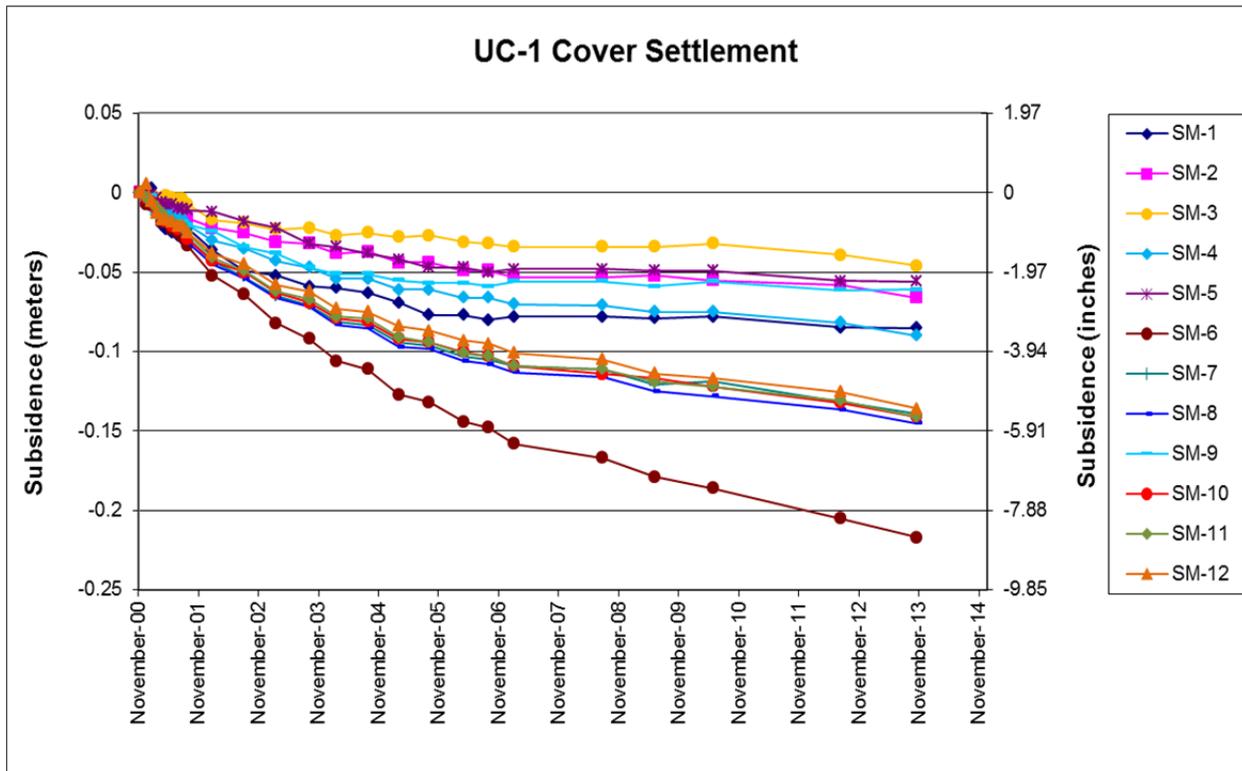


Figure 7. UC-1 CMP Cover Settlement

The degree of settlement in the relocation trench and CMP shows no unusual subsidence, but one SM has exceeded the predicted range of 0.2 m (8 inches). The data collected over the CMP section of the cover indicate that the largest subsidence is along the centerline of the CMP, including SM-6, SM-7, and SM-8, and along the southern portion of the cap at SM-10, SM-11, and SM-12. This was expected because of the thicker layer of underlying mud in these areas. The northern monuments (SM-2, SM-3, and SM-4) and the westernmost monuments (SM-1, SM-5, and SM-9) show less subsidence because the layer of underlying mud along these margins of the cover is thinner. The greatest degree of settlement continues to be on SM-6, which has subsided a total of 0.217 m (8.543 inches) since the baseline survey in December 2000. This exceeds the predicted range of 0.2 m (8 inches).

3.2.2 UC-4 Survey

Two SMs (west and east monuments) were installed in the UC-4 Mud Pit C cover to provide elevation control for measuring the subsidence of the cover. Figure 8 shows these SMs. An initial subsidence survey was completed on October 12, 1999, and is used as a baseline to calculate subsidence. The UC-4 baseline survey locations and elevations are provided in Table B-2 in Appendix B, and are presented in graphical form in Figure 9. In the November 2013 subsidence survey, both SMs showed a decrease from the most recent subsidence survey in 2012. The elevation of the East SM decreased 0.003 m (0.118 inches), and the elevation of the West SM decreased 0.002 m (0.079 inches). Historically, settling of the West SM is still slightly greater than the predicted settling of 0.05 m (2 inches); the total subsidence is 0.059 m (2.323 inches) since the baseline survey in October 1999. The East SM has subsided a total of 0.027 m (1.063 inches) since the baseline survey. The largest changes occurred during the first 3 years.

3.3 Vegetation Survey Results

In 2000 and 2001, the DOE Office of Environmental Management reclaimed the UC-1 CMP by seeding the pit's constructed soil cover with native species and planting 5,000 live plants. A fence was constructed around the disposal cell to exclude livestock. Post-closure requirements for the UC-1 CMP include periodic vegetation surveys to assess the health and stability of the vegetated cover. A preliminary evaluation of the site was conducted in July 2001 to confirm germination. Additional surveys were conducted in October 2001, March and September 2002, June 2003, June 2004, May 2006, May 2007, June 2009, and July 2012 to evaluate the density, diversity, and overall condition of the vegetation. The biennial vegetation survey was performed concurrently with the site inspection on July 16, 2014. Details about the methods, results, and success criteria for the 2014 survey are provided in Appendix C, "Vegetation Survey—2014."

The vegetation survey conducted in 2006 determined the revegetation had met the success criteria and had exceeded industry standards for reclamations (Anderson 2005, 2006). Vegetation is an integral component of the pit's cover. Through evapotranspiration, vegetation reduces storm-water infiltration and percolation through the cover. It also helps reduce wind and water erosion on the soil cover by reducing surface velocities. Previous monitoring indicates that a healthy plant community has become established on the soil cover and in disturbed areas outside the fence, although areas outside the fence have been slower to establish because of periodic livestock grazing.

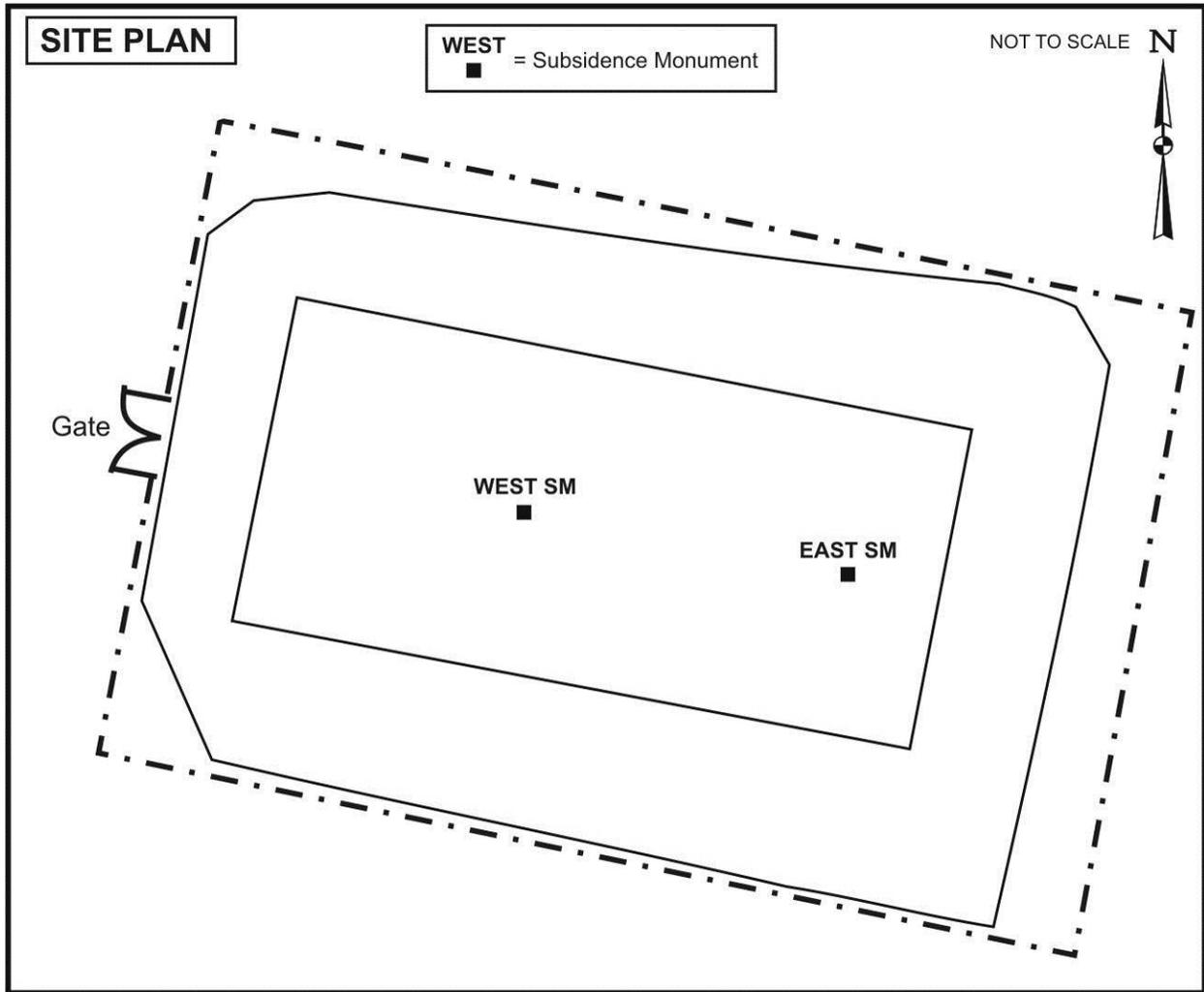


Figure 8. UC-4 West and East Monuments

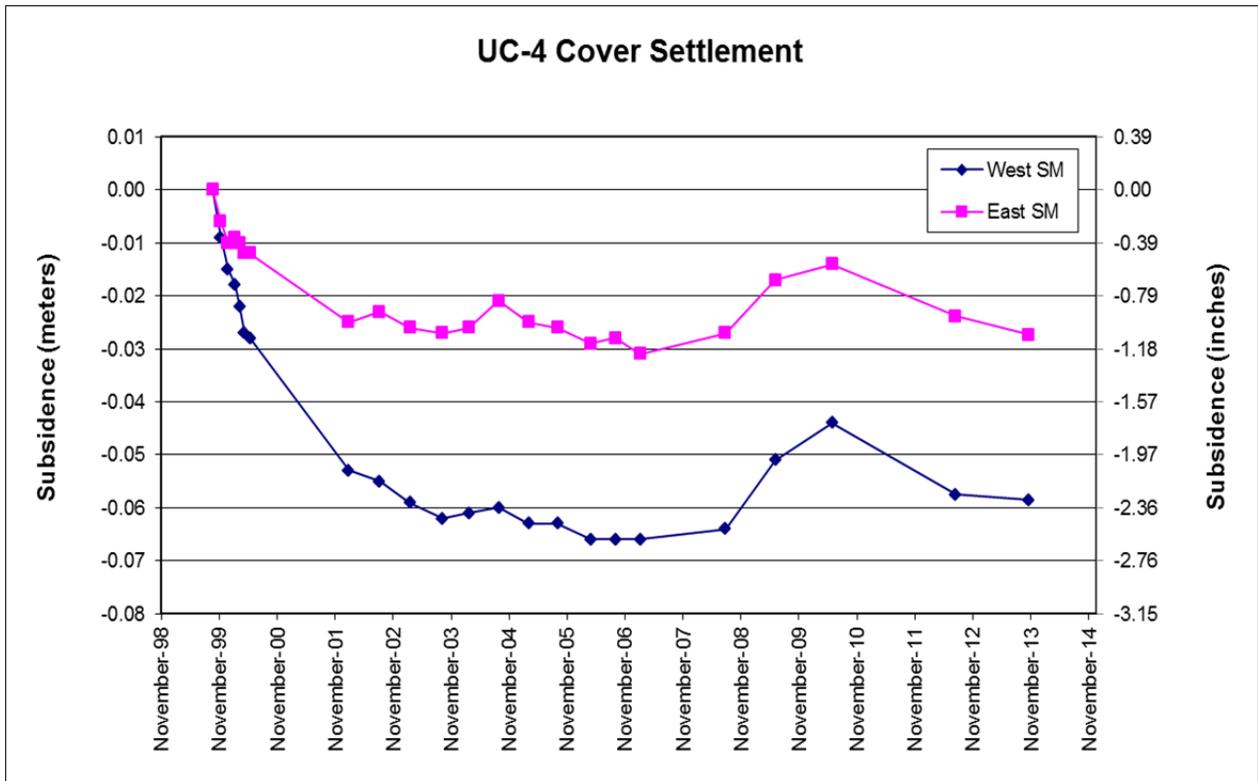


Figure 9. UC-4 Cover Settlement

A plant specialist assisting with the 2014 inspection confirmed that vegetation on the UC-1 CMP cover continued to be healthy and sustainable (Figure 10). Total foliar cover was estimated at 25 percent and was dominated by rubber rabbitbrush, sagebrush, and thread snakeweed. Secondary species included fourwing saltbush, galleta grass, indian ricegrass, and bottlebrush squirreltail, all desirable species. The percentage of total foliar cover in the CMP cover area increased from the previous years. In comparison, values for total foliar cover in 2007, 2009, and 2012 were 18, 23, and 20 percent, respectively (DOE 2008, 2009, and 2013). The continued increase in total foliar cover further supports the success of the revegetation effort that was determined as having met the vegetation success criteria in 2006 (Anderson 2005, 2006).

On the UC-4 Mud Pit C cover, vegetation is no longer being controlled, and desirable plants are becoming established (Figure 11). Total foliar cover was estimated at 12 percent and was dominated by rubber rabbitbrush. Secondary species included Mexican cliffrose and bottlebrush squirreltail.

Inspectors also conducted revegetation assessments of monitoring well pads MV-2, MV-3, MV-4, and MV-5. Well pads MV-2 and MV-3 were reclaimed prior to 2009, and well pads MV-4 and MV-5 were reclaimed in November 2010. All revegetated well pads were stable, as no signs of active erosion were noted. Revegetation success was considered good on the two older pads, MV-2 and MV-3, which had plant covers of 20 and 23 percent, respectively. On MV-4, revegetation success was rated as fair (15 percent plant cover), and on MV-5, it was considered poor (5 percent plant cover). Inspectors noticed that the plants on MV-4 and MV-5 had been heavily grazed.



Figure 10. View southeast of UC-1 CMP from middle of gate along north fence line



Figure 11. View east of UC-4 Mud Pit Cap from west survey marker

3.4 Precipitation and Soil Moisture Monitoring Results

A Campbell Scientific TE525 tipping bucket rain gauge collects precipitation data at the UC-1 CMP cover. A Campbell Scientific CS705 precipitation adapter is used for snowfall measurements. The rain gauge data are collected and stored by the data logger and sent to an onsite telemetry station. The data are then sent to, and saved on, SOARS. The rain gauge was evaluated and repaired during a general site maintenance visit conducted in early October 2008.

Figure 12 presents the 2-year precipitation record from the UC-1 CMP rain gauge. Precipitation measured from July 1, 2012, through June 30, 2013, totaled 179.6 millimeters (mm) or 7.1 inches. Precipitation measured from July 1, 2013, through June 3, 2014, totaled 157.0 mm or 6.2 inches. Precipitation measured for the same July–June time period ending in 2011 and 2012 was 251.2 mm (9.9 inches) and 126.0 mm (5.0 inches), respectively. Refer to Appendix B (Figure B-1 and Table B-3) for the historic precipitation data from 2008 through 2014.

3.4.1 UC-1 Soil Moisture Results

Figure 13 through Figure 16 present graphs of the TDR-derived soil moisture content for July 1, 2012, through June 3, 2014. Soil moisture contents greater than 36 percent are not displayed in Figure 13 through Figure 16 because they would indicate soil moisture contents greater than saturation. Figure 13 and Figure 14 show that the soil moisture data from the two deepest TDRs in the east nest are erratic and discontinuous. It was recently determined that these data are corrupt. More information about this determination is presented in the “UC-1 East TDR Nest” subsection (immediately following Figure 16) and in Section 4.2. A full summary of the soil moisture data collected from the east and west nests is provided below.

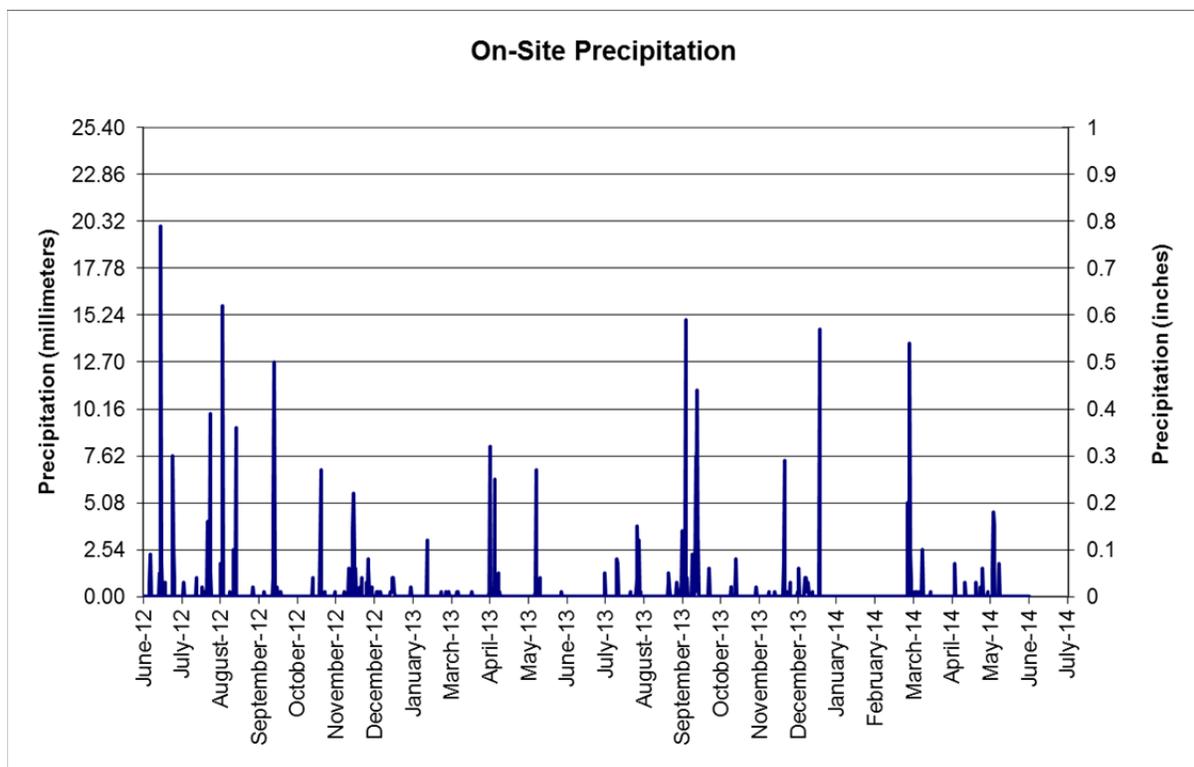


Figure 12. July 1, 2012, through June 3, 2014, Site Precipitation Data

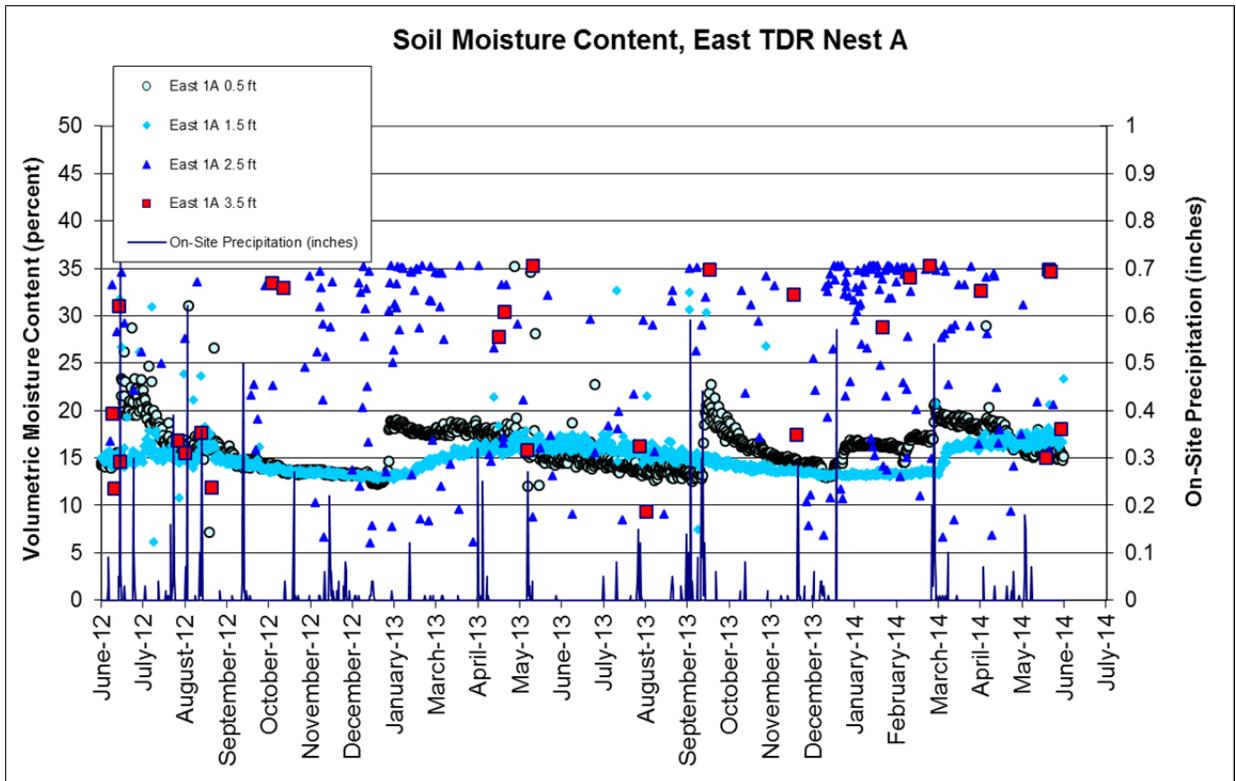


Figure 13. UC-1 Soil Moisture Content, East TDR Nest A

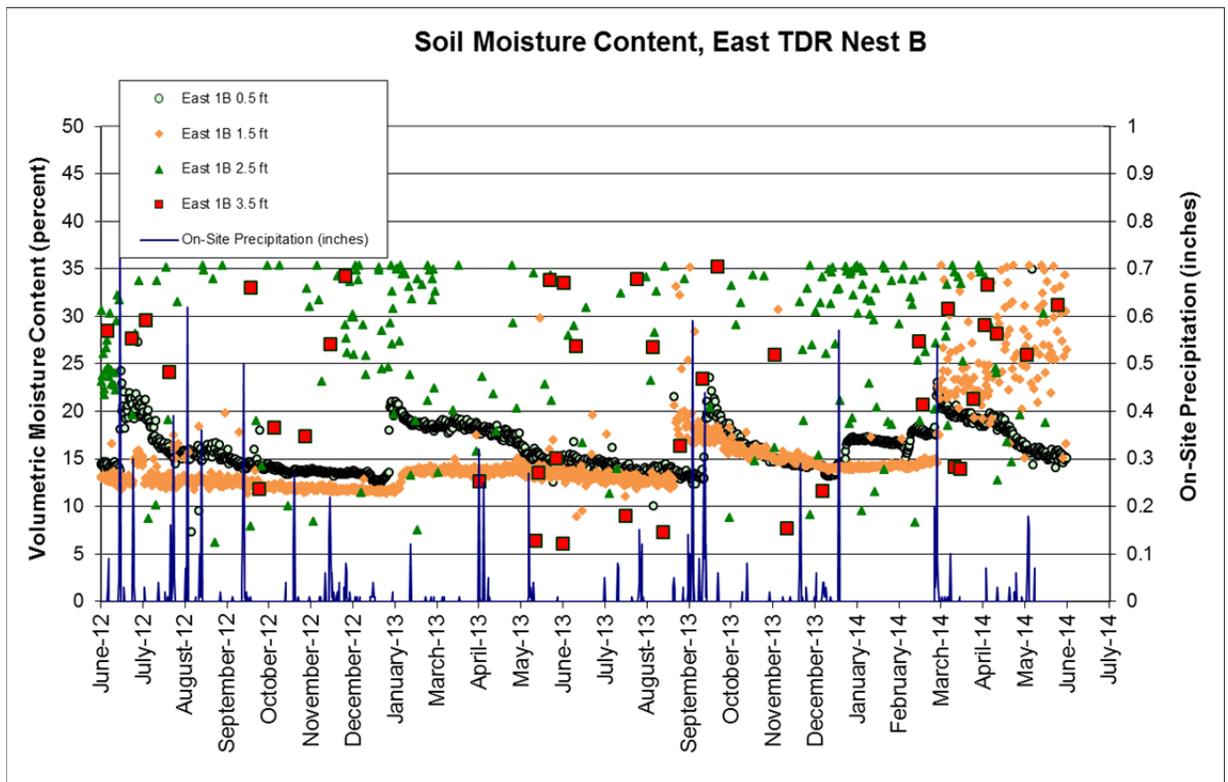


Figure 14. UC-1 Soil Moisture Content, East TDR Nest B

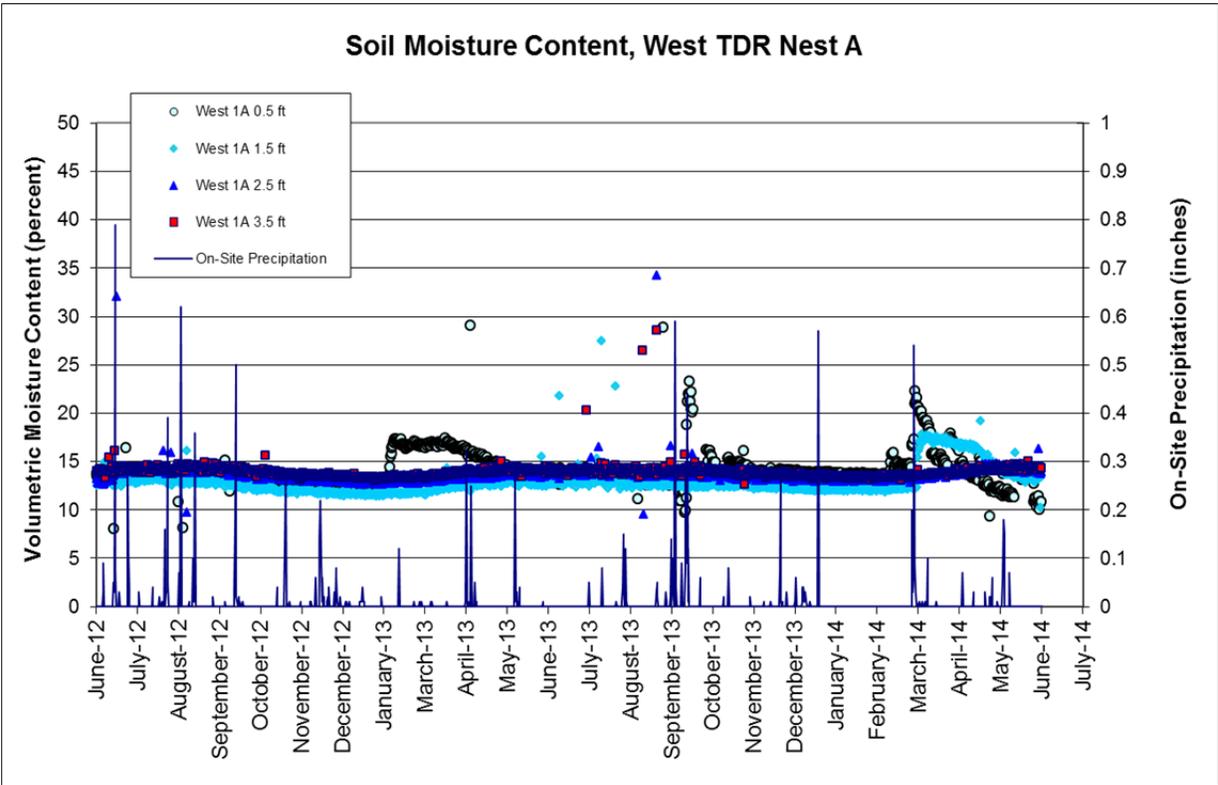


Figure 15. UC-1 Soil Moisture Content, West TDR Nest A

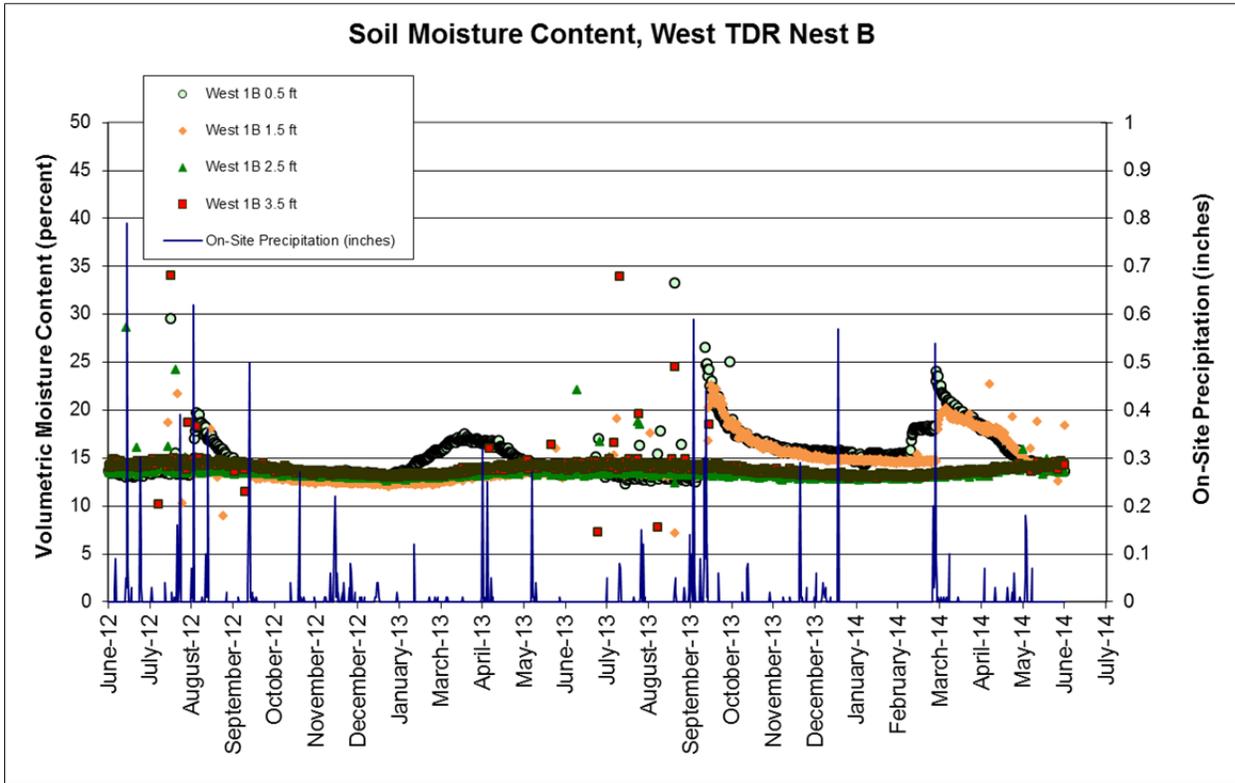


Figure 16. UC-1 Soil Moisture Content, West TDR Nest B

UC-1 East TDR Nest

Soil moisture data obtained for the 0.76 and 1.07 m (2.5 and 3.5 ft) depths of the east TDR nests (Figure 13 and Figure 14) continue to be discontinuous and appear to be corrupted. Previously, the lengthy cable created a problem in measuring the reflected signal from the TDR probes (NNSA/NV 2007). It was also thought that the erratic data may be an indication of saturated conditions at these depths. Soil samples were collected near the deepest TDR sensors on August 23, 2013, to evaluate this theory. Soil moisture results indicated the soil was not saturated and that the moisture content at these depths was approximately 8 percent. Data from the two deepest sensors are required to establish soil-moisture-monitoring compliance criteria. A Path-Forward plan is being developed to address the requirement for establishing soil-moisture-monitoring compliance criteria and for future monitoring at the site.

The TDR data from the shallower depths appear to be correct because the data appear to correspond with precipitation events. The VMC data fluctuate seasonally in response to snowmelt during spring thaw and precipitation events. The VMC data are typically highest during spring thaw, and they slowly decrease throughout the spring and early summer when the VMC reaches steady-state conditions, ranging from 11 to 15 percent in the upper 1.5 ft of the cover. This seasonal trend was somewhat disrupted with large precipitation events in September 2013. Refer to Appendix B (Figures B-2 and B-3) for historical moisture data obtained from the 0.5, 1.5, and 3.5 ft depths from 2007 through 2014.

UC-1 West TDR Nest

Soil moisture data obtained for the west TDR nests (Figure 15 and Figure 16) corresponds with precipitation events. The VMC data fluctuate seasonally in response to snowmelt during spring thaw and precipitation events. The VMC data are typically highest during spring thaw, and they slowly decrease throughout the spring and early summer when the VMC reaches steady-state conditions, ranging from 11 to 15 percent in the upper 3.5 ft of the cover. This seasonal trend was somewhat disrupted with large precipitation events in September 2013. Refer to Appendix B (Figures B-4 and B-5) for historical moisture data obtained from the 0.5, 1.5, and 3.5 ft depths from 2007 through 2014.

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4.0 Summary, Conclusions, and Recommendations

4.1 Summary

The UC-1 CMP was observed as being in good condition during the 2014 inspection. No new fractures or extension of existing fractures were observed, and no issues with the fence or gate were identified. The vegetation on the cover continues to look healthy. Precipitation measured from July 1, 2012, through June 30, 2013, totaled 179.6 mm or 7.1 inches. Precipitation measured from July 1, 2013, through June 3, 2014, totaled 157.0 mm or 6.2 inches. The precipitation events are evident in the soil moisture data obtained from the TDR sensors. Soil moisture content data show that the UC-1 CMP cover is performing as designed, and evapotranspiration is effectively removing water from the cover.

The biennial survey of the UC-1 and UC-4 SMs was conducted during the 2014 inspection period. Survey data from the UC-1 CMP monuments indicate a settling trend that has been occurring since the baseline survey in December 2000. The data also continue to indicate that the largest subsidence is in areas where the mud thickness is greatest, along the centerline (SM-6, SM-7, and SM-8) and southern portion (SM-10, SM-11, and SM-12) of the CMP. This corresponds with the dewatering of the underlying drilling mud. The degree of settling in the relocation trench is within the predicted range and shows no unusual subsidence. The CMP shows no unusual subsidence, but SM-6 exceeded the predicted settlement with a total subsidence of 0.217 m (8.543 inches) since the baseline survey in December 2000. Survey data from the UC-4 monuments indicate a decrease in elevation. Subsidence at the west monument is still slightly greater than the predicted settling; the total subsidence was 0.059 m (2.323 inches) since the baseline survey in October 1999.

The inspection of UC-3 indicated that the sites are in excellent condition. All monuments and use-restriction signs are in good condition. No issues were identified, and no maintenance or repair activities are recommended at this time.

The inspection of UC-4 indicated that the sites are in excellent condition. All monuments and use-restriction signs are in good condition. No concerns with the monuments or gate were identified.

4.2 Conclusions

The following conclusions are based on the 2014 biennial inspection:

- No significant concerns were noted for the UC-1 CMP and UC-4 Mud Pit C covers during the biennial inspections, and no further maintenance or repairs are recommended at this time.
- No significant concerns were noted on the subsidence surveys for UC-1 and UC-4. The next subsidence survey will be conducted during the 2016 biennial inspection.
- The UC-1 CMP cover is performing as designed. Soil moisture monitoring data indicate that evapotranspiration is effectively removing water from the cover; however, data from the two deepest sensors in the east TDR nest appear to be corrupted, making it difficult to establish soil-moisture-monitoring compliance criteria. The continued settling of the SMs at UC-1 CMP indicates that steady-state conditions have not yet been reached. A Path-Forward plan

is being developed to address the requirement for establishing soil-moisture monitoring compliance criteria and future monitoring at the site.

4.3 Recommendations

The following recommendations are based on the 2014 inspection:

- Continue site inspections biennially, as scheduled, to observe the condition of the covers, fence, vegetation, signs, and monuments, with the next report to be produced in 2016.
- Continue biennial subsidence surveys on UC-1 and UC-4 in 2016.
- Conduct a biennial vegetation survey in 2016.
- Continue to collect soil moisture data from the TDR nests, but develop a Path-Forward plan to address the requirement for establishing soil-moisture-monitoring compliance criteria and to develop a new strategy for future monitoring at the site.
- Respond within 90 days to any reports from the public of detrimental conditions at the site.

5.0 References

- Barnes, W., 1968. *Report of Exploration Progress, Central Nevada, Period August 1, 1967, December 31, 1967*, U.S. Geological Survey Technical Letter, Central Nevada 3-2.
- DOE/NV (U.S. Department of Energy, Nevada Operations Office), 2000. *Corrective Action Plan for Corrective Action Unit 417: Central Nevada Test Area Surface, Nevada*, DOE/NV-588, Las Vegas, Nevada.
- FFACO (Federal Facility Agreement and Consent Order), 1996 (as amended). Agreed to by the State of Nevada, the U.S. Department of Energy, and the U.S. Department of Defense.
- Healey, D.L., 1968. *Gravity Survey of Northern Hot Creek Valley, Nye County, Nevada*, U.S. Geological Survey Technical Letter, Central Nevada-18.
- NNSA/NV (U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office), 2001. *Closure Report for Corrective Action Unit 417: Central Nevada Test Area Surface, Nevada*, DOE/NV-743, Rev. 1, Las Vegas, Nevada.
- NNSA/NV (U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office), 2007. *Post-Closure Inspection and Monitoring Report for Corrective Action Unit 417: Central Nevada Test Area—Surface Hot Creek Valley, Nevada*, DOE/NV/25946-168, Las Vegas, Nevada.
- Topp, G.C., Davis, J.L., and Annan, A.P., 1980. “Electromagnetic Determination of Soil Water Content: Measurements in Coaxial Transmission Lines,” *Water Resources Research*, vol. 16, pp. 574–582.

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Appendix A
Inspection Checklists
and Photographs—2014

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CAU 417: CNTA UC-1 CENTRAL MUD PIT COVER, POST-CLOSURE INSPECTION CHECKLIST

Date of Last Inspection: July 31, 2012 Reason for Last Inspection: Annual Inspection

Responsible Agency: DOE-LLM Project Manager: RICK FINDLAY

Inspection Date: July 16, 2014

Inspector (name, title, organization): Paul S. Darr, Project Specialist, S.M. STOLLER

Assistant Inspector (name, title, organization): Marilyn Kasteus, Vegetation Specialist, S.M. STOLLER

A. GENERAL INSTRUCTIONS

1. All checklist items must be completed and detailed comments made to document the results of the site inspection. The completed checklist is part of the field record of the inspection. Additional pages should be used as necessary to ensure that a complete record is made. Attach the additional pages and number all pages upon completion of the inspection.
3. Any checklist line item marked by an inspector in a SHADED BOX, must be fully explained or an appropriate reference to previous reports provided. The purpose of this requirement is to provide a written explanation of inspector observations and the inspector's rationale for conclusions and recommendations. Explanations are to be placed on additional attachments and cross-referenced appropriately. Explanations, in addition to narrative, may take the form of sketches, measurements, annotated site maps.
4. The site inspection is a walking inspection of the entire site including the perimeter and sufficient transects to be able to inspect the entire surface and all features specifically described in this checklist.
5. A standard set of color 35 mm photographs (or equivalent) is required. In addition, all anomalous features or new features (such as changes in adjacent area land use) are to be photographed. A photo log entry will be made for each photograph taken.
6. This unit will be inspected every two years with formal reporting to the Nevada Division of Environmental Protection to be done within a reasonable amount of time after completion of the inspection. The report will include an executive summary, this inspection checklist with field notes and photo log attached, and recommendations and conclusions.

B. PREPARATION (To be completed prior to site visit)

	YES	NO	EXPLANATION
1. Site as-built plans and site base map reviewed.	✓		
2. Previous inspection reports reviewed.	✓		
a. Were anomalies or trends detected on previous inspections?		✓	<u>TWO NEW CRACKS, SMALL.</u>
b. Was maintenance performed?		✓	
3. Site maintenance and repair records reviewed.	✓		
a. Has site repair resulted in a change from as-built conditions?		✓	
b. Are revised as-builts available that reflect repair changes?		✓	

C. SITE INSPECTION (To be completed during inspection)

	YES	NO	EXPLANATION
1. Adjacent off-site features within watershed areas.			
a. Have there been any changes in use of adjacent area?		✓	
b. Are there any new roads or trails?		✓	
c. Has there been a change in the position of nearby washes?		✓	
d. Has there been lateral excursion or erosion/deposition of nearby washes?		✓	
e. Are there new drainage channels?		✓	
f. Change in surrounding vegetation?		✓	
2. Security fence, signs.			
a. Displacement of fences, site markers, boundary markers, or monuments?		✓	
b. Have any signs been damaged or removed? (Number of signs replaced: <u>10</u>)		✓	
c. Were gates locked?	✓		

CAU 417: CNTA UC-1 CENTRAL MUD PIT COVER, POST-CLOSURE MONITORING CHECKLIST

3. Waste Unit cover.	YES	NO	EXPLANATION
a. Is there evidence of settling?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Two small, new cracks
b. Is there cracking?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	see above.
c. Is there evidence of erosion around the cap (wind or water)?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
d. Is there evidence of animal burrowing?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
e. Have the site markers been disturbed by man or natural processes?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
f. Do natural processes threaten to integrity of any cover or site marker?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
g. Other?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

4. Vegetative cover.			
a. Is perimeter fence or mesh fencing damaged?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
b. Is there evidence of horses or rabbits on site?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	small deer carcass observed.
c. Is organic mulch and/or plants adequate to prevent erosion?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
d. Are weedy annual plants present? If yes, are they a problem?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
e. Are seeded plant species found on site?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
f. Is there evidence of plant mortality?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	

5. Photo Documentation			
a. Has a photo log been prepared?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
c. Number of photos exposed (18)			

D. FIELD CONCLUSIONS

1. Is there an imminent hazard to the integrity of the unit? (Immediate report required)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Person/Agency to whom report made:			
2. Are more frequent inspections required?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
3. Are existing maintenance/repair actions satisfactory?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
4. Is other maintenance/repair necessary?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
5. Is current status/condition of vegetative cover satisfactory?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	

6. Rationale for field conclusions: *Overall integrity of the site is good.*

E. CERTIFICATION

I have conducted an inspection of the UC-1 Central Mud Pit Cover, CAU 417, at the Central Nevada Test Area in accordance with the Post-Closure Monitoring Plan (see Closure Report) as recorded on this checklist, attached sheets, field notes, photo logs, and photographs.

Chief Inspector's Signature: <i>Paul S. Darr</i>	Printed Name: PAUL S. DARR
Title: <i>Project Specialist</i>	Date: <i>July 16, 2014</i>

CAU 417: CNTA UC-3, POST-CLOSURE INSPECTION CHECKLIST

Date of Last Inspection: July 31, 2012 Reason for Last Inspection: Annual Inspection

Responsible Agency: DOE-LM Project Manager: Rick Findlay

Inspection Date: July 16, 2014

Inspector (name, title, organization): Paul S. Darr, Project Specialist, S.M. Stoller

Assistant Inspector (name, title, organization): Marilyn Kilstens, Vegetation Specialist, S.M. Stoller

A. GENERAL INSTRUCTIONS

1. All checklist items must be completed and detailed comments made to document the results of the site inspection. The completed checklist is part of the field record of the inspection. Additional pages should be used as necessary to ensure that a complete record is made. Attach the additional pages and number all pages upon completion of the inspection.
3. Any checklist line item marked by an inspector in a SHADED BOX, must be fully explained or an appropriate reference to previous reports provided. The purpose of this requirement is to provide a written explanation of inspector observations and the inspector's rationale for conclusions and recommendations. Explanations are to be placed on additional attachments and cross-referenced appropriately. Explanations, in addition to narrative, will take the form of sketches, measurements, annotated site maps.
4. The site inspection is a walking inspection of the entire site including the perimeter and sufficient transects to be able to inspect the entire surface and all features specifically described in this checklist.
5. A standard set of color 35 mm photographs (or equivalent) is required. In addition, all anomalous features or new features (such as changes in adjacent area land use) are to be photographed. A photo log entry will be made for each photograph taken.
6. This unit will be inspected every two years with formal reporting to the Nevada Division of Environmental Protection to be done within a reasonable amount of time after completion of the inspection. The report will include an executive summary, this inspection checklist with field notes and photo log attached, and recommendations and conclusions.

B. PREPARATION (To be completed prior to site visit)

	YES	NO	EXPLANATION
1. Site as-built plans and site base map reviewed.	✓		
2. Previous inspection reports reviewed.	✓		
a. Were anomalies or trends detected on previous inspections?		✓	
b. Was maintenance performed?		✓	
3. Site maintenance and repair records reviewed.	✓		
a. Has site repair resulted in a change from as-built conditions?		✓	
b. Are revised as-builts available that reflect repair changes?		✓	

C. SITE INSPECTION (To be completed during inspection)

	YES	NO	EXPLANATION
1. Adjacent off-site features within watershed areas.			
a. Have there been any changes in use of adjacent area?		✓	
b. Are there any new roads or trails?		✓	
c. Has there been a change in the position of nearby washes?		✓	
d. Has there been lateral excursion or erosion/deposition of nearby washes?		✓	
e. Are there new drainage channels?		✓	
f. Change in surrounding vegetation?		✓	
2. Security fence, signs.			
a. Displacement of fences, site markers, boundary markers, or monuments?		✓	
b. Have any signs been damaged or removed? (Number of signs replaced: <u>0</u>)		✓	
c. Were gates locked?		✓	<u>No gate at site.</u>

CAU 417: CNTA UC-3, POST-CLOSURE INSPECTION CHECKLIST

D. FIELD CONCLUSIONS

1. Is there an imminent hazard to the integrity of the unit? (Immediate report required)		✓	
Person/Agency to whom report made:			
2. Are more frequent inspections required?		✓	
3. Are existing maintenance/repair actions satisfactory?	✓		
4. Is other maintenance/repair necessary?		✓	
5. Is current status/condition of unit satisfactory?	✓		
6. Rationale for field conclusions: <i>The site is in good condition.</i>			

E. CERTIFICATION

I have conducted an inspection of UC-3, CAU 417, at the Central Nevada Test Area in accordance with the Post-Closure Monitoring Plan (see Closure Report) as recorded on this checklist, attached sheets, field notes, photo logs, and photographs.

Chief Inspector's Signature: <i>Paul S. Darr</i>	Printed Name: <i>Paul S. Darr</i>
Title: <i>Project Specialist</i>	Date: <i>July 16, 2014</i>

CAU 417: CNTA UC-4 MUD PIT C COVER, POST-CLOSURE INSPECTION CHECKLIST

Date of Last Inspection: July 31, 2012 Reason for Last Inspection: Annual Inspection

Responsible Agency: DOE-LM Project Manager: Rick Findlay

Inspection Date: July 16, 2014

Inspector (name, title, organization): Paul S. Darr, Project Specialist, S.M. Stoller

Assistant Inspector (name, title, organization): Marilyn Kastens, Vegetation Specialist, S.M. Stoller

A. GENERAL INSTRUCTIONS

1. All checklist items must be completed and detailed comments made to document the results of the site inspection. The completed checklist is part of the field record of the inspection. Additional pages should be used as necessary to ensure that a complete record is made. Attach the additional pages and number all pages upon completion of the inspection.
3. Any checklist line item marked by an inspector in a SHADED BOX, must be fully explained or an appropriate reference to previous reports provided. The purpose of this requirement is to provide a written explanation of inspector observations and the inspector's rationale for conclusions and recommendations. Explanations are to be placed on additional attachments and cross-referenced appropriately. Explanations, in addition to narrative, will take the form of sketches, measurements, annotated site maps.
4. The site inspection is a walking inspection of the entire site including the perimeter and sufficient transects to be able to inspect the entire surface and all features specifically described in this checklist.
5. A standard set of color 35 mm photographs (or equivalent) is required. In addition, all anomalous features or new features (such as changes in adjacent area land use) are to be photographed. A photo log entry will be made for each photograph taken.
6. This unit will be inspected every two years with formal reporting to the Nevada Division of Environmental Protection to be done within a reasonable amount of time after completion of the inspection. The report will include an executive summary, this inspection checklist with field notes and photo log attached, and recommendations and conclusions.

B. PREPARATION (To be completed prior to site visit)		YES	NO	EXPLANATION
1.	Site as-built plans and site base map reviewed.	✓		
2.	Previous inspection reports reviewed.	✓		
a.	Were anomalies or trends detected on previous inspections?		✓	
b.	Was maintenance performed?		✓	
3.	Site maintenance and repair records reviewed.	✓		
a.	Has site repair resulted in a change from as-built conditions?		✓	
b.	Are revised as-builts available that reflect repair changes?		✓	
C. SITE INSPECTION (To be completed during inspection)		YES	NO	EXPLANATION
1.	Adjacent off-site features within watershed areas.			
a.	Have there been any changes in use of adjacent area?		✓	
b.	Are there any new roads or trails?		✓	
c.	Has there been a change in the position of nearby washes?		✓	
d.	Has there been lateral excursion or erosion/deposition of nearby washes?		✓	
e.	Are there new drainage channels?		✓	
f.	Change in surrounding vegetation?		✓	
2.	Security fence, signs.			
a.	Displacement of fences, site markers, boundary markers, or monuments?		✓	
b.	Have any signs been damaged or removed? (Number of signs replaced: <u>0</u>)		✓	
c.	Were gates locked?	✓		

CAU 417: CNTA UC-4 MUD PIT C COVER, POST-CLOSURE INSPECTION CHECKLIST

3. Waste Unit cover.

	YES	NO	EXPLANATION
a. Is there evidence of settling?		✓	
b. Is there cracking?		✓	
c. Is there evidence of erosion around the cap (wind or water)?	✓		Small rill on east side of cap and southeast side of cap.
d. Is there evidence of animal burrowing?		✓	
e. Have the site markers been disturbed by man or natural processes?		✓	
f. Is there vegetation on the cover?	✓		sparsely spread out over entire cap.
g. Do natural processes threaten to integrity of any cover or site marker?		✓	
h. Other?		✓	None.

4. Photo Documentation

- a. Has a photo log been prepared?
- c. Number of photos exposed (6)

D. FIELD CONCLUSIONS

1. Is there an imminent hazard to the integrity of the unit? (Immediate report required)

	✓	
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Person/Agency to whom report made:

2. Are more frequent inspections required?
3. Are existing maintenance/repair actions satisfactory?
4. Is other maintenance/repair necessary?
5. Is current status/condition of vegetative cover satisfactory?

	✓	
✓		
	✓	
✓		

6. Rationale for field conclusions: Site is in good condition. Two small rills on cap were fixed by bringing more soil and rock up onto the edge of the cap.

E. CERTIFICATION

I have conducted an inspection of the UC-4 Mud Pit C Cover, CAU 417, at the Central Nevada Test Area in accordance with the Post-Closure Inspection Plan (see Closure Report) as recorded on this checklist, attached sheets, field notes, photo logs, and photographs.

Chief Inspector's Signature: *Paul S. Darr*

Printed Name: Paul S. Darr

Title: Project Specialist

Date: July 16, 2014



Photograph 1. UC-1, view from south edge, looking west



Photograph 2. UC-1, view from south edge, looking northwest



Photograph 3. UC-1, view from south edge, looking north



Photograph 4. UC-1, view from south edge, looking northeast



Photograph 5. UC-1, view south along SM-1, SM-5, and SM-9



Photograph 6. UC-1, view north along SM-9, SM-5, and SM-1



Photograph 7. UC-1, view south along SM-2, SM-6, and SM-10



Photograph 8. UC-1, view north along SM-10, SM-6, and SM-2



Photograph 9. UC-1, view south along SM-3, SM-7, and SM-11



Photograph 10. UC-1, view north along SM-11, SM-7, and SM-3



Photograph 11. UC-1, view south along SM-4, SM-8, and SM-12



Photograph 12. UC-1, view north along SM-12, SM-8, and SM-4



Photograph 13. UC-4, view east from west SM



Photograph 14. UC-4, view west from east SM

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Appendix B

Historical Survey, Precipitation, and Moisture Data

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Table B-1. UC-1 Monument Elevations and Subsidence

Date	Elevation at Top of Monument ^{a,b} Subsidence (m)											
	SM-1 N 6,430,874.2869 E 539,588.2339	SM-2 N 6,430,863.3239 E 539,644.8195	SM-3 N 6,430,855.2553 E 539,684.3327	SM-4 N 6,430,849.7763 E 539,715.7991	SM-5 N 6,430,852.0243 E 539,585.4651	SM-6 N 6,430,841.7590 E 539,641.4674	SM-7 N 6,430,834.5289 E 539,680.5243	SM-8 N 6,430,828.6994 E 539,712.4350	SM-9 N 6,430,828.8720 E 539,582.4750	SM-10 N 6,430,818.6353 E 539,638.2030	SM-11 N 6,430,812.8276 E 539,676.0839	SM-12 N 6,430,806.7973 E 539,708.9837
	1836.604	1835.154	1834.995	1834.854	1836.541	1834.887	1834.709	1834.681	1836.547	1834.943	1834.744	1834.635
12/04/2000 Baseline	0	0	0	0	0	0	0	0	0	0	0	0
01/10/2001	1836.603 -0.001	1835.149 -0.005	1834.991 -0.004	1834.850 -0.004	1836.540 -0.001	1834.880 -0.007	1834.704 -0.005	1834.676 -0.005	1836.545 -0.002	1834.940 -0.003	1834.741 -0.003	1834.641 0.006
2/06/2001	1836.607 -0.003	1835.150 -0.004	1834.992 -0.003	1834.849 -0.005	1836.540 -0.001	1834.879 -0.008	1834.703 -0.006	1834.674 -0.007	1836.545 -0.002	1834.937 -0.006	1834.738 -0.006	1834.630 -0.005
03/13/2001	1836.595 -0.009	1835.147 -0.007	1834.992 -0.003	1834.845 -0.009	1836.538 -0.003	1834.874 -0.013	1834.699 -0.010	1834.669 -0.012	1836.534 -0.013	1834.933 -0.010	1834.735 -0.009	1834.622 -0.013
04/11/2001	1836.584 -0.020	1835.144 -0.010	1834.991 -0.004	1834.841 -0.013	1836.535 -0.006	1834.869 -0.018	1834.693 -0.016	1834.662 -0.019	1836.531 -0.016	1834.928 -0.015	1834.731 -0.013	1834.618 -0.017
05/09/2001	1836.581 -0.023	1835.144 -0.010	1834.993 -0.002	1834.841 -0.013	1836.534 -0.007	1834.869 -0.018	1834.691 -0.018	1834.661 -0.020	1836.529 -0.018	1834.925 -0.018	1834.728 -0.016	1834.618 -0.017
6/12/2001	1836.579 -0.025	1835.142 -0.012	1834.992 -0.003	1834.840 -0.014	1836.534 -0.007	1834.864 -0.023	1834.689 -0.020	1834.659 -0.022	1836.529 -0.018	1834.922 -0.021	1834.726 -0.018	1834.617 -0.018
07/18/2001	1836.577 -0.027	1835.141 -0.013	1834.991 -0.004	1834.838 -0.016	1836.532 -0.009	1834.862 -0.025	1834.686 -0.023	1834.656 -0.025	1836.529 -0.018	1834.920 -0.023	1834.723 -0.021	1834.614 -0.021
08/14/2001	1836.575 -0.029	1835.140 -0.014	1834.991 -0.004	1834.838 -0.016	1836.531 -0.010	1834.859 -0.028	1834.685 -0.024	1834.655 -0.026	1836.529 -0.018	1834.921 -0.022	1834.723 -0.021	1834.614 -0.021
09/12/2001	1836.582 -0.022	1835.138 -0.016	1834.988 -0.007	1834.834 -0.020	1836.530 -0.011	1834.854 -0.033	1834.681 -0.028	1834.650 -0.031	1836.527 -0.020	1834.914 -0.029	1834.719 -0.025	1834.610 -0.025
02/13/2002	1836.568 -0.036	1835.132 -0.022	1834.978 -0.017	1834.824 -0.030	1836.529 -0.012	1834.835 -0.052	1834.666 -0.043	1834.636 -0.045	1836.523 -0.024	1834.900 -0.043	1834.703 -0.041	1834.597 -0.038
08/26/2002	1836.555 -0.049	1835.129 -0.025	1834.976 -0.019	1834.819 -0.035	1836.523 -0.018	1834.823 -0.064	1834.656 -0.053	1834.627 -0.054	1836.513 -0.034	1834.893 -0.050	1834.695 -0.049	1834.590 -0.045
03/06/2003	1836.552 -0.052	1835.123 -0.031	1834.972 -0.023	1834.811 -0.043	1836.519 -0.022	1834.805 -0.082	1834.644 -0.065	1834.615 -0.066	1836.509 -0.038	1834.880 -0.063	1834.682 -0.062	1834.577 -0.058
09/26/2003	1836.545 -0.059	1835.122 -0.032	1834.973 -0.022	1834.807 -0.047	1836.509 -0.032	1834.795 -0.092	1834.638 -0.071	1834.609 -0.072	1836.500 -0.047	1834.874 -0.069	1834.677 -0.067	1834.573 -0.062
03/10/2004	1836.544 -0.060	1835.116 -0.038	1834.968 -0.027	1834.800 -0.054	1836.507 -0.034	1834.781 -0.106	1834.628 -0.081	1834.598 -0.083	1836.496 -0.051	1834.864 -0.079	1834.666 -0.078	1834.562 -0.073
09/15/2004	1836.541 -0.063	1835.117 -0.037	1834.970 -0.025	1834.800 -0.054	1836.503 -0.038	1834.776 -0.111	1834.626 -0.083	1834.596 -0.085	1836.496 -0.051	1834.862 -0.081	1834.665 -0.079	1834.560 -0.075
03/22/2005	1836.535 -0.069	1835.110 -0.044	1834.967 -0.028	1834.793 -0.061	1836.499 -0.042	1834.760 -0.127	1834.615 -0.094	1834.584 -0.097	1836.492 -0.055	1834.851 -0.092	1834.653 -0.091	1834.551 -0.084
09/21/2005	1836.527 -0.077	1835.110 -0.044	1834.968 -0.027	1834.793 -0.061	1836.494 -0.047	1834.755 -0.132	1834.613 -0.096	1834.583 -0.098	1836.490 -0.057	1834.849 -0.094	1834.650 -0.094	1834.548 -0.087
04/19/2006	1836.527 -0.077	1835.105 -0.049	1834.964 -0.031	1834.788 -0.066	1836.494 -0.047	1834.743 -0.144	1834.606 -0.103	1834.575 -0.106	1836.490 -0.057	1834.843 -0.100	1834.643 -0.101	1834.542 -0.093
09/19/2006	1836.524 -0.08	1835.105 -0.049	1834.963 -0.032	1834.788 -0.066	1836.491 -0.05	1834.739 -0.148	1834.604 -0.105	1834.573 -0.108	1836.488 -0.059	1834.840 -0.103	1834.641 -0.103	1834.54 -0.095
02/22/2007	1836.526 -0.078	1835.101 -0.053	1834.961 -0.034	1834.784 -0.070	1836.493 -0.048	1834.729 -0.158	1834.600 -0.109	1834.568 -0.113	1836.491 -0.056	1834.834 -0.109	1834.635 -0.109	1834.534 -0.101
08/12/2008	1836.526 -0.078	1835.101 -0.053	1834.961 -0.034	1834.783 -0.071	1836.493 -0.048	1834.720 -0.167	1834.598 -0.111	1834.565 -0.116	1836.491 -0.056	1834.829 -0.114	1834.633 -0.111	1834.530 -0.105
06/23/2009	1836.525 -0.079	1835.102 -0.052	1834.961 -0.034	1834.779 -0.075	1836.492 -0.049	1834.708 -0.179	1834.588 -0.121	1834.556 -0.125	1836.488 -0.059	1834.826 -0.117	1834.625 -0.199	1834.521 -0.114
06/15/2010	1836.526 -0.078	1835.099 -0.055	1834.963 -0.032	1834.779 -0.075	1836.492 -0.049	1834.701 -0.186	1834.590 -0.119	1834.553 -0.128	1836.491 -0.056	1834.821 -0.122	1834.622 -0.122	1834.518 -0.117
07/31/2012	1836.519 -0.085	1835.096 -0.058	1834.956 -0.039	1834.722 -0.082	1836.406 -0.055	1834.682 -0.205	1834.577 -0.132	1834.544 -0.137	1836.486 -0.061	1834.811 -0.132	1834.613 -0.131	1834.510 -0.125
11/06/2013	1836.519 -0.085	1835.088 -0.066	1834.949 -0.046	1834.764 -0.090	1836.485 -0.056	1834.670 -0.217	1834.570 -0.139	1834.536 -0.145	1836.486 -0.061	1834.802 -0.141	1834.603 -0.141	1834.499 -0.136

^a Vertical datum: National Geodetic Vertical Datum of 1929 in meters

^b Horizontal datum: U.S. State Plane 1983

N = northing

E = easting

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Table B-2. UC-4 Monument Elevations and Subsidence

Date	Elevation at Top of Monument ^{a,b} Subsidence (m)	
	West Monument N 6,435,982.965 E 538,966.436	East Monument N 6,435,978.404 E 538,992.231
10/12/1999	1999.269	1999.062
Baseline	0.000	0.000
11/29/1999	1999.260	1999.056
	-0.009	-0.006
01/14/2000	1999.254	1999.052
	-0.015	-0.010
02/28/2000	1999.251	1999.053
	-0.018	-0.009
03/28/2000	1999.247	1999.052
	-0.022	-0.010
04/27/2000	1999.242	1999.05
	-0.027	-0.012
06/01/2000	1999.241	1999.05
	-0.028	-0.012
02/13/2002	1999.216	1999.037
	-0.053	-0.025
08/27/2002	1999.214	1999.039
	-0.055	-0.023
03/06/2003	1999.21	1999.036
	-0.059	-0.026
09/26/2003	1999.207	1999.035
	-0.062	-0.027
03/10/2004	1999.208	1999.036
	-0.061	-0.026
09/14/2004	1999.209	1999.041
	-0.060	-0.021
03/22/2005	1999.206	1999.037
	-0.063	-0.025
09/21/2005	1999.206	1999.036
	-0.063	-0.026
04/18/2006	1999.203	1999.033
	-0.066	-0.029
09/19/2006	1999.203	1999.034
	-0.066	-0.029
02/22/2007	1999.203	1999.031
	-0.066	-0.031
08/12/2008	1999.205	1999.035
	-0.064	-0.027
06/23/2009	1999.218	1999.045
	-0.051	-0.017
06/15/2010	1999.225	1999.048
	-0.057	-0.014
07/31/2012	1999.212	1999.038
	-0.057	-0.024
11/06/2013	1999.210	1999.035
	-0.059	-0.027

^a Vertical datum: National Geodetic Vertical Datum of 1929 in meters

^b Horizontal datum: U.S. State Plane 1983; Vertical datum

N = northing

E = easting

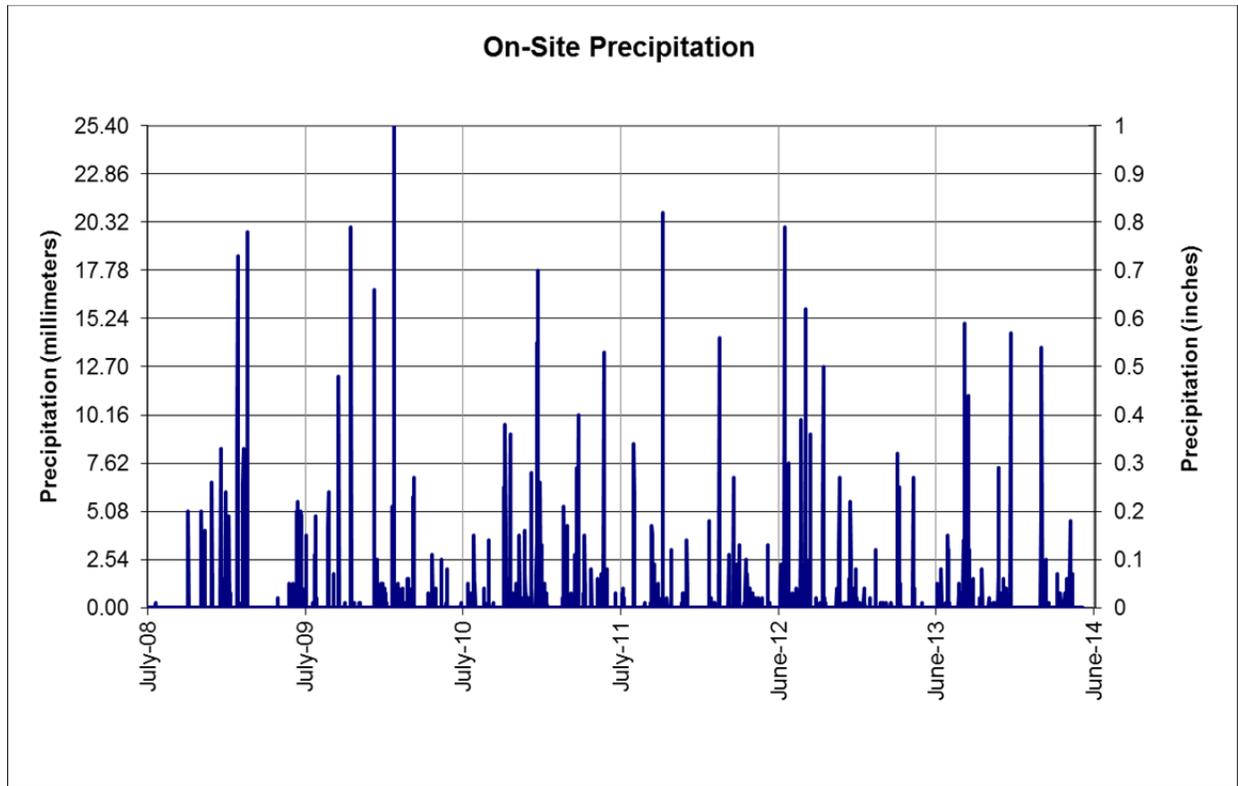


Figure B-1. July 2008 through July 2012, Precipitation Data

Table B-3. Yearly and Average Precipitation

Date Range	Yearly Precipitation Total		Average Yearly Precipitation	
	Millimeters	Inches	Millimeters	Inches
7/1/2008–6/30/2009	174.75	6.88	177.30	6.98
7/1/2009–6/30/2010	175.26	6.90		
7/1/2010–6/30/2011	251.20	9.89		
7/1/2011–6/30/2012	125.99	4.96		
7/1/2012–6/30/2013	179.59	7.07		
7/1/2013–6/03/2014	156.98	6.18		

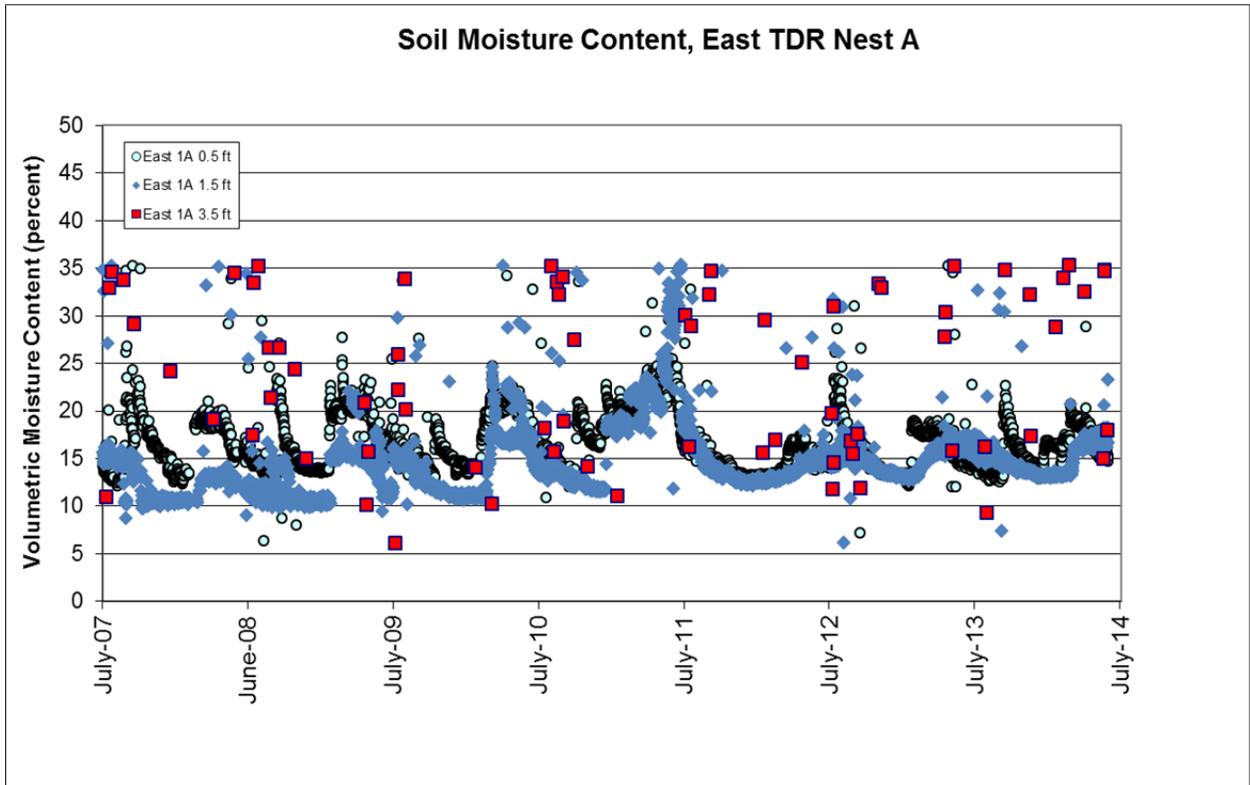


Figure B-2. July 2007 through July 2014 UC-1 Soil Moisture Content, East TDR Nest A

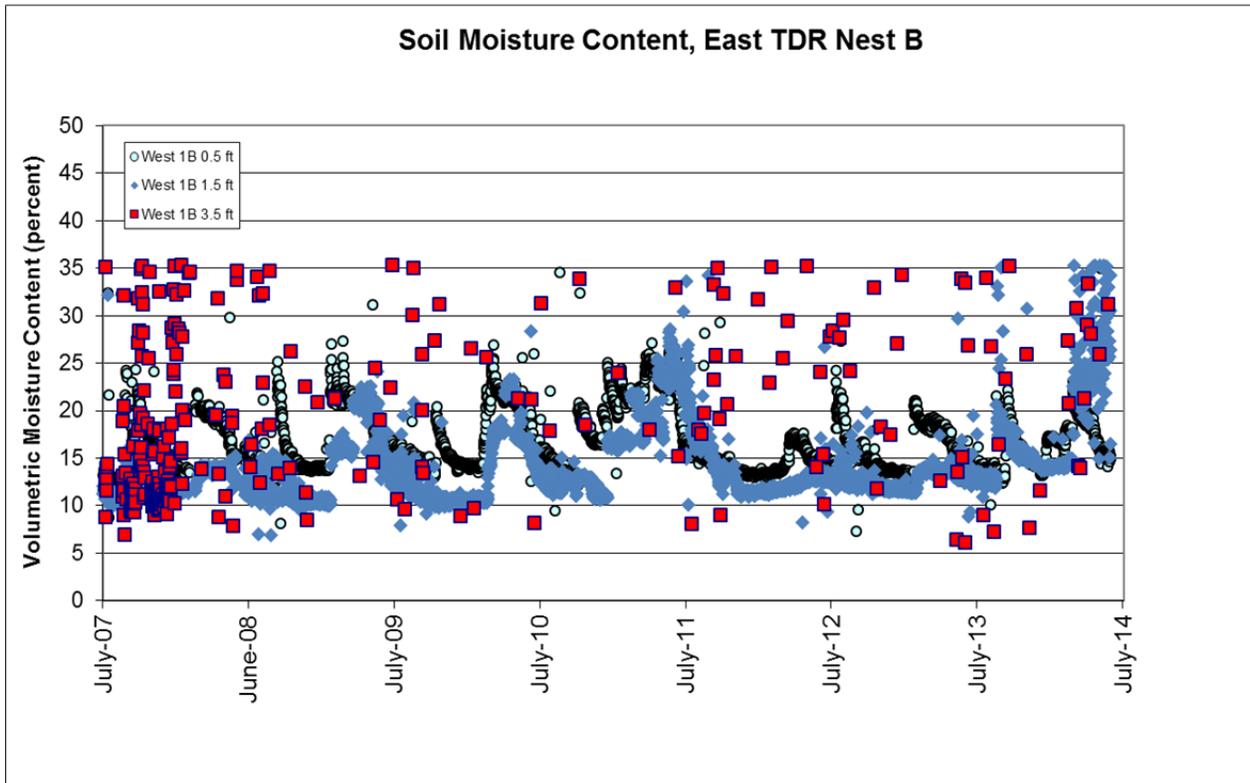


Figure B-3. July 2007 through July 2012 UC-1 Soil Moisture Content, East TDR Nest B

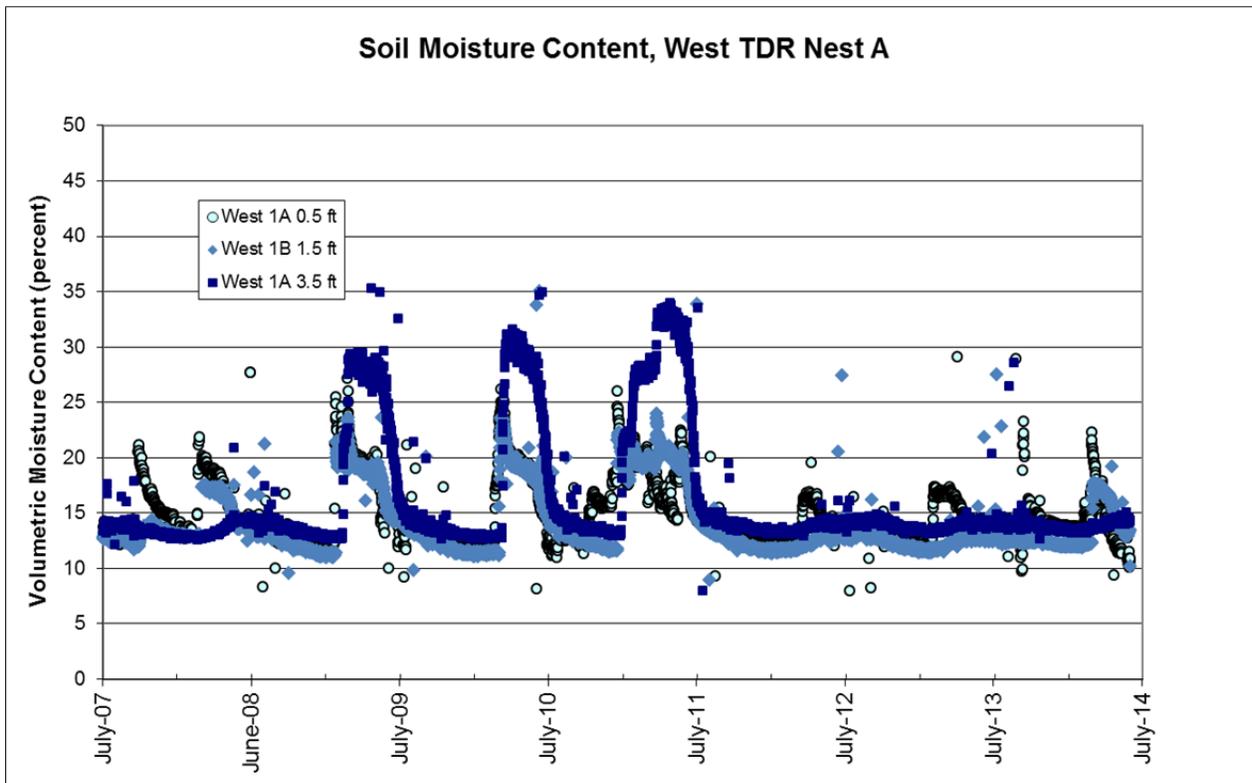


Figure B-4. July 2007 through July 2014 UC-1 Soil Moisture Content, West TDR Nest A

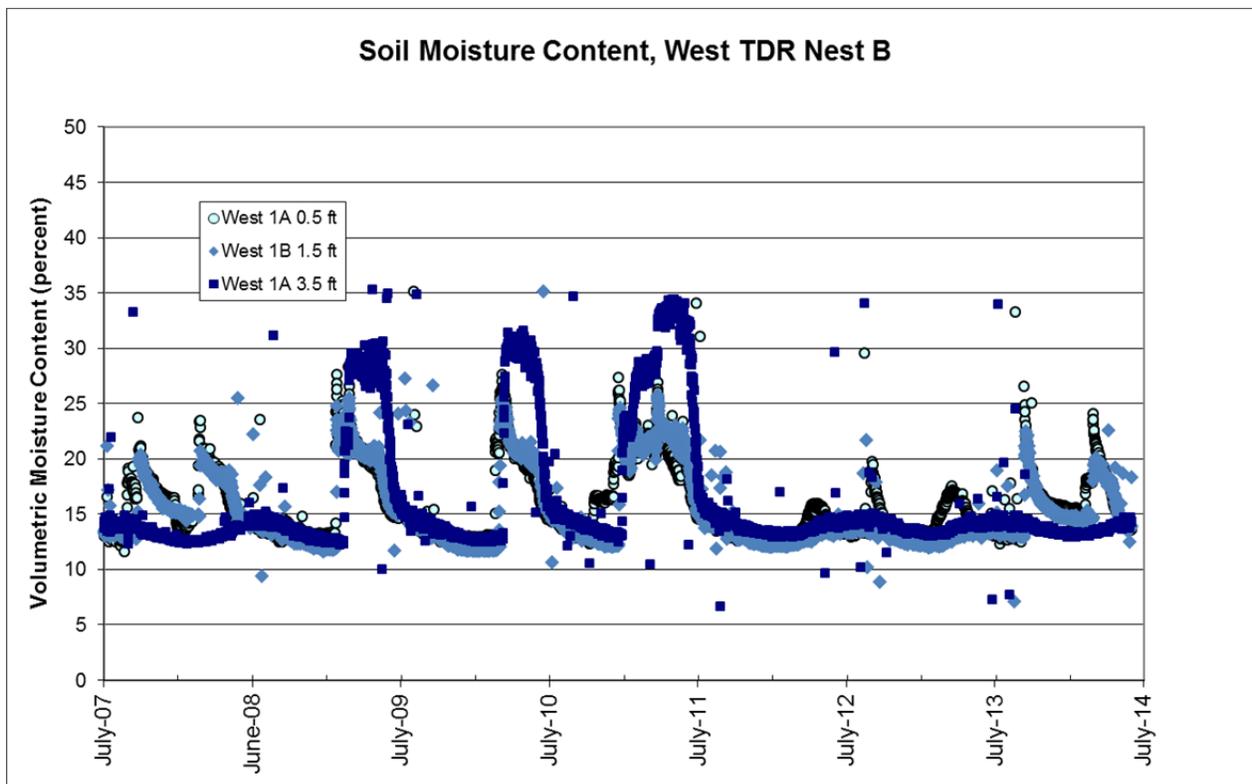


Figure B-5. July 2007 through July 2012 UC-1 Soil Moisture Content, West TDR Nest B

Appendix C

Vegetation Survey—2014

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Contents

C1.	Introduction and Purpose.....	C-1
C2.	Monitoring Methods.....	C-1
C3.	Results	C-2
C4.	Discussion	C-3
C5.	References	C-3
C6.	Photographs	C-5

Tables

Table C-1.	Plant Species Observed on the CMP Cover, CMP Perimeter, and Native Areas	C-2
Table C-2.	Comparison of Vegetation Data Collected at CMP Cover, CMP Perimeter, and Native Areas.....	C-2

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C1. Introduction and Purpose

The UC-1 Central Mud Pit (CMP) is located within the surface Corrective Action Unit 417 at the Central Nevada Test Area site in Hot Creek Valley, Nevada. The U.S. Department of Energy (DOE) Office of Environmental Management reclaimed the CMP in 2000 and 2001 by seeding the constructed soil cover with native species and planting 5,000 live plants. Because vegetation is an integral component of the design of the UC-1 CMP cover, post-closure requirements include periodic vegetation monitoring to assess the health and stability of the vegetation.

The CMP cover is approximately 2 hectares (5 acres) in size and is enclosed by a fence. The CMP cover is composed of a clean, vegetated soil layer installed over hydrocarbon-containing waste materials that were generated by drilling. Vegetation, through evapotranspiration, reduces storm-water infiltration and percolation through the cover. It also helps reduce wind and water erosion on the soil cover by reducing surface velocities. Approximately 1.5 hectares (3.7 acres) of additional land, the CMP perimeter area, was disturbed outside the fence during reclamation. This area, also seeded with native species in 2000, is included in monitoring along with a nearby undisturbed native area that is used as a comparison to assess the development of the reclaimed areas over time. In 2010, a separate soil and vegetation baseline characterization was performed at the UC-1 parcel (DOE 2011). The baseline was a best management practice and was not a post-closure requirement. Results of the baseline can also be used to assess the long-term development of vegetation in the reclaimed areas. In particular, the appearance of native species from the surrounding undisturbed areas in the revegetated areas is an indication of ecological development toward a mature, climax plant community.

Ecologists monitored the success of the revegetation effort periodically between 2001 and 2006 (Anderson 2005, 2006). In 2006, success criteria were met on the CMP cover and in the CMP perimeter area. Additional post-closure vegetation monitoring occurred in 2007, 2009, and 2012 (DOE 2008, 2009, and 2013). This report presents results of the most recent vegetation survey, which was conducted concurrently with the site inspection on July 16, 2014. The vegetation survey included an assessment of the revegetation of the monitoring well pads MV-2, MV-3, MV-4, and MV-5.

C2. Monitoring Methods

Ecologists have used semi-quantitative monitoring methods to assess vegetation health of the CMP cover since 2006, when vegetation success criteria were met. Field observations, including a list of plant species and a general assessment of plant health, are recorded for the CMP cover, for the CMP perimeter area, and for an undisturbed native area. Additionally, visual estimates of the foliar cover of all live plant species and the covers of litter (dead plant material), rock, and bare ground are recorded. A representative photograph of each area is taken for comparison with previous monitoring photos.

C3. Results

A list of plant species identified at and near the CMP is shown in Table C-1. Nomenclature follows the U.S. Department of Agriculture PLANTS Database (USDA 2014). A comparison of vegetation attributes between the three sampled areas (CMP cover, CMP perimeter, and the native area) is shown in Table C-2.

Table C-1. Plant Species Observed on the CMP Cover, CMP Perimeter, and Native Areas

Scientific Name	Common Name	CMP Cover	CMP Perimeter	Native Area ²
		Observed in 2014		
<i>Achnatherum hymenoides</i>	Indian ricegrass	x	x	
<i>Aristida purpurea</i>	Purple three-awn			x
<i>Artemisia tridentata</i>	Big sagebrush	x	x	x
<i>Aster</i> sp.	Aster		x	
<i>Atriplex canescens</i>	Fourwing saltbush	x		
<i>Bromus tectorum</i>	Cheatgrass	x		
<i>Descurainia pinnata</i>	Western tansymustard			x
<i>Elymus elymoides</i>	Bottlebrush squirreltail	x	x	x
<i>Ericameria nauseosa</i>	Rubber rabbitbrush	x	x	
<i>Gutierrezia microcephala</i>	Threadleaf snakeweed	x	x	x
<i>Halogeton glomeratus</i>	Halogeton	x	x	
<i>Hesperostipa comata</i>	Needle-and-thread			x
<i>Pleuraphis jamesii</i>	Galleta grass	x	x	x
<i>Sarcobatus vermiculatus</i>	Greasewood	x		
<i>Sisymbrium altissimum</i>	Tall tumbled mustard	x	x	

Table C-2. Comparison of Vegetation Data Collected at CMP Cover, CMP Perimeter, and Native Areas

Vegetation Attributes	CMP Cover Area	CMP Perimeter Area	Native Area ³
Total Foliar Cover	25%	20%	23%
Litter	15%	15%	9%
Rock	35%	30%	33%
Bare Ground	25%	35%	35%
Species Richness ⁴	11 species	10 species	6 species

Vegetation on the fenced CMP cover continues to be healthy and sustainable (Photograph 1). Total foliar cover averaged 25 percent and was dominated by rubber rabbitbrush, sagebrush, and threadleaf snakeweed. Secondary species included fourwing saltbush, galleta grass, Indian ricegrass, and bottlebrush squirreltail, all desirable species. The percentage of total foliar cover in the CMP cover area increased from the previous years. In comparison, values for total foliar

² Vegetation in the Native Area was not sampled in 2014; the species listed were observed in 2009 and 2012.

³ Vegetation attribute values in the Native Area were not collected in 2014; the values shown are averages of the values collected in 2009 and 2012.

⁴ "Species richness" is the number of distinct plant species observed.

cover in 2007, 2009, and 2012 were 18, 23, and 20 percent, respectively (DOE 2008, 2009, and 2013). The continued increase in total foliar cover further supports the success of the revegetation effort that was determined as having met the vegetation success criteria in 2006 (Anderson 2005, 2006).

Total foliar cover in the CMP perimeter area (Photograph 2), typically not as high as that inside the fenced area, was estimated at 20 percent. The same plants dominated the CMP perimeter area as dominated the CMP cover. As in previous years, the plants in the perimeter area showed signs of being grazed.

Total foliar cover in the native area⁵ (Photograph 3), estimated at 23 percent, was similar to that on the CMP cover and perimeter. However, the species richness value (6) was less than the values observed on the CMP cover (11) and perimeter areas (10) (Table C-2). Vegetation was dominated by sagebrush and galleta grass.

Inspectors also conducted revegetation assessments of monitoring well pads MV-2, MV-3, MV 4, and MV-5. Well pads MV-2 and MV-3 were reclaimed prior to 2009, whereas well pads MV-4 and MV-5 were reclaimed in November 2010. All revegetated well pads were stable, as no signs of active erosion were noted. Revegetation success was considered good on the two older pads, MV-2 and MV-3, which had plant covers of 20 and 23 percent, respectively. On MV-4, revegetation success was rated as fair (15 percent plant cover), and on MV-5, it was considered poor (5 percent plant cover). Inspectors noticed that the plants on MV-4 and MV-5 had been heavily grazed. Revegetation success is expected to improve with time on all the well pads.

C4. Discussion

In accordance with the success criterion established for the CMP, revegetation is considered successful when the total foliar cover equals or exceeds 70 percent of total foliar cover in the native, undisturbed area (Anderson 2005, 2006). This success criterion was met in 2006 and continued to be met or exceeded through 2012 (DOE 2008, 2009, and 2013). In 2014, estimated total foliar cover on the CMP was 109 percent of the native area, and total foliar cover in the CMP perimeter area was 87 percent of the native area, both exceeding the success criterion.

C5. References

Anderson, D., 2005. *Revegetation Success Monitoring, Corrective Action Unit 417 Central Nevada Test Area—Surface, Hot Creek Valley, Nevada*, included as Appendix to *Post-Closure Inspection and Monitoring Report for Corrective Action Unit 417: Central Nevada Test Area – Surface, Hot Creek Valley, Nevada For Calendar Year 2005*, DOE/NV-1122, U.S. Department of Energy, National Nuclear Security Administration, Nevada Site Office, April 2006.

⁵Because the native area was not sampled in 2014, data values are averages from those collected in 2009 and 2012.

Anderson, D., 2006. *Revegetation Success Monitoring, Central Nevada Test Area Corrective Action Unit 417*, included as Appendix C to *Draft Post-Closure Inspection and Monitoring Report for Corrective Action Unit 417: Central Nevada Test Area – Surface, Hot Creek Valley, Nevada*, DOE/NV/25946-168, U.S. Department of Energy, National Nuclear Security Administration, Nevada Site Office, April 2007.

DOE (U.S. Department of Energy), 2008. *Vegetation Monitoring Report, Appendix C of Post-Closure Inspection and Monitoring Report for Corrective Action Unit 417: Central Nevada Test Area Surface, Hot Creek Valley, Nevada, for Calendar Year 2007*, DOE-LM/1558-2007, September 2008.

DOE (U.S. Department of Energy), 2009. *2009 Revegetation Success Monitoring, Appendix C of Post-Closure Inspection and Monitoring Report for Corrective Action Unit 417: Central Nevada Test Area Surface, Hot Creek Valley, Nevada*, LMS/CNT/S05767, U.S. Department of Energy Office of Legacy Management, October.

DOE (U.S. Department of Energy), 2011. *Baseline Soil and Vegetation Characterization of the Central Nevada Test Area*, LMS/CNT/S07591, U.S. Department of Energy Office of Legacy Management, April.

DOE (U.S. Department of Energy), 2013. *Vegetation Survey—2012, Appendix C of Post-Closure Inspection and Monitoring Report for Corrective Action Unit 417: Central Nevada Test Area Surface, Hot Creek Valley, Nevada*, LMS/CNT/S09307, U.S. Department of Energy Office of Legacy Management, March.

USDA (U.S. Department of Agriculture), 2014. Natural Resources Conservation Service PLANTS Database, available online at <http://plants.usda.gov>, accessed on September 4, 2014.

C6. Photographs



Photograph 1. View southeast of CMP cover vegetation from northwest fence corner



Photograph 2. View east of CMP perimeter area along the north fence line

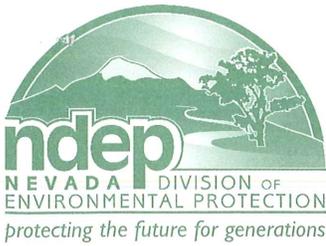


Photograph 3. View southwest of native area immediately north of the CMP cover (taken in 2009)

Appendix D

NDEP Correspondence and Record of Review

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STATE OF NEVADA
Department of Conservation & Natural Resources
DIVISION OF ENVIRONMENTAL PROTECTION

Brian Sandoval, Governor
Leo M. Drozdoff, P.E., Director
Colleen Cripps, Ph.D., Administrator

November 22, 2014

Mr. Mark Kautsky
Site Manager
U.S. Department of Energy
Office of Legacy Management
2597 B ³/₄ Road
Grand Junction, CO 81503



RE: Draft Post-Closure Inspection and Monitoring Report for Surface Corrective Action Unit 417 at the Central Nevada Test Area, Nevada Site
November 2014
Federal Facility Agreement and Consent Order

Dear Mr. Kautsky:

The Nevada Division of Environmental Protection, Bureau of Federal Facilities (NDEP) staff has received and reviewed the above-referenced report on the post-closure inspection and monitoring activities conducted at the Central Nevada Test Area during calendar years 2013 and 2014. The report was received in this office on November 6, 2014. The annual report was prepared in accordance with the Federal Facility Agreement and Consent Order (FFACO) and the Closure Report for Corrective Action Unit 417. While this letter does serve as a Notice of Completion for the November 6, 2014 milestone of the Draft Post-Closure Inspection Report for CAU 417: Central Nevada Test Area Surface, pursuant to Subpart XXV.1 of the FFACO, the NDEP has the following comment:

1. Page 16, Section 3.4.1, First paragraph, second sentence: In regards to this sentence, "Soil moisture contents greater than 36 percent are not displayed in Figure 13 through Figure 16 because they would indicate soil moisture contents greater than saturation." please refer the reader to the following paragraph (and possibly the third bullet of Section 4.2, Conclusions) which provides an explanation for the high soil moisture content measurements.

The NDEP concurs with the recommendations stated in Section 4.3 of the report. Please address any questions regarding this matter to Chris Andres at (702) 486-2850 ext. 232 or Mark McLane at ext. 226.



Mr. Mark Kautsky
Page 2 of 2
November 22, 2014

Sincerely,



Christine D. Andres
Chief
Bureau of Federal Facilities

ec: EM Records, AMEM, NNSA/NFO, Las Vegas, NV
Mark McLane, NDEP

cc: Jeffrey Fraher, DTRA/CXTS, Kirtland AFB, NM
J. B. Chapman, DRI, Las Vegas, NV
NSTec Technical Information Officer, Las Vegas, NV
FFACO Group, SNJV, Las Vegas, NV
EM Records, AMEM, NNSA/NFO, Las Vegas, NV
R. F. Boehlecke, NNSA/NFO, Las Vegas, NV
D. Crawford, Stoller, Grand Junction, CO
R. Hutton, Stoller, Grand Junction, CO
R. Findlay, Stoller, Grand Junction, CO

Record of Review

Due Date 1/6/15	Review No. 1	Project Offsites Legacy Management -CNTA	Type of Review Technical
Document Title and/or Number and Revision 2014 Post-Closure Inspection and Monitoring Report for Surface Corrective Action Unit 417 at the Central Nevada Test Area, Nevada, Site			Reviewers' Recommendation <input type="checkbox"/> Release Without Comment <input type="checkbox"/> Consider Comments <input checked="" type="checkbox"/> Resolve Comments and Reroute for Review <p style="text-align: right;">Refer to the NDEP letter dated November 22, 2014</p> <hr/> <p style="text-align: right;"><i>Signature of Reviewer and Date</i></p> <input checked="" type="checkbox"/> Comments Have Been Addressed <input checked="" type="checkbox"/> Comment Resolution Satisfactory <input type="checkbox"/> Comment Resolution Unsatisfactory
Author Mark Kautsky			
Author's Organization DOE - Office of Legacy Management		Author's Phone (970) 248-6018	
Reviewer Christine D. Andres			
Reviewer's Organization Nevada Division of Environmental Protection (NDEP)		Reviewer's Phone (702) 486-2850	
Digitally signed by Mark Kautsky Date: 2015.01.08 08:21:04 -07'00' <hr/> <i>Signature of Author and Date</i> Digitally signed by Christine D. Andres Date: 2015.01.08 11:18:15 -07'00' <hr/> <i>Signature of Reviewer and Date</i>			

Item No.	Reviewer's Comments and Recommendation	Reqd. (Y/N)	Item No.	Author's Response (if required)
1	Page 16, Section 3.4.1, First paragraph, second sentence: In regards to this sentence, "Soil moisture contents greater than 36 percent are not displayed in Figure 13 through Figure 16 because they would indicate soil moisture contents greater than saturation." please refer the reader to the following paragraph (and possibly the third bullet of Section 4.2, Conclusions) which provides an explanation for the high soil moisture content measurements.	Y	1	The following sentences were added after the second sentence of the first paragraph in Section 3.4.1. "Figure 13 and Figure 14 show that the soil moisture data from the two deepest TDRs in the east nest are erratic and discontinuous. It was recently determined that these data are corrupt. More information about this determination is presented in the "UC-1 East TDR Nest" subsection (immediately following Figure 16) and in Section 4.2. A full summary of the soil moisture data collected from the east and west nests is provided below."

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